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FINAL REPORT

DEVELOPMENT OF A

WEIGHT/SIZING DESIGN SYNTHESIS

COMPUTER PROGRAM

28 FEBRUARY 1973

MDC E0746

VOLUME II

PROGRAM DESCRIPTION

SUBMITTED TO
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

CONTRACT NAS 9-12989

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MCDONNELL DOUGLAS





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FOREWORD

The Weight/Sizing Design Synthesis Computer Program was developed by McDonnell Douglas Astronautics Company - East under Contract NAS 9-12989 for the National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Texas. The contract involved a study to derive basic weight estimation relationships for those elements of the Space Shuttle vehicle which contribute a significant portion of the inert weight. These relationships measure the pacing parameters of load, geometry, material, and environment. The weight estimation relationships are then combined into the Weight/Sizing Design Synthesis Computer Program.

This report is submitted in three volumes;

- | | |
|-----|---------------------|
| I | Program Formulation |
| II | Program Description |
| III | User Manual |

This Volume contains a listing for each module and subroutine of the program. Also included is a generalized flow chart describing the subroutine linkage of the complete program, plus detailed flow charts of each subprogram.



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ACKNOWLEDGEMENTS

The following McDonnell Douglas Astronautics Company - East personnel were the major contributors to the technical contents of this study.

L. M. Gnojewski/R. W. Ridenour	Program Coding/Assembly Integration
B. A. Grob	External Tank & Empirical Equations
J. J. Morgan	Wing
J. M. Garrison	Structure Models

The Technical Monitor for the National Aeronautics and Space Administration, Mr. Norman A. Piercy, of the Engineering Technology Branch, provided valuable guidance and direction throughout the study.



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2

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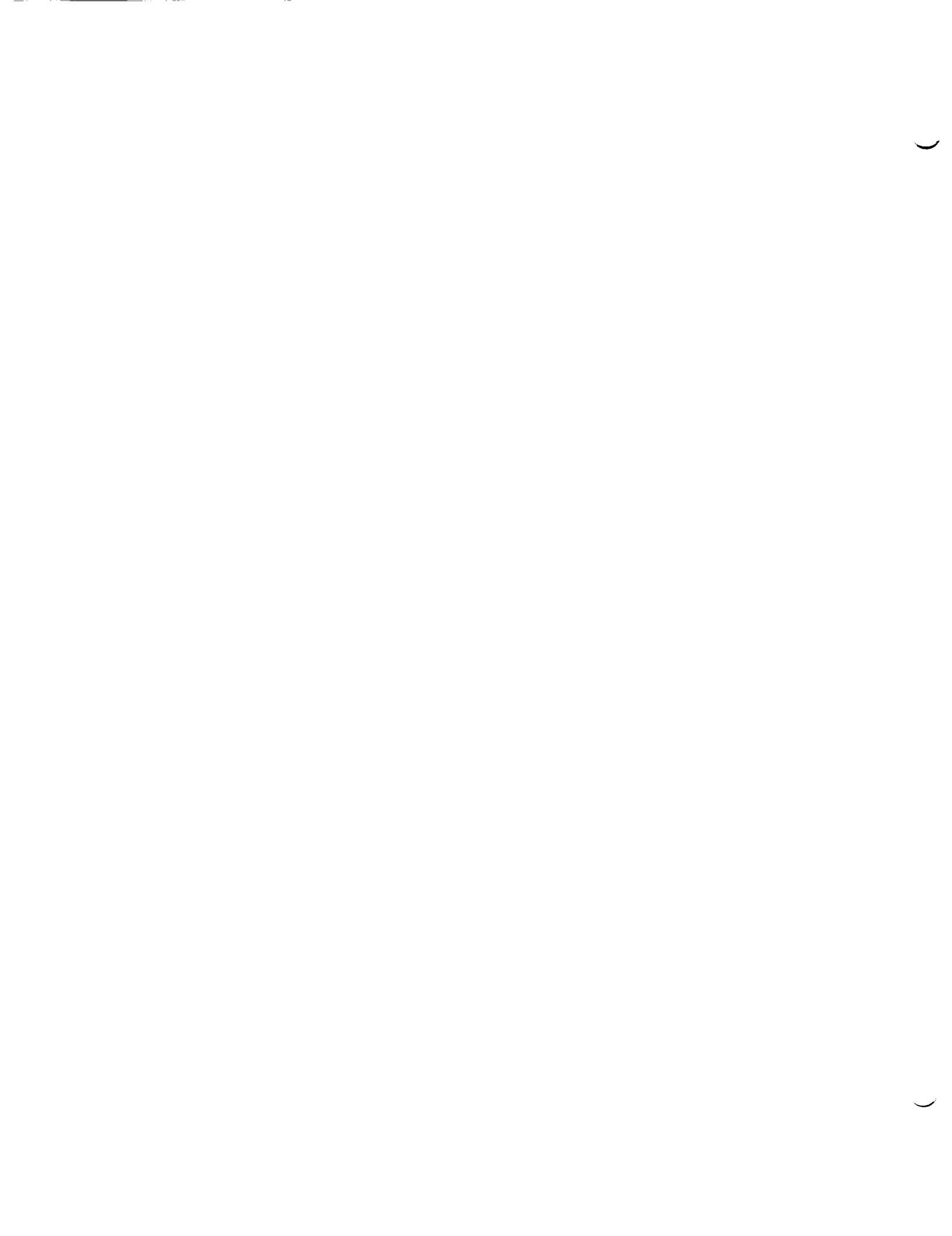
1. INTRODUCTION

The primary objective of this study was the development of a Weight/Sizing Design Synthesis Methodology to be used in support of the mainline Space Shuttle Program. This methodology has a minimum number of data inputs and quick turn around capabilities consistent with the objectives of enabling the NASA to rapidly: (a) make weight comparisons between the current Shuttle configuration and proposed changes, (b) determine the effects of various subsystem trade on total system weight, and (c) determine the effects of weight on performance and performance on weight. The Executive Sizing and Performance (ESPER) program is the culmination of this development effort.

The complete listing of the input and output variables, as well as a complete program description, are found in Volume I, Program Formulation, and again, along with usage instructions, in Volume III, The User Manual. The program listings in this volume are as they actually appear in ESPER. They are comprised of statements belonging to one of two general classes:

1. executable statements that perform computations, input/output operations, and program flow control.
2. nonexecutable statements that provide information to the compiler about storage assignments, data types, and program form, as well as providing information to the program and subroutines during execution about input/output formats and data initialization.

These programs differ considerably from those in Volume I in that they are not self-sustaining, but rather, they are totally dependent upon the iterative computational sequence in ESPER for their execution.



2. ESPER PROGRAM

The ESPER program is a multioption sizing/synthesis program geared to the Solid Rocket Motor (SRM) Booster in parallel with an external hydrogen/oxygen tank Orbiter for either the easterly (28-1/2 deg inclination) polar (90-deg inclination), or resupply (55-deg inclination) missions. Although these are the primary missions of current interest, the program will handle any mission falling within the inclination constraints of 28.5 deg to 90 deg as shown in Figure 2-7, Page 2-17 of Volume I.

The program has two primary options:

- (a) fixed hardware, and
- (b) iterative vehicle sizing.

The fixed hardware option determines the payload capability of a given configuration. This allows the user to determine the effect on performance of configuration and/or criteria changes, either real or proposed.

The iterative vehicle sizing option physically sizes the vehicles for a given payload. It determines the size of the SRM and its propellant load, and the size of the external tank and its corresponding propellant load. The iterative procedure is based on the sizing criteria of a fixed staging velocity or it will size the vehicle to a minimum gross lift off weight (GLOW). The minimum GLOW option is provided as it is generally associated with a minimum cost operation.

In turn, either of the sizing requirements can be run with a fixed thrust option in which both the booster and orbiter thrust are set at given values, and the propellant requirements are determined, or the orbiter thrust can be fixed and the first stage thrust-to-weight ratio input. The fixed thrust-to-weight options determines the booster engine size plus the propellant requirements.

Each of the vehicles has several modes of analysis available. The orbiter, external tank, and booster weight can be determined by the option of detail analysis, while maintaining a user input dry weight, or no analysis but simply utilizing an input weight to represent the vehicle. In addition, the external tank and the booster are represented by simplified equations in which the parameters of interest are curve-fit to determine the vehicle weight.

In addition to printing out the performance parameters, the option is available to print out the detail subsystems weights of each vehicle, providing a line item comparison with the current Shuttle vehicle. The other option would be a simplified printout, containing only the vehicle dry or burn out weight as listed in the performance parameter.

Two performance subroutines are tied into the ESPER programs to allow the user to determine growth characteristics or vehicle sensitivities.

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ESPER is fundamentally based on the control logic found in the Analytical Parametric Systems Evaluation (APSE) program delivered to NASA at ATP plus 6 weeks. APSE is primarily a multivehicle program in which many types of vehicles and configurations can be compared, i.e., fully reusable configuration, external hydrogen tank orbiter, pressure feed booster, series burn, as well as the current baseline solid rocket motor (SRM) booster with an external hydrogen/oxygen tank orbiter.

Inherent with the multivehicle concept are extremely simplified weight relations. The weight equations in APSE consisted primarily of mass fractions, with the booster being a function of thrust and propellant load, the orbiter a function of thrust, and the external tank a function of required propellant. These mass fractions were derived from study point designs, and required continual updating to meet the ever changing criteria. With ESPER being based on the current baseline vehicle, and the multivehicle studies dropped, the major emphasis of this study was directed to the expansion of the weight relationships.

Figure 2-1 presents a simplified flow chart of the ESPER program. The program consists of three vehicle modules, two functional modules, and three performance subroutines. The vehicle modules contain the analytical and empirical equations and relationships required to completely define the orbiter and booster,

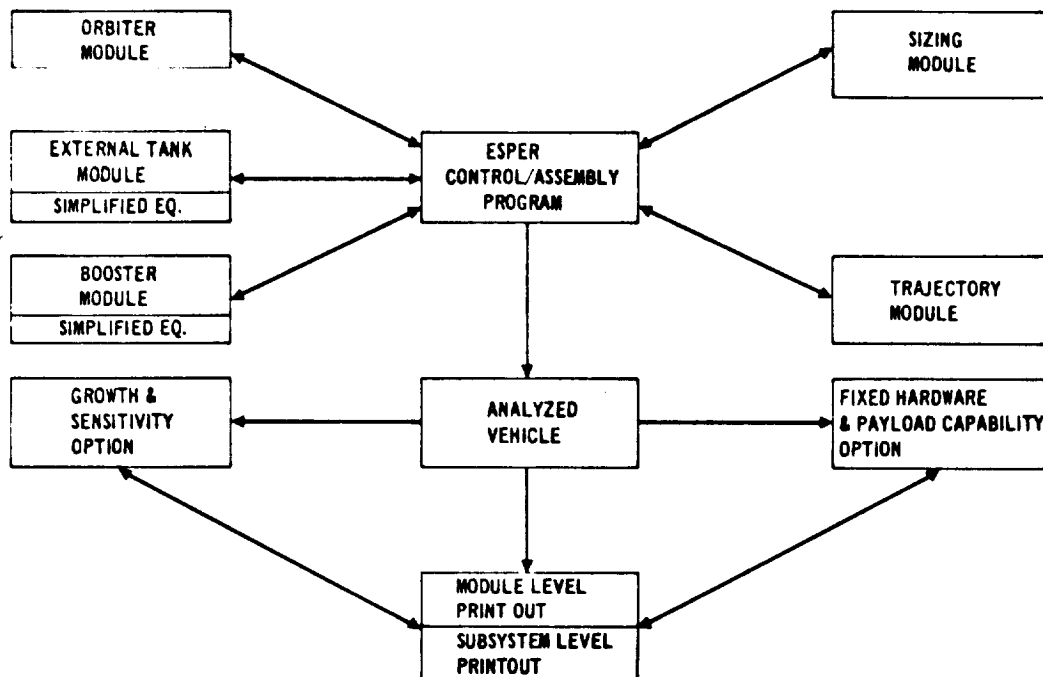


FIGURE 2-1 ESPER FLOW CHART

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and the external tank respectively. These equations will measure the pacing parameters of load, material, and geometry. The functional modules describe the vehicle sizing and the trajectory analysis. The output is an analyzed vehicle which, when coupled with the performance subroutines, will allow the user to derive growth accommodations, sensitivities, and payload capabilities. These modules and subroutines operate under the logic and direction of the Control/Assembly program. This program, in essence the heart of ESPER, integrates the vehicle modules and combines them in an iterative sequence for the orbiter, external tank, and booster. This iterative sequence, however, is under the complete control of the user and is altered according to the option specified by the user in the 'PERF' (Performance) data block. The use of separate modules, which contain their own input/output common blocks, provide a systematic means of controlling the logic flow in the programs. The ESPER Control/Assembly logic is shown in the flow diagram, Figure 2-2, which is followed by a listing of this program.

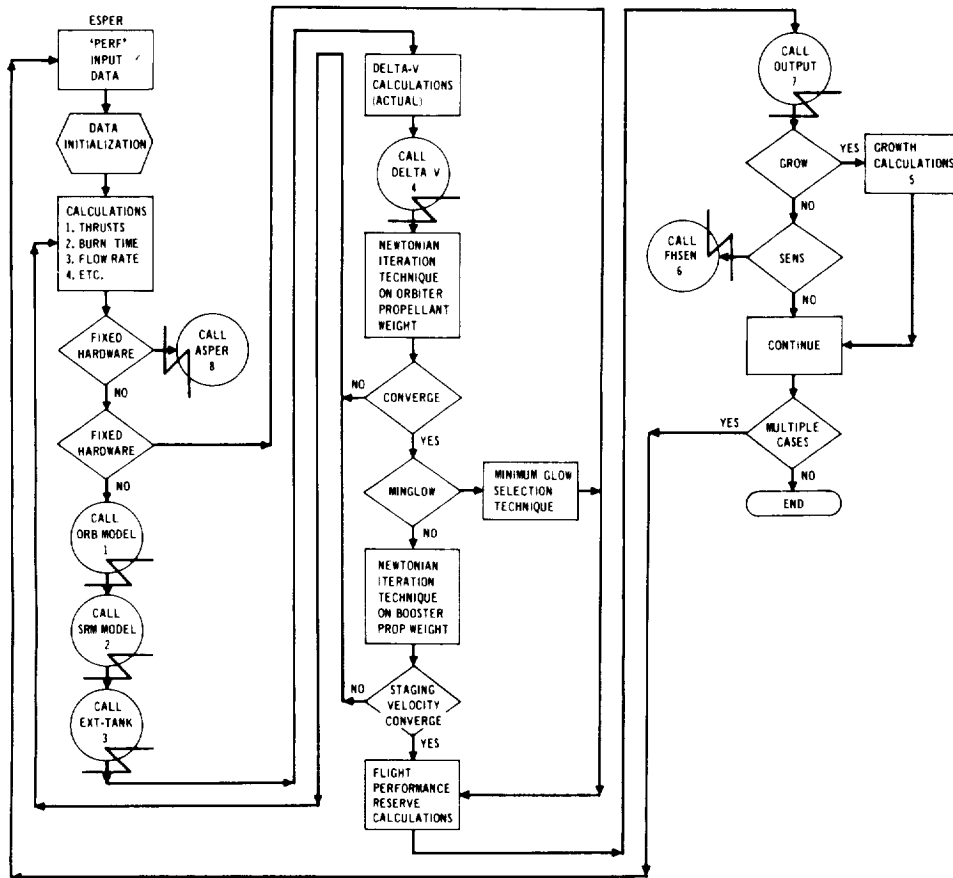


FIGURE 2-2 ESPER FLOW DIAGRAM

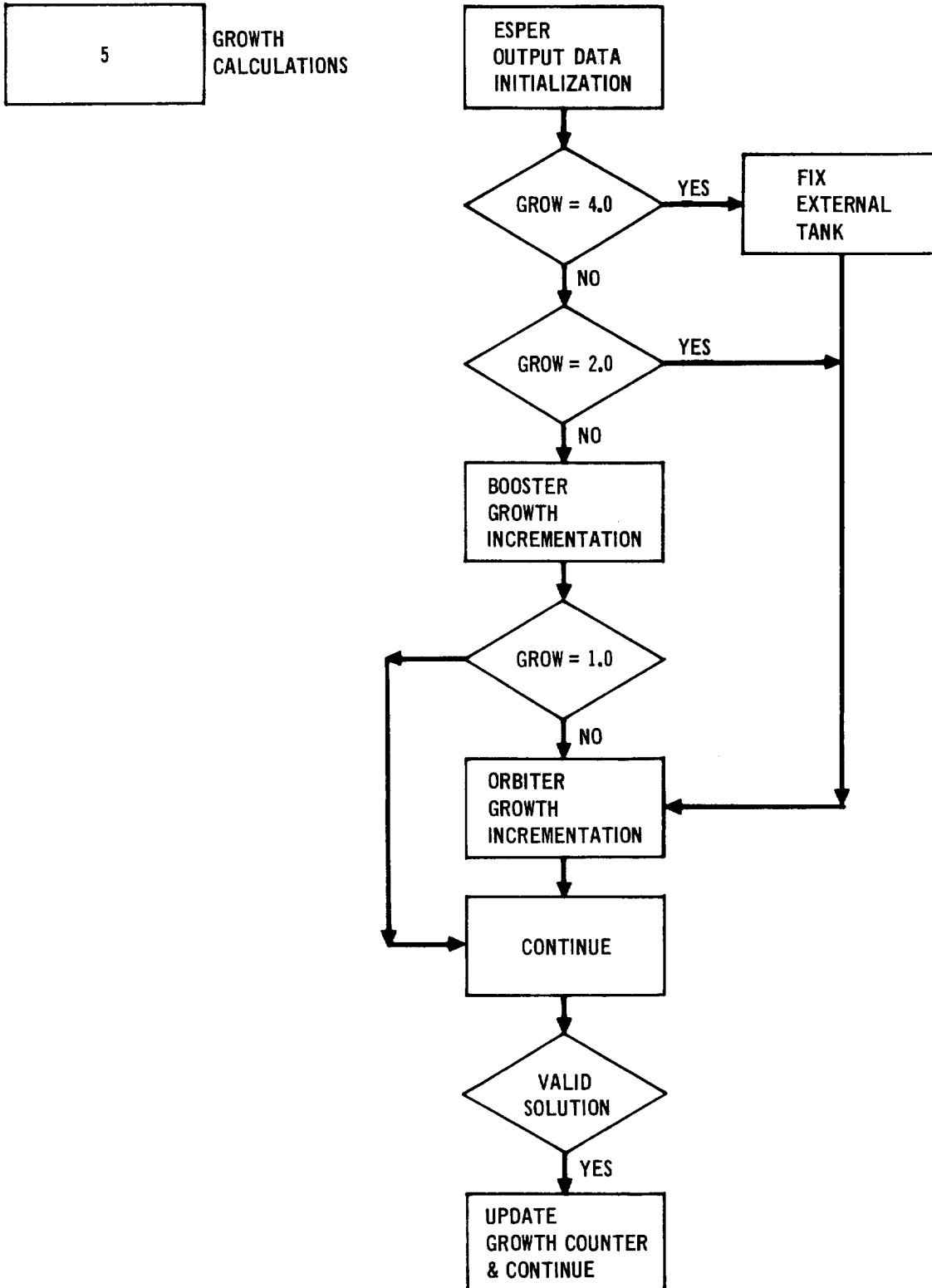


FIGURE 2-2 ESPER FLOW DIAGRAM (Continued)

To facilitate rapid turnaround and ease of updating for major configuration changes, the modularized concept was utilized. The vehicle modules are comprised of data files and subsystem models.

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These data files are as follows:

1. ØRB & ØAERØ - ORBITER MODULE DATA
2. EXT - EXTERNAL TANK MODULE DATA
3. SRM - SRM MODULE DATA

Collectively separating the data in this fashion serves two purposes, (1) it greatly facilitates the locating and changing of input parameters, (2) if an entire module is replaced it becomes an easy task to replace the existing data block with the new one.

Linkage of data between the vehicle modules and their subsystem models is accomplished through named common blocks ending in the letter 'D' (for example, 'STRD,' where 'STR' designates the model into which the data is to be transferred, and 'D' designates a Data common). Parameters calculated in each model are in turn linked back to their respective module through argument lists. These calculated module parameters are linked to the rest of the main program through named common blocks ending in the letter 'O' (for example, 'SRMO,' where 'SRM' designates the module in which they were generated, and 'O' designates an Output common).

The entire Formulation Concept of ESPER, that is, utilizing modularization, utilizing subsystem models, collectively separating data and common block linkage, elevates ESPER from just another sizing program to a dynamically powerful tool that can evolve in complexity with the mainline Shuttle program, thus averting the pitfall of obsolescence.

This Formulation Concept makes the evolution process by the user an easy task, for subsystem modifications can be made without affecting the rest of the module, and module replacement can be accomplished without affecting the rest of the program. The user needs only to program the new module or subsystem, correct the common linkage and proper functioning is insured.

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8	-	8.000 C
9	-	9.000 C
10	-	10.000 C
11	-	11.000 C
12	-	12.000 C
13	-	13.000 C
14	-	14.000 C
15	-	15.000 C
16	-	16.000 C
17	-	17.000 C
18	-	18.000 C
19	-	19.000 C
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39	-	39.000 C
40	-	40.000 C
41	-	41.000 C
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47	-	47.000 C
48	-	48.000 C
49	-	49.000 C
50	-	50.000 C
51	-	51.000 C
52	-	52.000 C
53	-	53.000 C
54	-	54.000 C
55	-	55.000 C
56	-	56.000 C
57	-	57.000 C
58	-	58.000 C
59	-	59.000 C

ESPER

THIS PROGRAM INTEGRATES THE VEHICLE MODULES AND
COMBINES THEM IN AN ITERATIVE COMPUTATIONAL SEQUENCE
FOR THE ORBITER, EXTERNAL TANK, AND SRM, THE SPECIFIC

WEIGHT RELATIONSHIPS DEVELOPED FOR EACH VEHICLE MODULE
AND THE ASCENT TRAJECTORY CURVE FIT OF VELOCITY LOSSES
FEED INTO THIS CONTROL/ASSEMBLY PROGRAM.

IMPLICIT REAL (A-Z)
DIMENSION BDVC(3), SDVC(3), PRB(3), PRS(3)
DIMENSION MGSL(2), MGQVR(2)

INTEGER J, NI

PERFORMANCE COMMON BLOCK

COMMON/MAIN/ PRSP3, PRSPB, RTT, BCANT, BCANT, BCANT
1, BCANT, NGENR, NGENG9, THBSL, THSSL, THOV, TGV, FLOWR

2, TF, FTW, FIXHRD

3, ISPBS, ISPBV, ISP93S, ISP93V, SCD, BTW

4, H, DVCRR, INC, STAGV, DVCBN, DVCNST

5, REL, THRC, THSLT, THSTC, ISPB, ISPB, PRSP3T

6, PRSPB1, PRSPB2, FW(2), DVANC, DVB, DVTSTC, WSCD, QINVT, BLANWT

7, QINVT, QLVWT, QGL9W, QGL9W, TGTAL, S, P, MATCH, TLSSR, PRSP

8, QMLD, QLLPL9, QL9L8, QMSISP, QMSDVT, QMSDVP, QMR

9, LQNGP, TQ9, TQWB, SENS, Q99W, MINGLW

SRM OUTPUT COMMON BLOCK

COMMON/SRMS/PR9WT, PDRYWT, RGL9W, LAMB, PW91

1, WASSRM, WCASE, WJ9INT, WNBZZ, WTTT, WINST, WIGN, BSRMC

2, SRMISS, PWFS, PWASLS, PWAS, PWNF, PWTN, PWAV, WNCTPS, SRMIC

3, WRECRV, PPAR, PWPI, PWRR, PWRP, PWR, SRMRC

4, UNCERT, EYPINS, B9SLUN, SRML, SRMD

5, PGR9SS, PR9WT, PR9PB, PDRYWT, P99SLJ

6, FIX999, SIMPR9

ORBITER OUTPUT COMMON BLOCK

COMMON/ORR/R1, R2, RL, WTAJX, WTACS, ACSENG, ACSSYS, WTACTK

1, ACSMD, WT9MS, QMSENG, PR9PSY, WT9MTK, M9DJLE

1, SURFC, PPAR, ELEC, HYDR, AVI9V9, ECLS9, PPR9V, QUNCWT

2, Q99MS, TABPR9, SURFK

1, P999N, QRES9, QRESV, PL9ADU, PL9ADD, ACSPR9, W99PR9, SUDLE

2, FIX999, FIX999, Q99WT, Q99FL

1, WWT, WSG, W99STR, W99RBE, W99RRC, LEW, WTE, WAIL, WAS, WADR, WAW

2, WAP, W99BV, PWINGK, TAIL, TSG, T99STR, T99R99, TLE, WRUD, WRS

3, W99R, WRH, WRP, P99TLK

1, G37, G1, G2, G3, G6, G7, G8, G9, G10, G11, G12, G15, G16

2, G17, G18, G19, G22, G23, G24, G25, G26, G27, G32, G33, G34

3, G35, G36

1, T99TPS, T99GWT, W99WT, W99LEWT, TWT, TLEWT, BL9TPS

2, BASEWT, INTWT, PTPSCN, TTWT, BT99WT, MCSWT, LDTWT

3, P99WT, P99PC, P99YC, SCWT

1, TAP999, EN9PAC, EN9, TVC, C99TR, P99UTL, P99SYS

2, FAD, PRES, CHIL, PREVAL, FEEDS, DISC, MISC

1, LND99, NG1, NG2, NG3, NGEAR, M31, M32, M33, MGEAR, AX1, AX2

2, AX3, AXGEAR, LND99

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60	-	60.000	C	
61	-	61.000	C	EXTERNAL TANK OUTPUT COMMON BLOCK
62	-	62.000	C	
63	-	63.000		COMMON/EXT9/39DGR2,T9TPS,FWDTK,FAIRT,FWDBLF,FCCTPS
64	-	64.000		1,C9NSCT,TPSIN,CYLSCT,ACYDM,AFTRLF,WINT,PROSY,AFTNK
65	-	65.000		2,FE7SYS,FWDBLA,PRSVNT,AFTCYL,SUMP,AFTBLA,PNPJ,TWINT
66	-	66.000		3,N9SFAR,AVIBNT,JM3PNL,WRETRB,TUNNEL,MISCT,BAFF,SJ3DRY
67	-	67.000		4,GU,DRYWT,RESIDT,JNDRAN,FEEDTR,PRSJRT,FBIAS,INERT
68	-	68.000		5,GR9SSW,TLAMB,9TRAP,EXTL,EXTD,9LKH2,EXTH0,EXTH4,SIMPTK
69	-	69.000	C	
70	-	70.000	C	DELTA V OUTPUT COMMON BLOCK
71	-	71.000	C	
72	-	72.000		COMMON/DVA/DVT,DVAN,DVR,DVRR,DVBRP,X2,X3
73	-	73.000		1,DVFR,TTSLSS,DV9VR,DVALT
74	-	74.000	C	
75	-	75.000	C	PERFORMANCE (PERF) INPUT DATA BLOCK
76	-	76.000	C	
77	-	77.000		NAMELIST PROPRG,PR9P93,BCANT,BCANTY,BCANTP
78	-	78.000		1,N9ENGR,N9ENGR,TH9SL,TH9SL,T98VI
79	-	79.000		2,TF,FTW,FXHRD,ISP9S
80	-	80.000		3,ISP9V,ISP9BS,ISP9BV,SCD,BTW
81	-	81.000		4,H,DVCR9,INC,STAGV,REL,DVCON,DVCONST
82	-	82.000		5,DRYWT,RR9WT,9LL9LB,INERT,MATCH,TLSSR
83	-	83.000		6,DRYWT,RESIDT,MR,9MSISP,9MSDVT,9MSDVP,9MR
84	-	84.000		7,SENS,GR9,NI,GR949,GR9WB,L9NGP,MINGLW
85	-	85.000	C	
86	-	86.000		CALL E9FSET(99995)
87	-	87.000		F=0.0
88	-	88.000		PIN=0.0
89	-	89.000	1	INPUT(1)
90	-	90.000		IF(F.EQ.0.0) T9V=TH9VI
91	-	91.000		TH9V=T9V
92	-	92.000		PIN1=PR9P93
93	-	93.000		PIN2=PR9P93
94	-	94.000		BCANT=1.0
95	-	95.000		9GL9W=1000000.
96	-	96.000		9LANWT=100000.
97	-	97.000		9L9WT=100000.
98	-	98.000		9L9WLB=100000.
99	-	99.000		TH9SL=2000000.
100	-	100.000		P=0.0
101	-	101.000		J=1
102	-	102.000		M9=0.0
103	-	103.000		M9DV8(1)=0.0
104	-	104.000		M9DV8(2)=0.0
105	-	105.000		M9GL(1)=0.0
106	-	106.000		M9GL(2)=40000000.
107	-	107.000	10	PR9(2)=0.0
108	-	108.000		PR9(3)=0.0
109	-	109.000		PR9(2)=0.0
110	-	110.000		PR9(3)=0.0
111	-	111.000		9DVC(2)=0.0
112	-	112.000		9DVC(3)=0.0
113	-	113.000		9DVC(2)=0.0
114	-	114.000		9DVC(3)=0.0
115	-	115.000		IF(PIN.GT.0.0) PR9P93=PIN1
116	-	116.000		IF(PIN.GT.0.0) PR9P93=PIN2
117	-	117.000		IF(M9.EQ.1.0) STAGV=M9DV8(2)
118	-	118.000		IF(99SW.GT.0.0.AND.J.GT.1) G9 T0 2
119	-	119.000		IF(FIXHRD.EQ.0.0) BRT=100.
120	-	120.000		PR9P93=PR9P93

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121 - 121.000 2 IF (GRBW.EQ.4. AND .J.GT.1) GO TO 3
122 - 122.000 PR9P9=PR9P9G
123 - 123.000 3 IF (GRBW.EQ.4. AND .J.GT.1) PR9P8=PR9P8T
124 - 124.000 PR9(1)=PR9P8
125 - 125.000 PR9(1)=PR9P8
126 - 126.000 VALID=50000.
127 - 127.000 N=0.0
128 - 128.000 S=0.0
129 - 129.000 IE(BCANT.GT.1.0) GO TO 20
130 - 130.000 IF (NBENG9.EQ.3.0) CT49V=(TH9V+TH9V*2.
131 - 131.000 1+C9S(BCANTY/57.2958))/NBENG9
132 - 132.000 IF (NBENG9.NE.3.0) CT49V=TH9V*C9S(BCANTY/57.2958)
133 - 133.000 IF (BCANTP.GT.0.0) CT49SL=(CT49V*C9S(BCANTP/57.2958))*
134 - 134.000 1(ISP98S/ISP98V)
135 - 135.000 TH9V=CT49V
136 - 136.000 TH9SL=CT49SL
137 - 137.000 BCANT=BCANT+1.0
138 - 138.000 IF (GRBW.LE.3.0 AND .J.GT.1) GO TO 12
139 - 139.000 TH9SLC=TH9SL*C9S(BCANT/57.2958)
140 - 140.000 12 TH9TC=TH9V*NBENG9
141 - 141.000 FL9WR=TRV/ISP99V
142 - 142.000 9FL9WX=FL9WR/(1.+MR)
143 - 143.000 9FL9WY=(FL9WR*MR)/(1.+MR)
144 - 144.000 FSTART=3.2550*9FL9WX
145 - 145.000 9START=2.7912*9FL9WY
146 - 146.000 9HOLD=FSTART+9START
147 - 147.000 20 IF (FIXHRD.GT.0.0) CALL ASPER
148 - 148.000 IF (FIXHRD.GT.0.0) GO TO 100
149 - 149.000 PR9P91=BBT*FL9WR*NBENG9
150 - 150.000 PR9P9T=PR9P8+PR9P91
151 - 151.000 ISP9=(PR9P9+ISP9V+PR9P91*ISP9BV)/PR9PBT
152 - 152.000 ISP9=ISP99V
153 - 153.000 IF (GRBW.GE.2.0 AND .J.GT.1) GO TO 21
154 - 154.000 CALL BRMMODEL
155 - 155.000 21 IF (FIX9RB.GT.0.0) GO TO 4
156 - 156.000 PR9P9T=PR9P8+PR9P91
157 - 157.000 PR9P91=PR9P01
158 - 158.000 PR9P92=PR9P9
159 - 159.000 GO TO 5
160 - 160.000 4 PR9P9T=PR9P9
161 - 161.000 PR9P91=PR9P91
162 - 162.000 PR9P92=PR9P9T-PR9P91
163 - 163.000 5 IF (S.GT.0.0 AND .N.EQ.3.) GO TO 6
164 - 164.000 CALL BRMMODEL
165 - 165.000 6 CALL EXTANK
166 - 166.000 9GL9W=9GL9WT+PR9P9T+INERT
167 - 167.000 9GL9V=9GL9W+9GL9W
168 - 168.000 TH9AL=9GL9W+9HOLD
169 - 169.000 W9SCD=9GL9W/SCD
170 - 170.000 IF (FT.GT.0.0) GO TO 7
171 - 171.000 IF (GRBW.LE.3.0 AND .J.GT.1) GO TO 13
172 - 172.000 TH9TC=(TH9SLC*NBENG9)+(NBENG9*TH9SL)
173 - 173.000 TH9SL1=TH9SL*NBENG9
174 - 174.000 BBT=(PR9P9+ISP9S)/(TH9SL*NBENG9)
175 - 175.000 GO TO 8
176 - 176.000 7 TH9TC=BTW*9GL9W
177 - 177.000 TH9SL1=(TH9TC-(NBENG9*TH9SL))/C9S(BCANT/57.2958)
178 - 178.000 BBT=(PR9P9+ISP9S)/TH9SL1
179 - 179.000 8 IF (TF.NE.0.0) BBT=BBT/TF
180 - 180.000 13 T9WR=TH9TC/(9GL9W-PR9P91)
181 - 181.000 T9WB=TH9TC/9GL9W
  
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182	-	182.000	IF(FT.GT.0.0) T9=BTW
183	-	183.000	DVR=32.174*ISPR*AL9G(3L9W/(3L9W-PR9PBT))
184	-	184.000	DV9NC=32.174*JS29*AL93((3L9W-PR9PBT)/
185	-	185.000	1(4GL9/-PR9PBT))
186	-	186.000	DVT3TC=DVB+DV9NC
187	-	187.000	FW(1)=T9WB
188	-	188.000	FW(2)=T9WB
189	-	189.000	CALL DELTAV
190	-	190.000	S=S+1.0
191	-	191.000	P=P.0
192	-	192.000	IF(FIX999.GT.0.0) G8 T9 97
193	-	193.000	C
194	-	194.000	C ESPER ITERATION TECHNIQUE
195	-	195.000	C
196	-	196.000	C ARBITER ITERATION
197	-	197.000	C
198	-	198.000	9DVC(1)=DV9NC
199	-	199.000	TVALID=DV9NR-DV9NC
200	-	200.000	IF((DV9NR-DV9NC).GT.5000.) PR9P9G=PR9P9G+50000.
201	-	201.000	IF((DV9NR-DV9NC).GT.5000.) PR9P9G=PR9P9G+10000.
202	-	202.000	IF((DV9NR-DV9NC).GT.5000.) G9 T8 10
203	-	203.000	IF(ABS(DV9NR-DV9NC).LT.1.) G9 T9 50
204	-	204.000	IF(VALID.LT.0.0) G9 T9 52
205	-	205.000	IF(VALID.LT.TVALID) G9 T9 50
206	-	206.000	52 BRACK1=(DV9NR-9DVC(1))/(9DVC(1)-9DVC(2))
207	-	207.000	BRACK2=(PR9(1)-PR9(2))/(9DVC(1)-9DVC(2))
208	-	208.000	BRACK3=(PR9(2)-PR9(3))/(9DVC(2)-9DVC(3))
209	-	209.000	PR9P9=PR9(1)+(PR9(1)-PR9(2))*BRACK1
210	-	210.000	K+(((DV9NR-9DVC(1))*(DV9NR-9DVC(2)))/(9DVC(1)-9DVC(3)))
211	-	211.000	K*(BRACK2-BRACK3)
212	-	212.000	IF(PR9P9.LE.0.0) PR9P9G=PR9P9G+50000.
213	-	213.000	IF(PR9P9.LE.0.0) G9 T9 10
214	-	214.000	PR9(3)=PR9(2)
215	-	215.000	PR9(2)=PR9(1)
216	-	216.000	9DVC(3)=9DVC(2)
217	-	217.000	9DVC(2)=9DVC(1)
218	-	218.000	PR9(1)=PR9P9
219	-	219.000	VALID=TVALID
220	-	220.000	N=9.
221	-	221.000	IF(FIX999.GT.0.0) G8 T9 57
222	-	222.000	IF(REL.EQ.0.0.AND.DVB.LT.(STAGV-50.)) G9 T9 50
223	-	223.000	IF(REL.EQ.1.0.AND.DVBRP.LT.(STAGV-50.)) G8 T8 50
224	-	224.000	57 G9 T9 20
225	-	225.000	C THE SELECTOR 'STAGV' ENABLES THE USER TO CHOOSE THE
226	-	226.000	C STAGING VELOCITY HE WISHES THE PROBLEM TO BE SOLVED
227	-	227.000	C F99
228	-	228.000	50 IF(FIX999.GT.0.0) G9 T9 100
229	-	229.000	C
230	-	230.000	C SRM ITERATION
231	-	231.000	C
232	-	232.000	IF(MINGLW.EQ.0.0) G8 T9 15
233	-	233.000	IF(MG.EQ.1.0) G9 T9 15
234	-	234.000	IF(VALID.LT.TVALID) G9 T9 15
235	-	235.000	IF(ABS(DV9NR-DV9NC).GT.1.) G9 T8 15
236	-	236.000	M3GL(1)=GL9W
237	-	237.000	M3DVB(1)=DVB
238	-	238.000	IF(REL.GT.0.0) M3DVB(1)=DVBRP
239	-	239.000	IF(M3GL(1).GT.M3GL(2)) M3=1.0
240	-	240.000	IF(M3GL(1).GT.M3GL(2)) G8 T8 10
241	-	241.000	M3GL(2)=M3GL(1)
242	-	242.000	M3DVB(2)=M3DVB(1)

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243 -	243.000	15	IF (REL.GT.0.0) G9 T9 55
244 -	244.000		IF (ABS(DVB-STAGV).LT.1.) G9 T9 100
245 -	245.000		BDVC(1)=DVB
246 -	246.000		G9 T9 55
247 -	247.000	55	IF (ABS(DVBRP-STAGV).LT.1.) G9 T9 100
248 -	248.000		BDVC(1)=DVBRP
249 -	249.000	56	BRACK1=(STAGV-BDVC(1))/(BDVC(1)-BDVC(2))
250 -	250.000		BRACK2=(PR3(1)-PR3(2))/(BDVC(1)-BDVC(2))
251 -	251.000		BRACK3=(PR3(2)-PR3(3))/(BDVC(2)-BDVC(3))
252 -	252.000		PR9P3=PR3(1)+(PR3(1)-PR3(2))*BRACK1
253 -	253.000		1+(((STAGV-BDVC(1))*(STAGV-BDVC(2)))/(BDVC(1)-BDVC(3)))
254 -	254.000		2*(BRACK2-BRACK3)
255 -	255.000		IF (PR9P3.LE.0.0) PR9P3G=PR9P3G+50000.
256 -	256.000		IF (PR9P3.LE.0.0) G9 T9 10
257 -	257.000		PR3(3)=PR3(2)
258 -	258.000		PR3(2)=PR3(1)
259 -	259.000		BDVC(3)=BDVC(2)
260 -	260.000		BDVC(2)=BDVC(1)
261 -	261.000		PR3(1)=PR9P3
262 -	262.000		BDVC(2)=0.0
263 -	263.000		BDVC(3)=0.0
264 -	264.000		PR3(2)=0.0
265 -	265.000		PR3(3)=0.0
266 -	266.000		PR9P3G=PR9P3G
267 -	267.000		PR3(1)=PR9P3
268 -	268.000		VALID=50000.
269 -	269.000		N=10.
270 -	270.000		G9 T9 98
271 -	271.000	97	IF (ABS(DVT-DVT9TC).LT.1.) G9 T9 100
272 -	272.000		BDVC(1)=DVT9TC
273 -	273.000		BRACK1=(DVT-BDVC(1))/(BDVC(1)-BDVC(2))
274 -	274.000		PR9P3=PR3(1)+(PR3(1)-PR3(2))*BRACK1
275 -	275.000		IF (PR9P3.LE.0.0) PR9P3G=PR9P3G+50000.
276 -	276.000		IF (PR9P3.LE.0.0) G9 T9 10
277 -	277.000		PR3(2)=PR3(1)
278 -	278.000		BDVC(2)=BDVC(1)
279 -	279.000		PR3(1)=PR9P3
280 -	280.000	98	G9 T9 20
281 -	281.000	C	FLIGHT PERFORMANCE RESERVE CALCULATIONS
282 -	282.000	100	W9PFR=9LLPL9+PL9ADU+W9PR9P+INERT
283 -	283.000		W9PFR=W9PFR*EXP(DV9PFR/(32.174*ISP9))
284 -	284.000		FP9P=W9PFR-W9PFR
285 -	285.000		IF (GR9W.GT.0.0.AND.J.GT.1) G9 T9 400
286 -	286.000		CALL 9UTPUT
287 -	287.000		IF (GR9W.GT.0.0) G9 T9 400
288 -	288.000		IF (SENS.EQ.0.0) G9 T9 110
289 -	289.000		IF (SENS.GT.0.0.AND.FIXHRD.NE.1.0) CALL ASPER
290 -	290.000		CALL F4SEN
291 -	291.000		G9 T9 110
292 -	292.000	C	
293 -	293.000	C	GROWTH OPTION CALCULATIONS
294 -	294.000	C	
295 -	295.000	400	IF (J.GT.1) G9 T9 447
296 -	296.000		WRITE(108,1130)
297 -	297.000		WRITE(108,1140)
298 -	298.000		IF (GR9W.EQ.1.0) WRITE(108,1042)
299 -	299.000		IF (GR9W.EQ.2.0) WRITE(108,1044)
300 -	300.000		IF (GR9W.EQ.3.0) WRITE(108,1046)
301 -	301.000		IF (GR9W.EQ.4.0) WRITE(108,1048)
302 -	302.000		IF (GR9W.EQ.4.0) WRITE(108,1049)
303 -	303.000		IF (GR9W.EQ.4.0) G9 T9 441

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304 -	304.000		WRITE(108,1150)
305 -	305.000	441	IF(J.EQ.1) G9 T9 445
306 -	306.000	447	IF(GRW.EQ.4.0) WRITE(108,1150) PCENT,BGLBW,BDRYWT
307 -	307.000		1,PLWNT,DRYWT,G99D,DVBRP,T049
308 -	308.000		IF(GRW.EQ.4.0) G9 T9 445
309 -	309.000		WRITE(108,1160) PCENT,PR9PT,BDRYWT,BLWNT,DRYWT
310 -	310.000		1,G99D,DVBRP,T049
311 -	311.000	1130	FORMAT('1',/////////)
312 -	312.000	1140	FORMAT(30X,'GRWTH STJCY')
313 -	313.000	1042	FORMAT(29X,'BRRITER GRWTH')
314 -	314.000	1044	FORMAT(29X,'BRRITER GRWTH')
315 -	315.000	1046	FORMAT(24X,'BRRITER + BRRITER GRWTH')
316 -	316.000	1048	FORMAT(26X,'FIXED HQ TANK GRWTH')
317 -	317.000	1049	FORMAT(/,3X,'1',3X,'B99 GLBW',2X,'DRY-WT',3X,
318 -	318.000		1'DRY-WT',2X,'TK-WT',2X,'INVALID',2X,'STAGE',2X,'T/W(2)')
319 -	319.000	1150	FORMAT(/,3X,'1',3X,'B99 PR9P',2X,'DRY-WT',3X,
320 -	320.000		1'DRY-WT',2X,'TK-WT',2X,'INVALID',2X,'STAGE',2X,'T/W(2)')
321 -	321.000	1160	FORMAT(11X,F4.3,2X,F8.0,2X,F7.0,2X,F7.0,1X,F7.0,
322 -	322.000		12X,F3.1,4X,F5.0,1X,F5.3)
323 -	323.000	1180	FORMAT(/////////)
324 -	324.000	445	IF(J.EQ.N1) G9 T9 171
325 -	325.000		IF((J-1).GT.0) G8 T8 452
326 -	326.000		B9G=B99WT
327 -	327.000		B9G=BDRYWT
328 -	328.000		B9G=BLWNT
329 -	329.000		LAMB9=LAMB
330 -	330.000		FIX99=FIX99B
331 -	331.000		FTW9=FTW
332 -	332.000		FIX99B=FIX99B
333 -	333.000		FIX99B=FIX99B
334 -	334.000		REL9=REL
335 -	335.000	452	PCENT=FL9AT(J-1)*.01
336 -	336.000		IF(GRW.EQ.4.0) G9 T9 449
337 -	337.000		FIX99=1.0
338 -	338.000		FTW=0.0
339 -	339.000		IF(GRW.EQ.2.0) G9 T8 449
340 -	340.000		B9C9N=B9G-B9G
341 -	341.000		BDRYWT=B9G+(PCENT*10.*GRWB)
342 -	342.000		B9WNT=BDRYWT+B9C9N
343 -	343.000		IF(GRW.EQ.1.0) G9 T9 451
344 -	344.000	449	IF(GRW.EQ.4.0) FIX99B=1.0
345 -	345.000		IF(GRW.EQ.4.0) REL=0.0
346 -	346.000		BLWNT=B9G+(PCENT*10.*GRWB)*
347 -	347.000		1EXP(.945DVP/(32.174*G99D))
348 -	348.000		FIX99B=1.0
349 -	349.000		IF(GRW.EQ.4.0) G9 T9 453
350 -	350.000	451	IF(ABS(DV9NR-DV9NC).GT.1.0) G99D=2.0
351 -	351.000		IF(G99D.EQ.2.0) G9 T9 171
352 -	352.000		IF(ABS(DV9NR-DV9NC).GT.1.0) G9 T9 448
353 -	353.000		G99D=1.0
354 -	354.000		G9 T9 448
355 -	355.000	453	IF(FIX99B.GT.0.0) G8 T9 454
356 -	356.000		IF(ABS(DV9-STAGV).GT.1.0) G99D=2.0
357 -	357.000		IF(G99D.EQ.2.0) G9 T9 171
358 -	358.000		IF(ABS(DV9-STAGV).GT.1.0) G9 T8 448
359 -	359.000		G99D=1.0
360 -	360.000		G9 T9 448
361 -	361.000	454	IF(ABS(DVT-DVT9TC).GT.1.0) G99D=2.0
362 -	362.000		IF(G99D.EQ.2.0) G9 T9 171
363 -	363.000		IF(ABS(DVT-DVT9TC).GT.1.0) G8 T8 448
364 -	364.000		G99D=1.0

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365 - 365.000 448 J=J+1
366 - 366.000      38 T9 10
367 - 367.000 171 WRITE(108,1190)
368 - 368.000 1190 FORMAT(/,3X,'WHEN G890=1.0 VALID SOLUTION')
369 - 369.000      1,/,3X,'ESPER TERMINATES GROWTH OPTION'
370 - 370.000      2,/,3X,'WHEN G890=2.0 NO VALID SOLUTION')
371 - 371.000      WRITE(108,1180)
372 - 372.000      FIX890=FIX86
373 - 373.000      ETW=ETWG
374 - 374.000      9L9WT=9RG
375 - 375.000      9R9WT=9DG
376 - 376.000      LAMB=LAMRG
377 - 377.000      FIX9R2=FIX9R3
378 - 378.000      FIX9R=FIX9B3
379 - 379.000      REL=RELG
380 - 380.000      G990=1.0
381 - 381.000 110 F=0.0
382 - 382.000      PIN=1.0
383 - 383.000      39 T9 1
384 - 384.000 9999 CALL CLASSF1
385 - 385.000      STOP
386 - 386.000      END
  
```

3. ORBITER MODULE

The Orbiter Module contains the analytical and empirical weight estimation relationships necessary to completely define the vehicle. These relationships are combined into separate models, each model fully describing a weight group from the NASA functional coding. As an example, the Wing Group Model contains the analytical relationships describing the weight of the torque box plus empirical relationships defining the remaining elements of the wing, such as leading edge, landing gear provision, and elevon.

The Orbiter Module is set up to analyze a point design vehicle with minimum data. The NASA weight report and design data, coupled with a three-view drawing of the Orbiter, supplies all inputs necessary to analyze the configuration. Volume III, the User Manual, lists all required input data, and delineates the interface with the Group Weight Statement and the Design Data Summary. A point design analysis will give a detail line-item comparison with a contractor's weight report. This comparison will provide insight to variations of payload and performance characteristics as well as indicate subsystems that require scrutiny, either updating the model to a more realistic level or possible errors in the contractor data.

To run a point design analysis, it is first necessary to determine the performance characteristics, if unknown, from the ESPER program by running a fixed hardware case. In this case, the vehicle module weights, propellant, thrust, and velocity laws are input, and the payload capability is measured for a given mission. Next, an iterative case is run, using the data from the fixed hardware case. The payload, propellants, laws, and vehicle module dry weights are input. The program then analyzes the various subsystems and determines their weight. The growth/uncertainty of each vehicle module is allowed to "float," i.e., vary either up or down to maintain a constant dry weight, therefore physically sizing each system to the point design loads.

The primary purpose of the Orbiter Module is to provide the capability of analyzing an iterated vehicle to determine performance trades and to lend direction to the overall design effort by answering such questions as:

1. What happens if you vary engine characteristics, such as Orbiter thrust, or specific impulse?
2. Is the staging velocity optimized?
3. What is the minimum gross weight vehicle for the users constraints?

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4. What is the effect of changes to the primary construction material?
5. How do geometric changes, such as aspect ratio, payload bay length, or width, effect the configuration?

The inputted parameters start the Orbiter Module iteration for which liftoff weight, injected weight, etc., are calculated. These calculated weights, in turn, modify the aerodynamic surfaces; the wing area changes to maintain a constant wing loading and landing speed, and the tail changes to maintain control capability with a constant tail volume coefficient. In turn, these modify the surface controls and the thermal protection system. The auxiliary propulsion system is affected by injected weight and the landing gear by the landing loads. The body is modified by reaction from the above systems which, in turn, changes the interstage loads which ripple changes back through the body. The entire module continues the iteration until a completely balanced system exists.

Figure 3-1 is a flow diagram of the Orbiter Module, followed by the detail listing of the Module.

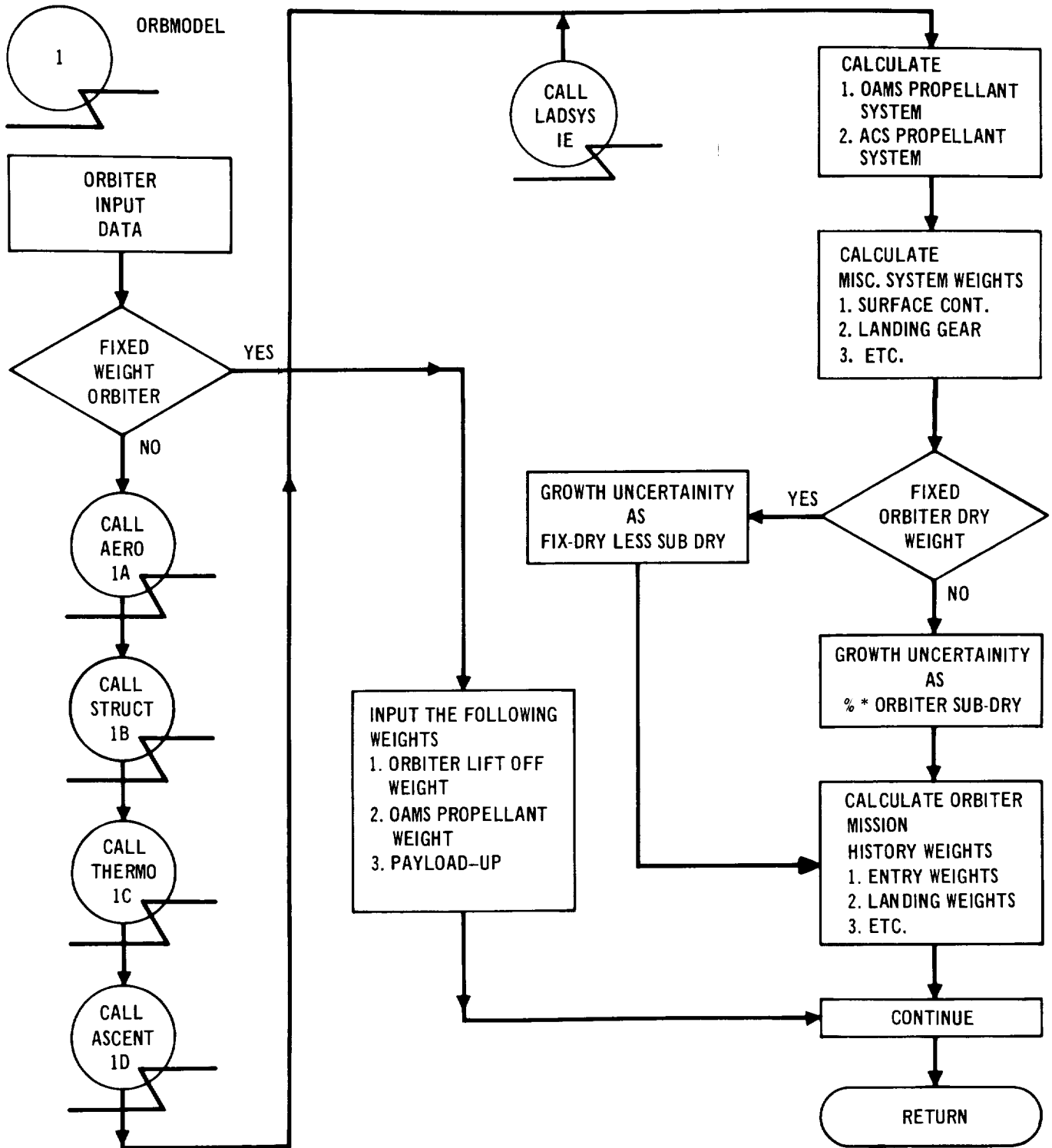


FIGURE 3-1 FLOW DIAGRAM

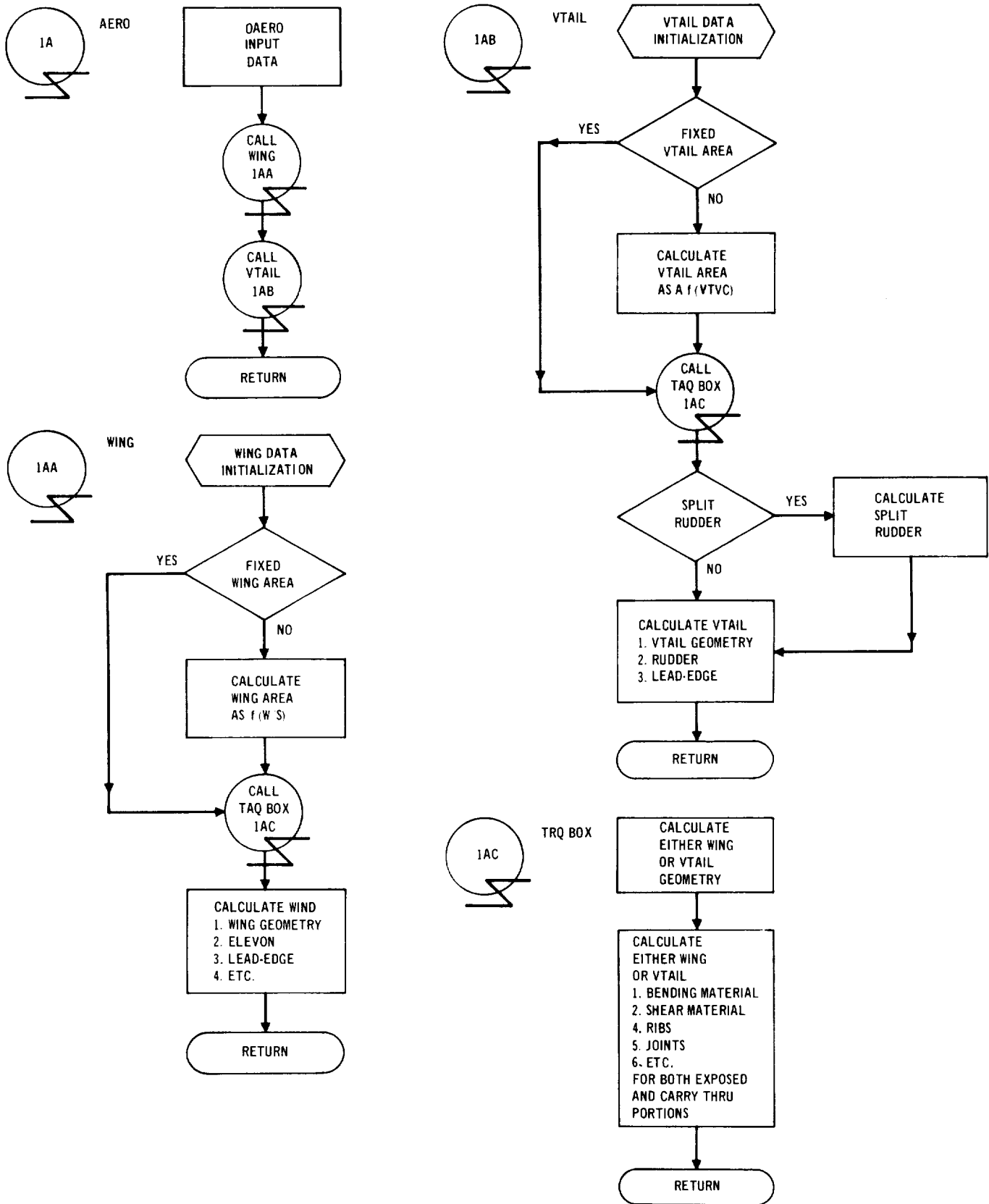


FIGURE 3-1 FLOW DIAGRAM (Continued)

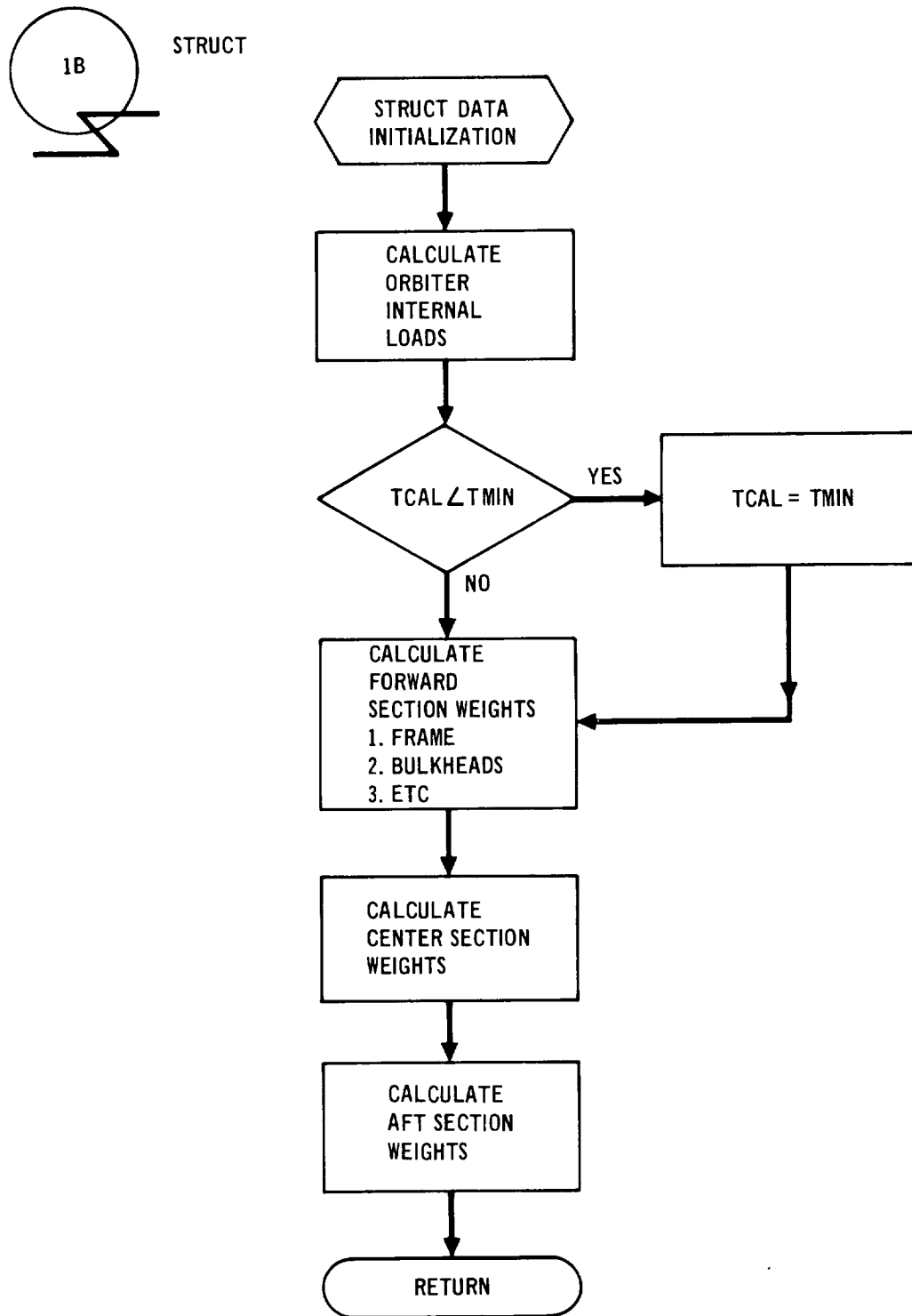


FIGURE 3-1 FLOW DIAGRAM (Continued)

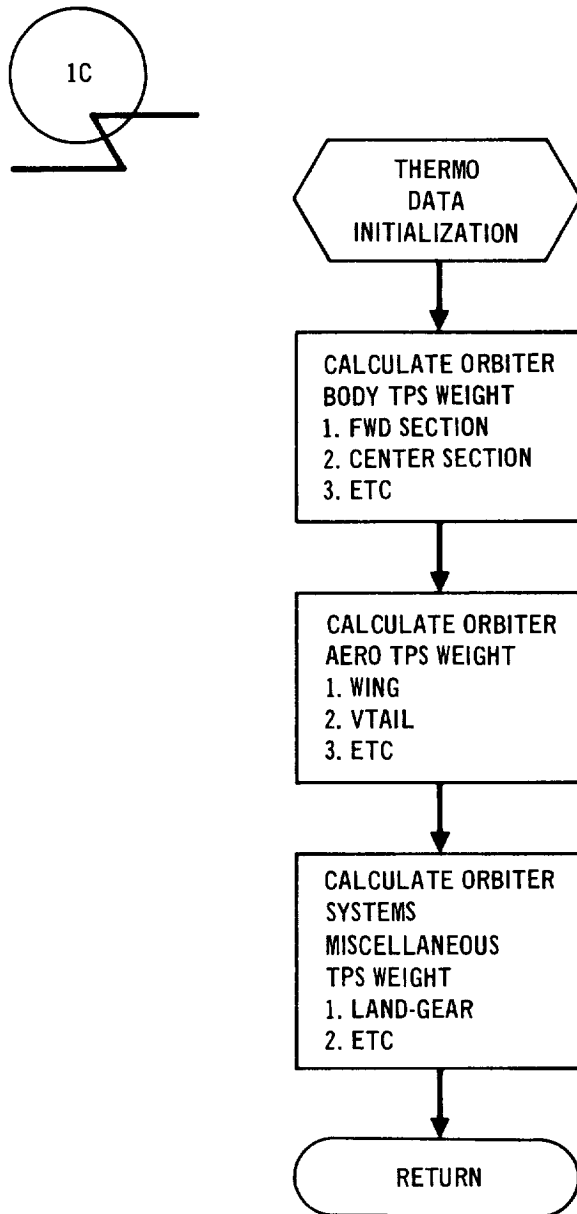


FIGURE 3-1 FLOW DIAGRAM (Continued)

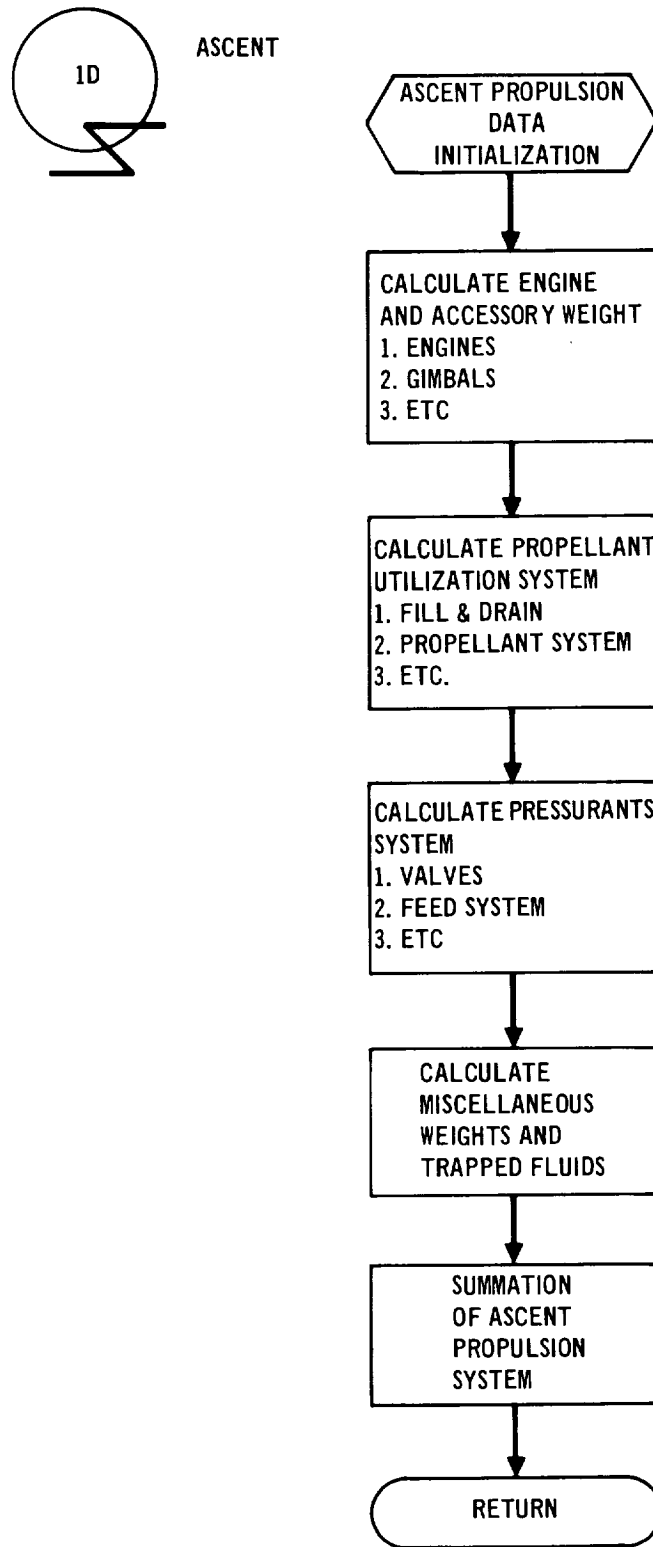


FIGURE 3-1 FLOW DIAGRAM (Continued)

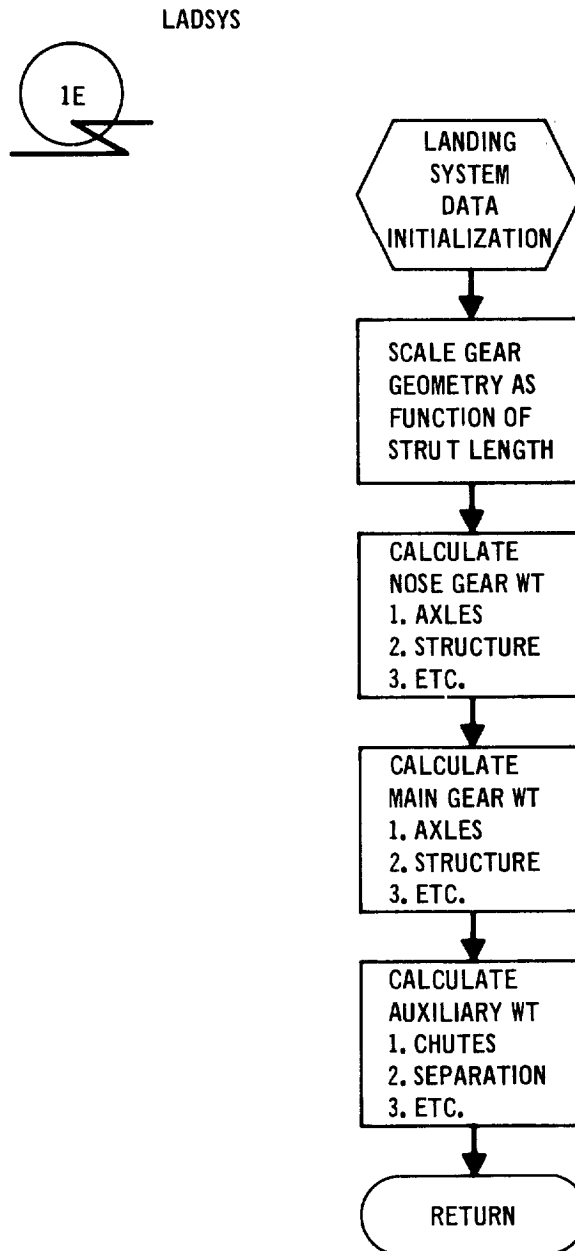


FIGURE 3-1 FLOW DIAGRAM (Continued)

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COPY NUMBER TO LP(K,NC)		
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53	53.000	C
54	54.000	C
55	55.000	C
56	56.000	C
57	57.000	C
58	58.000	C
59	59.000	C

ORBITER SUBROUTINE

SUBROUTINE ORRMDEL
THE ORBITER PROGRAM CONTAINS THE ANALYTICAL AND
EMPIRICAL WEIGHT ESTIMATION RELATIONSHIPS NECESSARY
TO COMPLETELY DEFINE THE VEHICLE. THESE RELATION-
SHIPS ARE COMBINED INTO SEPARATE MODELS, EACH MODEL
FULLY DESCRIBING A WEIGHT GROUP FROM THE NASA
FUNCTIONAL CODING. THE PRIMARY PURPOSE OF THE ORBITER
MODULE IS TO PROVIDE THE CAPABILITY OF ANALYZING AN
ITERATED VEHICLE TO DETERMINE PERFORMANCE TRADES AND TO
LEAD DIRECTION TO THE OVERALL DESIGN EFFORT.

PERFORMANCE COMMON BLOCK

COMMON/MAIN/ PR993, PR994, PR995, PR996, PR997, PR998, PR999, RPT, BCANT, BCANT, BCANTY
1, ACANTP, NGENSR, NGENGS, THSL, THSL, THSV, TBV, FLBR
2, TF, FTW, FIXHRD
3, ISPB, ISPBV, ISPRS, ISPBV, SCD, BTW
4, H, DVCRR, INC, STAGV, DVCN, DVCNST
5, REL, TH3TC, THSLT, TH3TC, ISP, ISPB, PR997
6, PR998, PR999, FW(2), DV9NC, DVB, DVT3TC, W8SCD, 9INWT, 9LANWT
7, 9INJNT, 9LWT, 9BLW, 9LW, 9TAL, S, P, MATCH, TLSSR, FRP
8, 9HLD, 9LLPL, 9LPL, 9MSIS, 9MSDV, 9MSDVP, 9MR
9, L9NSP, T9, T9, T9, 9NS, 9RSW, MINGLW

ORBITER OUTPUT COMMON BLOCK

COMMON/RR9/R1, R2, RL, WTAUX, WTACS, ACSENG, ACSSYS, WTACTK
1, ACSMD, WTSMS, R9SENG, PR9PSY, WTMTK, MODULE
1, SURFC, PR9, ELEC, HYDR, AVION, ECLSB, PR9V, DUNCWT
2, ORRMIS, TAPRD, SUREK
1, PERSON, RESD, RESV, PL9ADU, PL9ADD, ACSPRS, W9PRP, SUDLE
2, FIX99, FIX99, 9DRYWT, 9RIFL
1, WWT, 9G, 9RSTR, WT9RE, WT9RC, LEW, WTE, WAIL, WAS, WADR, WAH
2, WAP, 9PRV, PWINK, TAIL, TSG, T9STR, TT9OB, TLE, WRJD, WRS
3, WRDR, WR4, WRP, PTALK
1, G37, G1, G2, G3, G6, G7, G8, G9, G10, G11, G12, G15, G16
2, G17, G18, G19, G22, G23, G24, G25, G26, G27, G32, G33, G34
3, G35, G36
1, TBTPS, T3WT, W3WT, WGLEWT, TWT, TLEWT, BLBTPS
2, BASEWT, IATWT, PTPSCN, TTWT, BTPSWT, MCSWT, LDTWT
3, PR9WT, PR9C, PHYC, SCWT
1, TAPRD, EN9PAC, ENG, TVC, CNTR, PR9UTL, PR9SYS
2, FA, PRES, CHIL, PREVAL, FEEDS, DISC, MISC
1, LNDCK, NG1, NG2, NG3, NGEAR, MG1, MG2, MG3, MGEAR, AX1, AX2
2, AX3, AXGEAR, LNDCK

EXTERNAL TANK OUTPUT COMMON BLOCK

COMMON/EXT9/BODGRP, T9TPS, FWDTK, FAIRT, FWDBLE, FCCTPS
1, CONCT, TPSIN, CYLCT, ACYDM, AFTBLE, WINT, PR9SY, AFTK
2, FE9SYS, FWDLA, PR9VNT, AFTCYL, SUMP, AFTBLA, PNPJ, T9INT
3, N9SFAR, AVION, JM9PNL, WRETR9, TUNNEL, MISCT, BAFF, SJBDRY
4, GU, DRYWT, RESIDT, JNDRA, FEEDTR, PR9SRT, FBIAS, INERT
5, GR9SSW, TLAMB, 9TRAP, EXTL, EXT, BLKHD, EXTH, EXTHH, SIMPTK

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60	-	50.000	C	
61	-	51.000	C	STRUCTURE INPUT DATA COMMON BLOCK
62	-	52.000	C	
63	-	53.000		COMMON/STRD/ARI,HTV,LTV,H8,L9,LI,NX,NZ,FS
64	-	54.000		1,HF,HL,X,K1,SFW,VC,PC,D,SND,LNG
65	-	55.000		2,FAL,TMIN,RH9L,RH9S,TAUS,EF,LFS,DELP,FAB,RH83
66	-	56.000		3,TAJB,RH9F,K2,SW,<7,K3,K4,ACD,FAF,SAW,FAPB,TAUPB
67	-	57.000		4,DFAC,ET,RH8TP,RH9PB,K5
68	-	58.000	C	
69	-	59.000	C	THERM(TPS) INPUT DATA COMMON BLOCK
70	-	70.000	C	
71	-	71.000		COMMON/THERD/NCTPS,NCA,FWDTPS,FWDA,CTTPS,CTA,CSTPS
72	-	72.000		2,CSA,CBTPS,CBA,ATTPS,ATA,ASTPS,ASA,ABTPS,ABA,BASTPS
73	-	73.000		3,BASA,TPSCON,WGTPS,WGPLE,WLETPS,TLTPS,TLPLE
74	-	74.000		4,TLETPS,MCSTPS,MCSA,WACON,TACON,IBA,IBTPS,IBC,LDA,LDTPS
75	-	75.000		5,PR9A,PR9TPS,PR9C,PPC,HYC,SCA,SCTPS,SWI,SWC,WSI
76	-	76.000	C	
77	-	77.000	C	ASCENT PROPULSION INPUT DATA COMMON BLOCK
78	-	78.000	C	
79	-	79.000		COMMON/ASPD/PR99,SPI,HHEAD,GHEAD,HULL,GULL,FTU,R48
80	-	80.000		1,MATL,HLEN,BLEN,HELEN,BELEN,CPLGI
81	-	81.000	C	
82	-	82.000	C	LANDING AND DACKING INPUT DATA COMMON BLOCK
83	-	83.000	C	
84	-	84.000		COMMON/LDGD/LGFTU,LGVSL,LGLC,LGLS,LGDI,BCRF
85	-	85.000	C	
86	-	86.000	C	WRITER (WRB) INPUT DATA BLOCK
87	-	87.000	C	
88	-	88.000		NAMLIST ARI,HTV,LTV,H8,L9,LI,NX,NZ,FS
89	-	89.000		1,HF,HL,X,K1,SFW,VC,PC,D,SND,LNG
90	-	90.000		2,FAL,TMIN,RH9L,RH9S,TAUS,EF,LFS,DELP,FAB,RH83
91	-	91.000		4,TAJB,RH9F,K2,SW,<7,K3,K4,ACD,FAF,SAW,FAPB,TAUPB
92	-	92.000		5,DFAC,ET,RH8TP,RH9PB,K5
93	-	93.000		4,NCTPS,NCA,FWDTPS,FWDA,CTTPS,CTA,CSTPS,CSA,CBTPS
94	-	94.000		7,CBA,ATTPS,ATA,ASTPS,ASA,ABTPS,ABA,BASTPS,BASA,TPSCON
95	-	95.000		8,WGTPS,WGPLE,WLETPS,TLTPS,TLPLE,TLETPS
96	-	96.000		9,MCSTPS,MCSA,WACON,TACON,IBA,IBTPS,IBC,LDA,LDTPS,PR9A
97	-	97.000		9,PR9TPS,PR9C,PPC,HYC,SCA,SCTPS,SWI,SWC,WSI
98	-	98.000		4,PR99,SPI,HHEAD,GHEAD,HULL,GULL,FTU,RH9,MATL,HLEN,BLEN
99	-	99.000		5,HELEN,BELEN,CPLGI
100	-	100.000		1,DENSEF,DENSEB,RH8T,FTJT
101	-	101.000		1,PRES9M,RH9P,FTJP,9MSENG,PR99SY,MODULE,PRESF,PRES9
102	-	102.000		2,ACSP99,ACSDEN,ACSPRS,ACSENG,ACSSYS,ACSM8D
103	-	103.000		3,9R9MIS,FIXDWT,9JNCL,PERSON,9RESO,9RESV,PL9A9U,PL9ADD
104	-	104.000		4,FIX9RB,FIX9RB,PPWR,HYDRK,ELECK,AVI9NB,ECL9B
105	-	105.000		5,PP99V,9RIFL,TAB99,SURFK,BLLPLB,W9PR9P
106	-	106.000		6,LGFTU,LGVSL,LGLC,LGLS,LGDI,BCRF,AX2,AX3,LN9DKK
107	-	107.000	C	
108	-	108.000		IF(P.E9.2.0) G9 T9 2
109	-	109.000		INJT(1)
110	-	110.000	2	IF(FIX9RB.GT.0.0.9R.FIX9RB.GT.0.0) G8 T9 400
111	-	111.000		LD9=0
112	-	112.000		LM9=LGLC
113	-	113.000		CALL AER9(WS9,WBCT,WTHETA,WNZ,WB,SAIL,SRUD,VB,PV,WE9G
114	-	114.000		1,TS9,SURFI,LD9,LM9
115	-	115.000		2,WWT,WBTR,WTR9BE,WTR9BC,LEW,WTE,WAIL,WAS,WADR,WAH,WAP
116	-	116.000		3,PP99K,GR9BV
117	-	117.000		1,TAIL,TB9P,TT9R9B,TL9,WRUD,WRS,WRDR,WRH,WRP,PTAILK)
118	-	118.000		CALL STRUCT(WTR9BC,VB,WBCT,WTHETA,WNZ,WB,SAIL,SRJD,PV
119	-	119.000		6,P1,R2,RL
120	-	120.000		1,G37,G1,G2,G3,G6,G7,G8,G9,G10,G11,G12,G15,G16

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121 -	121.000	2, G17, G18, G19, G22, G23, G24, G25, G26, G27, G32, G33, G34
122 -	122.000	3, G35, G36)
123 -	123.000	CALL THERM9 (MSG, WESG, ISG, T9TTPS, TNGWT, WNGWT, WGLEWT, TWT, TLEWT
124 -	124.000	1, PLRTPS, BASEWT, IBTWT, PTPSCN, TTWT, BTPSWT, MCSWT, LDTWT
125 -	125.000	2, PR9WT, PPPC, PHYC, SCWT)
126 -	126.000	CALL ASCENT (TAPR9, ENGPAC, ENG, TVC, CNTR, PRPUTL
127 -	127.000	1, PR9SYS, FAD, PRES, CHIL, PREVAL, FEEDS, DISC, MISC)
128 -	128.000	CALL LADSYS (LNDCK, NG1, NG2, NG3, NGEAR, MG1, MG2, MG3
129 -	129.000	1, MGEAR, AX1, AX2, AX3, AXGEAR, LNDCK)
130 -	130.000	C MISCELLANEOUS SUBSYSTEM WEIGHT CALCULATIONS
131 -	131.000	K=1.0
132 -	132.000	IF (SURF1.GT.0.0) K=3.0
133 -	133.000	SURFC=1060.*+3.45*SAIL+K*(360.*+1.67*SRUD)+SURFK
134 -	134.000	PPWR=PPWR
135 -	135.000	HYDR=2264.*((WSSG+K*TS3)/4525.)*+HYDRK
136 -	136.000	ELEC=ELEFC+2805.*+1840.*((LI-X)/747.
137 -	137.000	AVI9N9=AVI9N9
138 -	138.000	ECL59=ECL59
139 -	139.000	PPR9V=PPR9V
140 -	140.000	TAPR9=TAPR9
141 -	141.000	C
142 -	142.000	C 9MS SYSTEM CALCULATIONS
143 -	143.000	C
144 -	144.000	WTR9P=9L9WL9*(EXP(9MSDVT/(32.174*9MSISP))-1.)
145 -	145.000	W9PR9=9L9XL9*(EXP(9MSDVT/(32.174*9MSISP))-1.)
146 -	146.000	WFUEL=WTR9P/(1.+3MR)
147 -	147.000	W9X=9MR*WFUEL
148 -	148.000	VFUEL=(WFUEL/DENSF)*1.15
149 -	149.000	V9X=(.9X/DENS9)*1.15
150 -	150.000	FTANK=3./2.*RH9T*PRESF*VFUEL/FTUT*1728.*+1.28
151 -	151.000	9TANK=3./2.*RH9T*PRES9/FTUT*V9X*1728.*+1.28
152 -	152.000	VPRES=(PRES9*V9X+PRESF*VFUEL)/PRES9*1.47
153 -	153.000	PREST=3./2.*RH9P*PRES9*VPRES/FTUP*1728.*+1.28
154 -	154.000	WT9MT=FTANK+9TANK+PRESTK
155 -	155.000	WT9MS=WT9MTK+9MSENG+PR9PSY+9MODULE
156 -	156.000	C
157 -	157.000	C ACS SYSTEM CALCULATIONS
158 -	158.000	C
159 -	159.000	C
160 -	160.000	ACSV9L=ACSPR9/ACSDEN*1.15
161 -	161.000	ACSTN=3./2.*RH9T*ACSPRS*ACSV9L/FTUT*1728.*+1.28
162 -	162.000	VPTNK=ACSV9L*ACSPRS/PRES9*1.47
163 -	163.000	PTNK=3./2.*RH9T*PRES9*VPTNK/FTUP*1728.*+1.28
164 -	164.000	WTACTK=(ACSTNK+PTNK)*1.25
165 -	165.000	WTACS=WTACTK+ACSSYS+ACSENG+ACSM9D
166 -	166.000	WT9JX=WT9MS+WTACS
167 -	167.000	9R9MIS=9R9MIS
168 -	168.000	C
169 -	169.000	C 9RITER MISSION HISTORY
170 -	170.000	C
171 -	171.000	SUBDRY=WWT+TAIL+G37+T9TTPS+SURFC+TAPR9P+WTAUX+9R9MIS
172 -	172.000	1+PPWR+HYDR+ELEC+AVI9N9+ECL59+PPR9V+LNDCK+TAPR9
173 -	173.000	SUDLE=SUBDRY-ENG
174 -	174.000	IF (FIXDWT.GT.0.0) 9UNCWT=FIXDWT-SUDRY
175 -	175.000	IF (FIXDWT.GT.0.0) 99 T9 50
176 -	176.000	9UNCWT=SUDLE*9UNC1
177 -	177.000	9DRYWT=SUDRY+9UNCWT
178 -	178.000	9INWT=9DRYWT+PERS9N+9RES9+PL9ADU
179 -	179.000	9LANWT=9INWT-PL9ADU+PL9ADD+9RESV
180 -	180.000	9INJWT=9LANWT+ACSPR9+99PR9P-9RESV-PL9ADD+PL9ADU+9RIFL
181 -	181.000	IF (P.EQ.0.0) 9TRAP=1000.
		9L9WT=9INJWT+9TRAP

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182	-	132.000		9L94L9=9L9WT-W9PR8P
183	-	133.000		9LL9L9=9L9WT-W9PR8P-PL9ADJ
184	-	134.000		99 T9 500
185	-	135.000	C	
186	-	135.000	C	FIXED WEIGHT ITERATION CALCULATIONS
187	-	137.000	C	
188	-	138.000	400	9LL9L9=9LL9L9
189	-	139.000		W9PR8P=99PR8P
190	-	140.000		PL9ADJ=PL9ADJ
191	-	141.000		9L94L9=9LL9L9+PL9ADJ+W9PR8P
192	-	142.000	500	CONTINUE
193	-	143.000		RETURN
194	-	144.000		END
195	-	145.000		SUBROUTINE AER9(W9SG,W9BCT,W9THETA,W9NZ,W9WB,SAIL,SRJD,VB
196	-	145.000		1,PV,W9SG,T9SG,SURF1,L9D,L9M9
197	-	147.000		2,W9WT,W9PSTR,W9TR9BE,W9TR9BC,LEW,W9TE,W9AIL,W9AS,W9ADR,W9AH,W9AP
198	-	148.000		3,W9WINGK,G9PR8V
199	-	149.000		1,TAIL,T9STR,T9TR9B,TLE,W9RUD,W9RS,W9RDR,W9RH,W9RP,PTAILK
200	-	200.000		REAL LAMB,LH,M,K,NZ,LE,KEAS,LAMB9,MP,KP,LEW
201	-	201.000		1,K9M99,K9MC,M9P,L9D,L9M9
202	-	202.000		DIMENSION AR(2),SG(2),LAMB(2),T9CR(2),T9CT(2)
203	-	203.000		1,HCT(2),THETA(2),NZ(2),DELTA(2),LH(2),PT9XC(2)
204	-	204.000		2,PT9XE(2),CB(2),RH9(2),FA(2),CS(2),TAU(2),TEMP(2)
205	-	205.000		3,ULE(2),CSR(2),TMIN(2),ULE(2),WLE(2),CLE(2)
206	-	206.000		4,E9M9D(2),WC1(2),WC2(2),CM1(2),BLP1(2),BLP2(2),BCM1(2)
207	-	207.000		COMMON/RWRC/ AR,SG,LAMB,T9CR,T9CT,BCT,THETA,NZ,DELTA,LH
208	-	208.000		1,PT9XC,PT9XE,CB,RH9,FA,CS,TAU,TEMP,U9W,W9B,SEXP,SL,RBM
209	-	209.000		3,E9M9D,W9PKR,W9REL,W9C1,W9C2,CM1,BLP1,BLP2,BCM1
210	-	210.000		2,WLE,CLE,CSR,TMIN,W9WING(22),TANS(22),SL1,SL2,CLE
211	-	211.000		COMMON/RWRW/KEAS,AILP,AICP,U9WAIL,W9WB,W9WINGK,TL9D,SM9DR,TL9M9
212	-	212.000		COMMON/RWRVT/R9DC,RUDJL,URS,VTVC,LVT,SPRUD,TAILK
213	-	213.000		COMMON/MAIN/ PR9P3,PR9P8,BRT,BCANT,BCANT,BCANT
214	-	214.000		1,BCANTP,N9ENGB,N9ENGR,TH9SL,TH9SL,TH9V,T9V,FL9WR
215	-	215.000		2,TF,FTW,FI9HRD
216	-	216.000		3,ISP9B,ISP9V,ISP9BS,ISP9BV,SCD,BTW
217	-	217.000		4,W9DVC9RR,INC,STABV,DVC9N,DVC9ST
218	-	218.000		5,REL,TH9TC,TH9SLT,TH9TC,ISP9R,ISP9B,PR9P8T
219	-	219.000		6,PR9P81,PR9P82,FW(2),DVB9C,DVB,DVT9TC,W9SCD,9INWT,9LANWT
220	-	220.000		7,9INJ,T,9L9WT,9GL9W,9L9W,T9TAL,S,P,MATCH,TL9SR,F9RP
221	-	221.000		8,949LD,9LL9L9,9L9WLB,9MSISP,9MSDVT,9MSDVP,9MR
222	-	222.000		9,L9NGP,T9W9,T9WB,SENS,GR9W,MINGLW
223	-	223.000	C	
224	-	224.000	C	WRITER AER9-SURFACE (9AER9) INPUT DATA BL9C<
225	-	225.000	C	
226	-	226.000		NAMELIST
227	-	227.000		1 AR,SG,LAMB,T9CR,T9CT,BCT,THETA,NZ,DELTA,LH,PT9XC
228	-	228.000		2,PT9XE,CB,RH9,FA,CS,TAU,TEMP,U9W,CSR,TMIN
229	-	229.000		3,ULE,KEAS,AICP,U9WAIL,CLE,AILP
230	-	230.000		4,R9DC,RUDJL,URS,WLE
231	-	231.000		5,W9WB,VTVC,LVT,SPRUD,W9WINGK,TAILK
232	-	232.000		6,E9M9D,WC1,WC2,CM1,BLP1,BLP2,BCM1,SM9DR
233	-	233.000	C	
234	-	234.000		TL9D=L9D
235	-	235.000		TL9M=L9M9
236	-	236.000		IF(P.EQ.2.0) 99 T9 20
237	-	237.000		INPJ(1)
238	-	238.000	20	CALL W9ING(W9SG,W9BCT,J,9LANWT,SAIL,LEW,W9AS,W9ADR,W9AH,W9AP,W9AIL
239	-	239.000		1,W9TE,W9WT,W9BSTR,G9PR8V)
240	-	240.000		W9NZ=W9NZ(J)
241	-	241.000		WR=9
242	-	242.000		W9THETA=THETA(J)

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243	-	243.000	WSS=SS(J)
244	-	244.000	WRCT=RCT(J)
245	-	245.000	WESG=SEXP
246	-	246.000	WTORBE=WANS(20)
247	-	247.000	WTORBC=WANS(21)
248	-	248.000	PWINGK=WINGK
249	-	249.000	CALL VTAIL(J),PLANWT,WSS,WB,SRUD,TL,WR,WROR,WRH
250	-	250.000	1,WRP,TAIL,VB,P,TBSTR,WRUD)
251	-	251.000	YH=3
252	-	252.000	PV=SL
253	-	253.000	TSS=SR(J)
254	-	254.000	SURFI=SPRUD
255	-	255.000	TORRBC=TANS(22)
256	-	256.000	RTAILK=TAILK
257	-	257.000	RETJRN
258	-	258.000	END
259	-	259.000	SUBROUTINE WING(WSS,WRCT,J,PLANWT,SAIL,LEW,WAS,WADR,WAH,WAP
260	-	260.000	1,WAIL,WTE,WWT,WBSTR,SPR9V)
261	-	261.000	REAL LAMB,LH,M,K,NZ,LE,KEAS,LAMB,MP,KP,LEW
262	-	262.000	1,KMP,KMC,MP,LDD,LMS
263	-	263.000	DIMENSION AR(2),SG(2),LAMB(2),TSCR(2),TCT(2)
264	-	264.000	1,RCT(2),THETA(2),VZ(2),DELP(2),LH(2),PTRXC(2)
265	-	265.000	2,PTX(2),CB(2),RH(2),FA(2),CS(2),TAU(2),TEMP(2)
266	-	266.000	3,UW(2),CSR(2),TMIN(2),JLE(2),WLE(2),CLE(2)
267	-	267.000	4,EM90J(2),WC1(2),WC2(2),CM1(2),BLP1(2),BLP2(2),BCM1(2)
268	-	268.000	CM4BN/RWRC/AR,SG,LAMB,TSCR,TCT,CT,THETA,VZ,DELP,LH
269	-	269.000	1,PTX,PTXE,CH,RH,FA,CS,TAJ,TEMP,UW,B,SEXP,SL,RBM
270	-	270.000	3,EM90J,WSPKR,WBREL,WC1,WC2,CM1,BLP1,RLP2,BCM1
271	-	271.000	2,WLE,JLE,CSR,TMIN,WANS(22),TANS(22),SL1,SL2,CLE
272	-	272.000	CM4BN/RWRW/KFAS,AILP,AICP,UWAIL,WWS,WINGK,TLDD,SYGDR,TLMB
273	-	273.000	J=1
274	-	274.000	IF(WWS.GT.0.0) SS(J)=PLANWT/WWS
275	-	275.000	CALL TORRBC(J,PLANWT)
276	-	276.000	LDD=TLDD
277	-	277.000	LMS=TLMS
278	-	278.000	BSC=BCT(J)/R
279	-	279.000	CR=(2.*SG(J))/(B*(1.+LAMB(J)))
280	-	280.000	BE=B-RCT(J)
281	-	281.000	STRE=PTX(J)*SEXP
282	-	282.000	CF=CR*(1.-BSC*(1.-LAMB(J)))
283	-	283.000	CRCF=CR/CF
284	-	284.000	SAIL=AILP*BE+AICP*CF/2.*(2.-(1.-LAMB(J))*CRCF*(1.-BSC)*(AILP))
285	-	285.000	CRST=CRS(THETA(J)/57.2958)
286	-	286.000	CR=(2.*SAIL)/(BE*(1.+LAMB(J)))
287	-	287.000	CT=CR*LAMB(J)
288	-	288.000	TR=CR*TSCR(J)
289	-	289.000	TT=CT*TCT(J)
290	-	290.000	CMR=(CR+CT)/2.
291	-	291.000	SRUD=SAIL
292	-	292.000	RHM=SRUD*.144.*KEAS*.12.*CMR*.5*.001
293	-	293.000	HLTR=12.*(TR+TT)/2.
294	-	294.000	HLLR=BE/CRST
295	-	295.000	WAS=JWAIL*SAIL
296	-	296.000	WADR=(CMR*(RHM/HLTR)**.75)*2.
297	-	297.000	WAH=(.40*HLLR*RHM**.2)*2.
298	-	298.000	WAP=.25*(WAS+WADR+WAH)
299	-	299.000	WAIL=WAS+WADR+WAH+WAP
300	-	300.000	SLE=CLE(J)*SEXP
301	-	301.000	WLET=2.*SLE+WLE(J)
302	-	302.000	LEW=WLET*JLE(J)
303	-	303.000	FMS=PLANWT*350000./215115.

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304 -	304.000	GPRBV=.43*LDQ**.3*SMGDR+.077*(.001*FMG*LMG)**.9
305 -	305.000	STE=SEXP-STBE-SAIL-SLE
306 -	306.000	WTE=1.87*STE*(.001*BLANWT*NZ(J)/SG(J))**.2
307 -	307.000	IF (SL2.GT.SL1) WTE=1.87*STE*(.001*DELPI(J))**.2
308 -	308.000	WWT=WANS(20)+LEW+WAIL+WTE+WINGK+GPRBV
309 -	309.000	WRSTR=WANS(20)+LEW+WTE
310 -	310.000	RETJRN
311 -	311.000	END
312 -	312.000	SUBROUTINE VTAIL (J,BLANWT,WSG,WB,SRUD,TLE,WRS,WRDR
313 -	313.000	1,WRH,WRP,TAIL,VB,P,TBSTR,WRUD)
314 -	314.000	REAL LAMB,LH,M,K,NZ,LE,KEAS,LAMB,P,MP,KP,LEW
315 -	315.000	1,KMPP,KMC,MP,LDD,LMG
316 -	316.000	DIMENSION AR(2),SG(2),LAMB(2),TOCR(2),T9CT(2)
317 -	317.000	1,RCT(2),THETA(2),NZ(2),DELP(2),LH(2),PTBXC(2)
318 -	318.000	2,PTBXC(2),CB(2),RH5(2),FA(2),CS(2),TAU(2),TEMP(2)
319 -	319.000	3,UWV(2),CSR(2),TMIN(2),ULE(2),WLE(2),CLE(2)
320 -	320.000	4,FM9DJ(2),WC1(2),WC2(2),CM1(2),BLP1(2),BLP2(2),BCM1(2)
321 -	321.000	C9MM9N/RWRC/ AR,SG,LAMB,TOCR,T9CT,BCT,THETA,NZ,DELP,LH
322 -	322.000	1,PTBXC,PTBXC,CR,RH5,FA,CS,TAJ,TEMP,UWV,B,SEXP,SL,RBM
323 -	323.000	3,FM9DJ,NSWPKR,WBREL,WC1,WC2,CM1,BLP1,BLP2,BCM1
324 -	324.000	2,WLE,ULE,CSR,TMIN,WANS(22),TANS(22),SL1,SL2,CLE
325 -	325.000	C9MM9N/RWVVT/FDC,RUDJL,URS,VTVC,LVT,SPRJD,TAILK
326 -	326.000	J=2
327 -	327.000	IF (VTVC.GT.0.0) SG(J)=(WSG*WB*VTVC)/(LVT/12.0)
328 -	328.000	CALL TRDRX(J,BLANWT)
329 -	329.000	CRST=C9S(THETA(J)/37.2958)
330 -	330.000	CR=(2.*SG(J))/(3*(1.+LAMB(J)))
331 -	331.000	CT=CR*LAMB(J)
332 -	332.000	IF (SPRJD.GT.0.0.AND.P.GT.0.0) GO TO 5
333 -	333.000	IF (SPRJD.GT.0.0) TTOCR=TOCR(J)*.5
334 -	334.000	IF (SPRJD.GT.0.0) TT9CT=T9CT(J)*.5
335 -	335.000	5 TR=CR+TTOCR
336 -	336.000	TT=CT+TT9CT
337 -	337.000	BE=R-RCT(J)
338 -	338.000	CMR=RDC*(CR+CT)/2.
339 -	339.000	SRUD=RDC*SG(J)
340 -	340.000	RHM=SRUD*144.*RUDJL*12.*CMR**.5*.001
341 -	341.000	HLTR=12.*(TR+TT)/2.
342 -	342.000	HLLP=BE/C9ST
343 -	343.000	WRS=JRS*SRUD
344 -	344.000	WRDR=.44*CMR*(RHM/HLTR)**.75
345 -	345.000	WRH=.40*HLLP*RHM**.2
346 -	346.000	IF (SPRJD.EQ.0.0) GO TO 10
347 -	347.000	WRS=WRS*2.
348 -	348.000	WRDR=WRDR*2.
349 -	349.000	WRH=WRH*2.
350 -	350.000	10 WRP=.25*(WRS+WRDR+WRH)
351 -	351.000	WRJD=WRS+WRDR+WRH+WRP
352 -	352.000	WLET=P.2*CLE(J)*SG(J)+WLE(J)
353 -	353.000	TLE=JLE(J)+WLET
354 -	354.000	TAIL=TANS(22)+WRUD+TLE+TAILK
355 -	355.000	TBSTR=TANS(22)+TLE
356 -	356.000	RETJRN
357 -	357.000	END
358 -	358.000	SUBROUTINE TRDRX(J,BLANWT)
359 -	359.000	REAL LAMB,LH,M,K,NZ,LE,KEAS,LAMB,P,MP,KP,LEW
360 -	360.000	1,KMPP,KMC,MP,LDD,LMG
361 -	361.000	DIMENSION S(22)
362 -	362.000	DIMENSION AR(2),SG(2),LAMB(2),TOCR(2),T9CT(2)
363 -	363.000	1,RCT(2),THETA(2),NZ(2),DELP(2),LH(2),PTBXC(2)
364 -	364.000	2,PTBXC(2),CB(2),RH5(2),FA(2),CS(2),TAU(2),TEMP(2)

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365	=	365.000	3, UMW(2), CSR(2), TMIN(2), WLE(2), WLE(2), CLE(2)
366	=	366.000	4, EM9J(2), WC1(2), WC2(2), CM1(2), BLP1(2), RLP2(2), BCM1(2)
367	=	367.000	COMM9/RWRC/ AR, SG, LAMB, TBCR, TACT, BCT, THETA, NZ, DELP, LH
368	=	368.000	1, PT3XC, PT3XE, CB, R49, FA, CS, TAJ, TEMP, UMW, B, SEXD, SL, RBM
369	=	369.000	3, EM9J, WSPKR, WREL, WC1, WC2, CM1, BLP1, BLP2, BCM1
370	=	370.000	2, WLE, WLE, CSR, TMIN, WANS(22), TANS(22), SL1, SL2, CLE
371	=	371.000	CBST=CB5(THETA(J)/57.2958)
372	=	372.000	R=(AR(J)*SG(J))**.5
373	=	373.000	CR=(2.*SG(J))/(3*(1.+LAMB(J)))
374	=	374.000	CT=CR*LAMB(J)
375	=	375.000	CF=CR*(1.-(1.-LAMB(J))*BCT(J)/3)
376	=	376.000	TR=TBCR(J)*12.*CR
377	=	377.000	TT=TACT(J)*12.*CT
378	=	378.000	IF(LAMB(J).EQ.0.) TT=TACT(J)
379	=	379.000	M=TT/TR
380	=	380.000	TF=T2*(1.+(M-1.))*BCT(J)/3)
381	=	381.000	MP=TT/TF
382	=	382.000	RHSPC=TF*(.8+.2*MP)
383	=	383.000	IF(RHSPC.LT.12.) RHSPC=12.
384	=	384.000	IF (MP.GT..99) MP=.99
385	=	385.000	LAMB=P*LAMB(J)/(1.-(1.-LAMB(J))*BCT(J)/3)
386	=	386.000	KP=3.*LAMB/P/(1.+LAMB)*((1.-3.*MP)*(1.-MP)-2.*MP**2*AL9G(MP))
387	=	387.000	KP=KP/(1.-MP)**3
388	=	388.000	KP=KP+(1.-LAMB)/(1.+LAMB)*((2.-7.*MP+1.*MP**2)
389	=	389.000	5*(1.-MP)+4.*MP**3*AL9G(MP))/3./(1.-MP)**4
390	=	390.000	SCT=BCT(J)*(CR+CF)/2.
391	=	391.000	SEXP=SG(J)-SCT
392	=	392.000	STRC=PT3XC(J)*SCT
393	=	393.000	STRE=PT3XE(J)*SEXP
394	=	394.000	WW=JW(J)*SG(J)
395	=	395.000	BE=R*BCT(J)
396	=	396.000	TANT=5IN(THETA(J)/57.2958)/CBST
397	=	397.000	TANLE=TANT+2.*(1.-LAMB(J))/(AR(J)*(1.+LAMB(J)))
398	=	398.000	TANTE=TANLE-4.*(1.-LAMB(J))/(AR(J)*(1.+LAMB(J)))
399	=	399.000	ANGLE=57.2958*ATAN(TANLE)
400	=	400.000	ETAANG=(.04+AR(J))*(.0049+.0000+5*ANGLE))*LAMB(J)
401	=	401.000	ETAANG=ETAANG+.05*(LAMB(J)-.4)**2
402	=	402.000	ETAANG=ETAANG+.41*(1.+00033*ANGLE)-(50.-ANGLE)/3000.
403	=	403.000	F=3.395-5.*ETAANG
404	=	404.000	GEE=AR(J)*TANTE*(-.01484)
405	=	405.000	H=(AR(J)-4.)*(1.+3.5*TANTE)**003
406	=	406.000	IF(AR(J).LT.4.) H=0.0
407	=	407.000	CBARCL=F+GEE+H
408	=	408.000	ETAF=BCT(J)/3
409	=	409.000	FF=F*(1.-ETAF**2)**.5+(20.*ETAANG-5.488)*ETAF**2
410	=	410.000	1*(1.-ETAF**2)**.5
411	=	411.000	GEEF=GEE*(1.-.666*ETAF+7.315*ETAF**2)*(1.-ETAF**2)**.5
412	=	412.000	HF=4*(1.-14.5*ETAF**2+21.*ETAF**4)*(1.-ETAF**2)**.5
413	=	413.000	CBARF=FF+GEEF+HF
414	=	414.000	SLRATI=(CBARCL+CBARF)*ETAF/2.
415	=	415.000	ETAEXP=(ETAANG-SLRATI)*ETAF*.5-(1.-SLRATI)*ETAF
416	=	416.000	1/(1.-SLRATI)
417	=	417.000	ETAEXP=ETAEXP*B/BE
418	=	418.000	ETAJNF=(2.*LAMB+1.)/(3.*(LAMB+1.))
419	=	419.000	RLEP=ETAEXP/ETAJNF
420	=	420.000	SLT9T=((9LANWT+.5*WW)*NZ(J)+LH(J)
421	=	421.000	SL1=SLT9T*(1.-SLRATI)
422	=	422.000	SL2=DELP(J)*SEXP
423	=	423.000	SL=SL1
424	=	424.000	IF (SL2.GT.SL1) SL=SL2
425	=	425.000	RRM=RLEP*(SL/4.)*3E/(2.*CBST)*(2.*LAMB+1.)/(LAMB+1.)

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426	=	426.000	IF (J.EQ.2) RRM=4.0*R3M
427	=	427.000	TCR=CB(J)*R3SPC/20.
428	=	428.000	PF=R3M/(TF*CF*PTBXE(J)*.8)
429	=	429.000	TCBVE=TCR/(RH(J)*144.)*PF/FA(J)
430	=	430.000	RRVN=2.*PF**2*R3SPC/(EMDU(J)*TCBVE*TF*.8)
431	=	431.000	TRIBF=TCR/(RH(J)*144.)*RRVN/FA(J)
432	=	432.000	TRSTF=67.5*R3M*12./(3.1416**2*EMDU(J)*PTBXE(J)*CF*12.*R3SPC)
433	=	433.000	IF (TRSTF.GT.TRIBF) TRIBF=TRSTF
434	=	434.000	TRIBT=TCB/(RH(J)*144.)
435	=	435.000	WRIBF=RH(J)*TRIBF*TF*CF*PTBXE(J)*12.
436	=	436.000	WRIBT=RH(J)*TRIBT*TF*CT*PTBXE(J)*12.
437	=	437.000	WSKP<R*.05R*(ARS(SL*.001*SIN(THETA(J)/57.2958))*3E/
438	=	438.000	1(C9ST*TF/1.2))**.92
439	=	439.000	G(1)=2.*CR(J)*STBE
440	=	440.000	G(2)=2.*CB(J)*STBC
441	=	441.000	G(3)=RH(J)*<P*3E*RRM*(1.+LAMBP)/(FA(J)*.8*TF*(2.*LAMBP+1.))*144.
442	=	442.000	G(4)=RH(J)*RRM*2.*C9ST*BCT(J)*144./(FA(J)*.8*TF)
443	=	443.000	TC=TR*(1.-(1.-M)*3LP1(J)*2./9E)
444	=	444.000	MPP=TC/TF
445	=	445.000	<MPP=2.*(1./(1.-MPP)+MPP*ALB3(MPP)/(1.-MPP)**2)
446	=	446.000	<MC=ALB3(MPP)/(MPP-1.)
447	=	447.000	BL1=(3LP1(J)-RCT(J)/2.)/C9ST
448	=	448.000	WREL1=RH(J)*WC1(J)*VZ(J)*BL1**2*144.*<MPP/(FA(J)*.8*TF)
449	=	449.000	WREL1=WREL1+RH(J)*WC1(J)*VZ(J)*BL1*144.*C9ST*BCT(J)/
450	=	450.000	1(FA(J)*.8*TF)
451	=	451.000	WREL1=WREL1+RH(J)*WC1(J)*VZ(J)*BL1*12./TAU(J)
452	=	452.000	TC=TR*(1.-(1.-M)*3LP2(J)*2./9E)
453	=	453.000	MPP=TC/TF
454	=	454.000	<MPP=2.*(1./(1.-MPP)+MPP*ALB3(MPP)/(1.-MPP)**2)
455	=	455.000	BL2=(3LP2(J)-RCT(J)/2.)/C9ST
456	=	456.000	WREL2=RH(J)*WC2(J)*VZ(J)*BL2**2*144.*<MPP/(FA(J)*.8*TF)
457	=	457.000	WREL2=WREL2+RH(J)*WC2(J)*VZ(J)*BL2*144.*C9ST*BCT(J)/
458	=	458.000	1(FA(J)*.8*TF)
459	=	459.000	WREL2=WREL2+RH(J)*WC2(J)*VZ(J)*BL2*12./TAU(J)
460	=	460.000	WCM=4.*RH(J)*CM1(J)*3CM1(J)*144.*<MC/(FA(J)*.8*TF)
461	=	461.000	WREL=(-WREL1-WREL2+WCM)
462	=	462.000	G(5)=12.*RH(J)*BE/C9ST*(2.*CS(J)*(.8*TF*(1.+MP)/2.))**2
463	=	463.000	1+TMV(J)*(.8*TF*(1.-MP))
464	=	464.000	G(6)=2.*CR(J)*.8*TF*BCT(J)/12.
465	=	465.000	G(7)=2.*RH(J)*RRM*12./TAU(J)
466	=	466.000	IF (J.EQ.2) G(7)=G(7)*.5
467	=	467.000	G(8)=(WRIBF+WRIBT)/(2.*R3SPC*C9ST)*BE*12.
468	=	468.000	G(9)=TRIBF/(R3SPC)*RCT(J)*12.
469	=	469.000	G(10)=(G(1)+G(3)+G(5)+G(7)+G(8))*0.1
470	=	470.000	G(11)=(G(2)+G(4)+G(6)+G(9))*0.1
471	=	471.000	G(12)=.14*STBE
472	=	472.000	G(13)=.14*STBC
473	=	473.000	G(14)=.10*G(3)+.20*(G(7)+G(8))
474	=	474.000	G(15)=.10*G(4)+G(9)*.2
475	=	475.000	G(16)=G(1)+G(3)+G(5)+G(7)+G(8)+G(10)+G(12)+G(14)
476	=	476.000	1+WSKP<R+WREL
477	=	477.000	G(17)=G(2)+G(4)+G(6)+G(9)+G(11)+G(13)+G(15)
478	=	478.000	G(18)=.25*G(16)
479	=	479.000	G(19)=.25*G(17)
480	=	480.000	G(20)=G(16)+G(18)
481	=	481.000	G(21)=G(17)+G(19)
482	=	482.000	G(22)=G(20)+G(21)
483	=	483.000	29 200 IK=1.2P
484	=	484.000	IF (J.EQ.1) WANS(IK)=G(IK)
485	=	485.000	IF (J.EQ.2) TANS(IK)=G(IK)
486	=	486.000	200 CONTINUE

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548	-	548.000	G9=38+37
549	-	549.000	C CENTER SECTION WEIGHT CALCULATIONS
550	-	550.000	PLY=MR1TL/HL
551	-	551.000	PLY=MLTR2/HL
552	-	552.000	AX=PLY/FAL
553	-	553.000	AY=PLY/FAL
554	-	554.000	G10=(AX+AY)*1.28*RH0L*(LI-X)
555	-	555.000	TBYT=(TR2TR1/(WBCT*12.*HL))*(1./TAUS)
556	-	556.000	IF(TBYI.LE.TMIN) TBYI=TMIN
557	-	557.000	TRY=(SLTR2/HL)*(1./TAJS)
558	-	558.000	IF(TBY.LE.TBYT) TBY=TBYT
559	-	559.000	TRX=(SR1TL/HL)*(1./TAJS)
560	-	560.000	IF(TBX.LE.TMIN) TBX=TMIN
561	-	561.000	TRAVG=(TRY+TBX)/2.
562	-	562.000	G11=TRAVG*(LI-X)*(2.*HL+WBCT*12.)*RH0S*1.28
563	-	563.000	C CENTER SECTION FRAME CALCULATION
564	-	564.000	CF=1./16000.
565	-	565.000	DF=6.0
566	-	566.000	XCSEC=(6.0*CF*MLTR2*(WBCT*12.)*2.)/(LFS*EF*DF*2.)
567	-	567.000	WBM=XCSEC*(WBCT*12.*2.*HF)*RH0F/LFS
568	-	568.000	SYCSEC=(3.*DELPH*HL*HL*LFS)/(DF*FAF*8.)
569	-	569.000	BXCSEC=(1.44*DELPH*WBCT*WBCT*LFS)/(4.*DF*FAF)
570	-	570.000	WRP=(SXCSEC*2.*HL+BXCSEC*WBCT*12.)*RH0F/LFS
571	-	571.000	IF(WBP.LE.WBM) WBP=WBM
572	-	572.000	G12=WRP*(LI-X)*1.28
573	-	573.000	C CENTER SECTION BULKHEAD CALCULATION
574	-	574.000	G13=RHR3*((R1/(2.*FAB))*(4.*HF+2.*WBCT*12.))
575	-	575.000	1+(R1*WBCT*12./(2.*TAUB)))*1.28
576	-	576.000	G14=RHR3*((R2/(2.*FAB))*(4.*HF+2.*WBCT*12.))
577	-	577.000	1+(R2*WBCT/(2.*TAUB)))*1.28
578	-	578.000	G15=G13+G14
579	-	579.000	G16=K*300.
580	-	580.000	C CENTER SECTION WING PROVISION CALCULATION
581	-	581.000	G17=.5*(PLANWT*.001*WZ)*(WB/CBS(WTHETA/57.2958))*01
582	-	582.000	G18=G10+G11+G12+G15+G16+G17+WT9RBC
583	-	583.000	C CENTER SECTION D99R CALCULATION
584	-	584.000	G19=1.5R5*ACD
585	-	585.000	G20=1.0R*(LI-X)*K3
586	-	586.000	G21=660.
587	-	587.000	G22=G20+G21
588	-	588.000	G23=K4
589	-	589.000	G24=G18+G19+G22+G23
590	-	590.000	C COVER CALCULATIONS
591	-	591.000	C COVER SHELL CALCULATION
592	-	592.000	G25=SAW*TRAVG*RH0S*1.44*1.28*1.3
593	-	593.000	C COVER FRAME CALCULATION
594	-	594.000	G26=220.*WRP*(2.*HF+2.*WBCT*12.)/(2.*HL+WBCT*12.)*1.28*1.3
595	-	595.000	C COVER LONGERON CALCULATION
596	-	596.000	G27=110.*AY*RH0L*2.*1.28*1.3
597	-	597.000	G28=G25+G26+G27
598	-	598.000	C THRUST STRUCTURE CALCULATIONS
599	-	599.000	C THRUST POST
600	-	600.000	LE=(LTV**2+HTV**2)**.5
601	-	601.000	FTP=ET*.00395
602	-	602.000	G29=((T8V*N8ENG9)/FTP)*LE*RH3TP*DFAC*2.
603	-	603.000	C THRUST GIMBAL PLANE BULKHEAD
604	-	604.000	G30=RHR3*((T8V*N8ENG9*SIN(A91/57.2958))/(2.*FAP3)
605	-	605.000	1*DFAC*FS)*(4.*HF+2.*WBCT*12.)+(T8V*N8ENG9*SIN(A91/57.2958)
606	-	606.000	2*WBCT*12./(2.*TAUPB)))*2.
607	-	607.000	G31=N8ENG9*200.
608	-	608.000	G32=G29+G30+G31

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600	=	600.000	G33=G4
610	=	610.000	G34=6.7*(PV**001)**.6
611	=	611.000	G35=G35+G26+G27+G32+G34
612	=	612.000	G36=G35+G33
613	=	613.000	G37=G3+G24+G34
614	=	614.000	RETJRN
615	=	615.000	END
616	=	616.000	SUBROUTINE THERM9 (WSG, WESG, TSG, TBTTPS, TWGWT, WGWT, WGLEWT, TWT, TLEWT
617	=	617.000	1, PLRTPS, BASEWT, IBTWT, PTPSCN, TTWT, RTPSWT, MCSWT, LOTWT
618	=	618.000	2, PR9WT, PPRC, PHYC, SCWT)
619	=	619.000	IMPLICIT REAL (A-Z)
620	=	620.000	COMMON/MAIN/PR9PB, PR9PS, BHT, BCANT, SCANT, SCANTY
621	=	621.000	1, PCANTP, N9ENGR, N9ENGS, THBSL, TH9SL, TH9V, T9V, FL9WR
622	=	622.000	2, TF, FTW, FIXHRD
623	=	623.000	3, IS9BS, IS9BV, IS99BS, IS99BV, SCD, BTW
624	=	624.000	4, H, DVC9RR, INC, STAGV, DVC9N, DVCNST
625	=	625.000	5, REL, TH9TC, TH9SLT, TH9TC, IS9B, IS9B, PR9P9T
626	=	626.000	6, PR9P91, PR9P92, FW(2), DV9NC, DVB, DVT9TC, W9SCD, 9INWT, 9LANWT
627	=	627.000	7, 9INJAT, 9L9WT, 9L9W, 9L9W, T9TAL, S, P, MATCH, TLSSR, F9P
628	=	628.000	8, 9ALD, 9L9L9, 9L9WLB, 9MSISP, 9MSDVT, 9MSDVP, 9MR
629	=	629.000	9, L9NGP, T9W, T9WB, 9ENS, 9R9W, M9N9LW
630	=	630.000	COMMON/THERD/NCTPS, NCA, FWDTPS, FWDA, CTTPS, CTA, CSTPS
631	=	631.000	1, CSA, CRTPS, CBA, ATTPS, ATA, ASTPS, ASA, ABTPS, ABA, RASTPS
632	=	632.000	2, HASA, TPSC9N, WGT9S, W9PLE, WLET9S, TLTPS, TLPLE
633	=	633.000	3, TLET9S, MCSTPS, MCSA, NAC9N, TAC9N, I9A, IBTPS, IBC, LDA
634	=	634.000	4, LDTPS, PR9A, PR9TPS, PR9C, PPC, HYC, SCA, SCTPS, SWI, SNC, WSI
635	=	635.000	SNC=WSG
636	=	636.000	C W/S CORRECTION
637	=	637.000	WSC=9LANWT/(SWI+SNC)
638	=	638.000	DUNT=(WSC/WSI)**.125
639	=	639.000	C BODY TPS WEIGHT
640	=	640.000	NCWT=NCTPS*NCA*DUNT
641	=	641.000	FWDWT=FWDTPS*FWDA*DUNT
642	=	642.000	CTWT=CTTPS*CTA*DUNT
643	=	643.000	CSWT=CSTPS*CSA*DUNT
644	=	644.000	CBWT=CBTPS*CBA*DUNT
645	=	645.000	CT9TA=CTA+CSA+CBA
646	=	646.000	CT9TWT=CTWT+CSWT+CBWT
647	=	647.000	ATWT=ATTPS*ATA*DUNT
648	=	648.000	ASWT=ASTPS*ASA*DUNT
649	=	649.000	ABWT=ABTPS*ABA*DUNT
650	=	650.000	AT9TA=ATA+ASA+ABA
651	=	651.000	AT9TWT=ATWT+ASWT+ABWT
652	=	652.000	RLHTPS=NCWT+FWDWT+CT9TWT+AT9TWT
653	=	653.000	BASEWT=RASTPS*HASA*DUNT
654	=	654.000	IBTWT=IBA*IBTPS+IBC
655	=	655.000	RTP9WT=NCWT+FWDWT+CT9TWT+AT9TWT+BASEWT+TPSC9N+IBTWT
656	=	656.000	C WING TPS WEIGHT
657	=	657.000	WGWA=XESG*NAC9N
658	=	658.000	WGLEA=WGWA*W9PLE
659	=	659.000	W9TPSA=WGWA-WGLEA
660	=	660.000	WGWT=W9TPSA*W9TPS*DUNT
661	=	661.000	WGLEWT=WGLEA*WLET9S*DUNT
662	=	662.000	TWGWT=WGWT+WGLEWT
663	=	663.000	C TAIL TPS WEIGHT
664	=	664.000	TWA=TSG*TAC9N
665	=	665.000	TLEA=TWA*TLPLE
666	=	666.000	TTPSA=TWA-TLEA
667	=	667.000	TWT=TTPSA*TLTPS*DUNT
668	=	668.000	TLEWT=TLEA*TLET9S*DUNT
669	=	669.000	TTWT=TWT+TLEWT

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670	-	670.000	MCSWT=MCSPTS*MCSA*DUWT
671	-	671.000	LDTWT=LDA*LDTPS
672	-	672.000	PRWT=PRAA*PRRTPS*PRBC
673	-	673.000	SCWT=SCA*SCTPS
674	-	674.000	TOTTPS=RTPSWT+TWGWT+TTWT+MCSWT
675	-	675.000	1+LDTWT+PRWT+PPC+HYC+SCWT
676	-	676.000	RTPSCN=TPSCBN
677	-	677.000	PPPC=PPC
678	-	678.000	PHYC=HYC
679	-	679.000	RETURN
680	-	680.000	END
681	-	681.000	SUBROUTINE ASCENT(TAPRSP,ENGPAC,ENG3,TVC,CNTR,PRPUTL
682	-	682.000	1,PRRYSYS,FAD,PRES,CHIL,PREVAL,FEEDS,DISC,MISC)
683	-	683.000	REAL MISC,MISCF,JAC,NBENG8
684	-	684.000	COMMON/MAIN/ PRP93,PRP98,RBT,BCANT,BCANT,BCANTY
685	-	685.000	1,MCANTP,NBENG3,NBENG9,THBSL,THBSL,THSV,TBV,FLWR
686	-	686.000	2,TF,FTW,FXHRD
687	-	687.000	3,ISP95,ISP9V,ISP995,ISP99V,SCD,BTW
688	-	688.000	4,H,DVC9RR,INC,STAGV,DVC8N,DVCN8
689	-	689.000	5,REL,THBTC,THBSLT,THBTC,ISP8,ISP8,PRP9T
690	-	690.000	6,PRP9J1,PRP9J2,FW(2),DVBNC,DVB,DVT9TC,W9SCD,9INWT,9LANWT
691	-	691.000	7,MINJNT,RL9WT,9GL9W,9L9W,T9TAL,S,P,MATCH,TLSSR,FPRP
692	-	692.000	8,9H9LD,9L9L9,9L9WL9,9MSISP,9MSDVT,9MSDVP,9MR
693	-	693.000	9,L9NGP,TR99,T9WB,SENS,GR9W,MINGLW
694	-	694.000	COMMON/ASPD/PRG9,SPI,4HEAD,8HEAD,HULL,GULL,FTU,R49
695	-	695.000	1,MATL,HOLEN,9CLEN,HELEN,9ELEN,CPLGT
696	-	696.000	BEENG9=3.0
697	-	697.000	BAENG=6326.
698	-	698.000	ESLP=1.225
699	-	699.000	BETHST=472000.
700	-	700.000	RPUTL=10.
701	-	701.000	BFAD=773.
702	-	702.000	BPRES=1097.
703	-	703.000	BCHIL=133.
704	-	704.000	BRECIR=885.
705	-	705.000	BFIAIN=12.
706	-	706.000	BP999=100.
707	-	707.000	BFIAD=17.
708	-	708.000	GES=3.
709	-	709.000	SUPTF=25.
710	-	710.000	H099R=50.
711	-	711.000	9099R=50.
712	-	712.000	MISCF=10.
713	-	713.000	C CALCULATE MAIN ENGINE WT.
714	-	714.000	ECST=BAENG/BETHST**ESLP
715	-	715.000	ENGJ=ECST*T9V**ESLP
716	-	716.000	ENG=NSENG9*ENGU
717	-	717.000	C CALCULATE TVC WT.
718	-	718.000	TVCJ=.000422*T9V+208.
719	-	719.000	TVC=TVCJ*NSENG9
720	-	720.000	C CALCULATE IGNITION AND CONTROL WT.
721	-	721.000	CNTR=377.+67.*NBENG9+P9G8*NBENG9+.53*34
722	-	722.000	C CALCULATE PROPELLANT UTILIZATION SYS WT.
723	-	723.000	PRPJTL=BPRTL
724	-	724.000	C CALCULATE FILL AND DRAIN WT.
725	-	725.000	FAD=BFAD
726	-	726.000	C CALCULATE PRESSURIZATION SYS WT.
727	-	727.000	PRES=BPRES*((T9V*NBENG9)/(BETHST*BEENG9))**.5
728	-	728.000	C CALCULATE CHILLDOWN DUMP SYS WT.
729	-	729.000	CHIL=(BCHIL/BEENG9)*(T9V/BETHST)**.5*NBENG9
730	-	730.000	C CALCULATE RECIRC SYS WT.

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731 - 731.000 RECIR=BRECIR*((T9V*N9ENG9)/(BETHST*BENGN9))**.5*SPI
732 - 732.000 IF(SPI.GT.0.) CHIL=0.
733 - 733.000 C CALCULATE PRE VALVE WT.
734 - 734.000 DIAIN=BDIAIN*(T9V/BETHST)**.5
735 - 735.000 VALVE=1.582*DIAIN**1.78
736 - 736.000 B2PV=N9ENG9*(VALVE+P9G9*BP9G9)
737 - 737.000 H2PV=N9ENG9*VALVE
738 - 738.000 C CALCULATE EXT TANK DISCONNECT WT.
739 - 739.000 DIAO=BDIAO*((T9V*N9ENG9)/(BETHST*BENGN9))**.5
740 - 740.000 DIAOR=(.125*DIAO**2.)*.5
741 - 741.000 DIAO9=SPI*(.5*DIAO**2.)*.5
742 - 742.000 IF(SPI.EQ.0.) DIAO9=DIAO
743 - 743.000 H2OV=.582*DIAO**1.78
744 - 744.000 B2OV=SPI**2.*1.582*DIAO9**1.78
745 - 745.000 IF(SPI.EQ.0.) B2OV=H2OV
746 - 746.000 C CALCULATE FEED DUCT WT.
747 - 747.000 HPRES=MULL+HMFAD*3ES**4./1728.
748 - 748.000 BPRES=MULL+HMFAD*3ES*71./1728.
749 - 749.000 THD=HPRES*DIAO/FTU
750 - 750.000 THDM=0.
751 - 751.000 IF(MATL.EQ.1) THDM=.002*DIAO+.008
752 - 752.000 IF(MATL.EQ.2) THDM=.003*DIAO+.010
753 - 753.000 IF(MATL.EQ.3) THDM=.003*DIAO+.030
754 - 754.000 IF(MATL.EQ.4) THDM=.002*DIAO+.024
755 - 755.000 IF(THDM.GT.TH0) THD=THDM
756 - 756.000 T9D=BPRES*DIAO9/FTU
757 - 757.000 T9DM=0.
758 - 758.000 IF(MATL.EQ.1) T9DM=.002*DIAO9+.008
759 - 759.000 IF(MATL.EQ.2) T9DM=.003*DIAO9+.010
760 - 760.000 IF(MATL.EQ.3) T9DM=.003*DIAO9+.030
761 - 761.000 IF(MATL.EQ.4) T9DM=.002*DIAO9+.024
762 - 762.000 IF(T9DM.GT.T9D) T9D=T9DM
763 - 763.000 THE=HPRES*DIAIN/FTU
764 - 764.000 T9E=BPRES*DIAIN/FTU
765 - 765.000 TEM=0.
766 - 766.000 IF(MATL.EQ.1) TEM=.002*DIAIN+.008
767 - 767.000 IF(MATL.EQ.2) TEM=.003*DIAIN+.010
768 - 768.000 IF(MATL.EQ.3) TEM=.003*DIAIN+.030
769 - 769.000 IF(MATL.EQ.4) TEM=.002*DIAIN+.024
770 - 770.000 IF(THE.LT.TEM) THE=TEM
771 - 771.000 IF(T9E.LT.TEM) T9E=TEM
772 - 772.000 HDUCT=HCLEN*3.1416*DIAO*THD*RHS
773 - 773.000 S+HELEN*N9ENG9*3.1416*DIAIN*THE*RHS
774 - 774.000 JAC=HCLEN*(3.1416/2.)*(2.+DIAO)*3.1416*.012
775 - 775.000 S+.286+HELEN*N9ENG9*3.1416/2.*(2.+DIAIN)*3.1416
776 - 776.000 S+.012*.286+(HCLEN*(1.+DIAO)*3.1416*1.
777 - 777.000 S+HELEN*N9ENG9*(1.+DIAO)*3.1416*1.)*5./1728.
778 - 778.000 HDUCT=HDUCT+JAC
779 - 779.000 GDUCT=HCLEN*3.1416*DIAO9*T9D*RHS*(1.+SPI)
780 - 780.000 S+HELEN*N9ENG9*3.1416*DIAIN*T9E*RHS
781 - 781.000 Y=.012
782 - 782.000 Z=.286
783 - 783.000 IF(CPLGI.EQ.1.) Y=.125
784 - 784.000 IF(CPLGI.EQ.1.) Z=.24
785 - 785.000 HC9JPL=2.*N9ENG9*(Y*DIAIN+Z*.193*DIAIN)
786 - 786.000 S+N9ENG9*(Y*DIAIN+Z*(.286+RHS)*DIAIN/2.)
787 - 787.000 S+N9ENG9*(Y*DIAIN+Z*RHS*DIAIN)
788 - 788.000 S+(Y*DIAO+Z*(.1+RHS)*DIAO/2.)
789 - 789.000 X=(Y*DIAIN+Z*(.286+RHS)*DIAIN/2.)*N9ENG9
790 - 790.000 IF(RHS.GT..28) HC9UPL=HC9UPL-X
791 - 791.000 HC9JPL=2.*N9ENG9*(Y*DIAIN+Z*.193*DIAIN)

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792	-	792.000	$S+N9ENG9*(Y*DIAIN+Z*(.286+R49)*DIAIN/2.)$
793	-	793.000	$S+N9ENG9*(Y*DIAIN+Z*R49*DIAIN)$
794	-	794.000	$S*(1.+SPI)*(Y*DIAD9+Z*(.1+R49)*DIAD9/2.)$
795	-	795.000	$X=(Y*DIAIN+Z*(.286+R49)*DIAIN/2.)*N9ENG9$
796	-	796.000	$IF(R49.GT..28) 9C9UPL=9C9UPL-X$
797	-	797.000	$X=INT(HCLEN/300.)$
798	-	798.000	$HREL9S=X*.04178*DIAD9**2.1+N9ENG9$
799	-	799.000	$S*(.04178*DIAIN**2.1+2**01854*DIAIN**2.8)$
800	-	800.000	$X=INT(9CLEN/300.)$
801	-	801.000	$9REL9S=X*.1475*DIAD9**2.05+N9ENG9$
802	-	802.000	$S*(.1475*DIAIN**2.05+2**03451*DIAIN**2.86)$
803	-	803.000	$HSUPT=.01*SUPTF*(HC8UPL+H2PV+H2DV+HDUCT+HBEL9S)$
804	-	804.000	$9SUPT=.01*SUPTF*(9C8UPL+92PV+92DV+9DUCT+9BEL9S)$
805	-	805.000	$HDR=H99R$
806	-	806.000	$9DR=909R$
807	-	807.000	$92FD=9C8UPL+9DUCT+9BEL9S+9SUPT+9DR$
808	-	808.000	$H2FD=HC8UPL+HDUCT+HBEL9S+HSUPT+HDR$
809	-	809.000	C CALCULATE MISC WT.
810	-	810.000	MISC=.01*MISCF*(TVC+C9NTR+PRPUTL+FAD
811	-	811.000	$S+PRES+CHIL+RECIR+92PV+H2PV+H2DV+92DV$
812	-	812.000	$S+92FD+H2FD)$
813	-	813.000	C SUM DRY WT.
814	-	814.000	AT9T=MISC/(.01*MISCF)+MISC+ENG
815	-	815.000	C MAIN ASCENT OUTPUT
816	-	816.000	ENGPAC=ENG+TVC+C9NTR+PRPJTL
817	-	817.000	PREVAL=92PV+H2PV
818	-	818.000	FEEDS=92FD+H2FD
819	-	819.000	DISC=92DV+H2DV
820	-	820.000	PR9SYS=FAD+PRES+CHIL+PREVAL+FEEDS+DISC+MISC
821	-	821.000	TAP99P=ENGPAC+PR9SYS
822	-	822.000	9ETJRN
823	-	823.000	END
824	-	824.000	SUBROUTINE LADSYS(LNDCK,NG1,NG2,NG3,NGEAR,MG1,MG2,MG3
825	-	825.000	1,MGEAR,AX1,AX2,AX3,AXGEAR,LNDCK)
826	-	826.000	IMPLICIT REAL(A-Z)
827	-	827.000	C9M9N/MAIN/ PR9P3,PR9P9,B9T,BCANT,9CANT,9CANTY
828	-	828.000	1,9CANTP,N9ENG9,N9ENG9,TH9SL,TH9SL,TH9V,T9V,FL9WR
829	-	829.000	2,TF,FTW,FIXHRD
830	-	830.000	3,ISP95,ISP9V,ISP9S,ISP9B,SCD,BTW
831	-	831.000	4,H,DVC9R,INC,STA3V,DVC9N,DVCNST
832	-	832.000	5,REL,TH9TC,TH9SLT,TH9TC,ISP9,ISP9,PR9P9T
833	-	833.000	6,PR9P91,PR9P92,FW(2),DVC9C,DVB,DVT9TC,W9SCD,9INWT,9LANWT
834	-	834.000	7,9INJAT,9L9WT,9GL9W,9L9W,T9TAL,S,P,MATCH,TLSSR,F9RP
835	-	835.000	8,9H9LD,9LL9L9,9L9WL9,9MSISP,9MS9VT,9MSDVP,9MR
836	-	836.000	9,L9V9P,T9W9,T9W9,SENS,GR9W,MINGLW
837	-	837.000	C9M9N/LD9D/ LGFTJ,LGVSL,L3LC,LGLS,L9DIA,BRCF
838	-	838.000	M9R=9LANWT*235000./215000.
839	-	839.000	N9R=9LANWT*79000./215000.
840	-	840.000	PHI=0.
841	-	841.000	THETA=45.
842	-	842.000	THETA=THETA+3.14159/180.
843	-	843.000	PHI=PHI+3.14159/180.
844	-	844.000	NUMNT=2.
845	-	845.000	NUMM=4.
846	-	846.000	L1=L3LC
847	-	847.000	L2=.2*L3LC
848	-	848.000	L3=.5*LGLS
849	-	849.000	L4=.5*L3LC
850	-	850.000	L5=25.5
851	-	851.000	L6=9.
852	-	852.000	L8=L4*TAN(PHI)

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853	853.000	$L7 = L6 + L3 / \tan(\theta) - L8$
854	854.000	$D = 9.$
855	855.000	$BRKWT = (9LANWT / 128.8) * (((1.6875 * LGVSL) ** 2) / BRCE)$
856	856.000	$SP = MGR$
857	857.000	$TWTT = SP * .00687 / 2.$
858	858.000	$TWH = SP / (266.666667 * 2.)$
859	859.000	$AXLES = TWH * .44226$
860	860.000	$VR = .5 * 9LANWT * 1.4$
861	861.000	$DR = .4 * 9LANWT * 1.4$
862	862.000	$VI = .4 * VR$
863	863.000	$V9 = .6 * VR$
864	864.000	$VC = (1. / L7) * (V9 * (L5 + L9) - VI * (L5 - L8))$
865	865.000	$SC = VC / \tan(\theta)$
866	866.000	$VA = (1. / L1) * (LGLS * DR - ((VR + VC) * (L1 / 2.)))$
867	867.000	$VB = VR + VC + VA$
868	868.000	$MAA = .5 * L1 * (VA + VB) - L4 * DR$
869	869.000	$AC = 1.26 * ((MAA / (.85 * LGFTU)) ** (2.0 / 3.0))$
870	870.000	$RC = \sqrt{AC / (.596902604165)}$
871	871.000	$WC = AC * (LGLC - L2) * .283$
872	872.000	$BRACE = .1 * WC$
873	873.000	$B = 2. * RC - 9. * \sin(\phi)$
874	874.000	$BETA = \arctan((L2 + L4) / L1)$
875	875.000	$LA = (.5 * L1 - RC) / (\cos(\beta) * \cos(\phi))$
876	876.000	$MSIDE = (VB * \cos(\phi) + SC * \sin(\phi)) * \cos(\beta) * LA$
877	877.000	$MFR9NT = (VB * \sin(\phi) - SC * \cos(\phi)) * LA$
878	878.000	$D1 = (729. - (54. * MSIDE) / (LGFTU * (2. * RC - 9. * \sin(\phi)))) ** (1. / 3.)$
879	879.000	$D4 = 6. * MFR9NT / (4. * LGFTU * RC)$
880	880.000	$AF = (D - (D1 - D4)) * 3 + (D1 - D4)$
881	881.000	$WFA = 1.05 * AF * LA * .283 * .5$
882	882.000	$MSIDEP = ((VB * \cos(\phi) + SC * \sin(\phi)) * \cos(\beta) - DR * \sin(\beta)) * LA$
883	883.000	$D1P = (729. - (54. * MSIDEP) / (LGFTU * (2. * RC - 9. * \sin(\phi)))) ** (1. / 3.)$
884	884.000	$AA = (D - (D1P - D4)) * 3 + (D1P - D4)$
885	885.000	$WAA = 1.05 * AA * LA * .283 * .5$
886	886.000	$MP = DR * (LGLS - LGLC)$
887	887.000	$AP = 1.26 * (MP / LGFTU) ** (2. / 3.)$
888	888.000	$WP = 1.5 * AP * LGLC * .283$
889	889.000	$TWSSC = WAA + WFA + WC + BRACE$
890	890.000	$ATF = .06 * TWSSC * 1.1$
891	891.000	$WT = TWSSC + WP + BRKWT + TWTT + AXLES + ATF + TWH$
892	892.000	$MC9NTM = .225 * (WT * .95)$
893	893.000	$WT = WT + MC9NTM$
894	894.000	$\theta_2 = \theta * 180. / 3.14159$
895	895.000	$\phi_2 = \phi * 180. / 3.14159$
896	896.000	$SPN = NGR / NUMNT$
897	897.000	$WNT = SPN * .006875$
898	898.000	$TWNT = WNT * NJMNT$
899	899.000	$WHN = SPN / 266.66667$
900	900.000	$AXLN = WHN * .44226$
901	901.000	$STN = TWSSC * .40$
902	902.000	$ATFN = .06 * TWSSC * 1.1$
903	903.000	$WTNG = TWNT + WHN * AXLN + STN + ATFN$
904	904.000	$NC9NTM = (WTNG * .95) * .850$
905	905.000	$WTNG = WTNG + NC9NTM$
906	906.000	$WC = WC * 1.25$
907	907.000	$WFA = WFA * 1.25$
908	908.000	$WAA = WAA * 1.25$
909	909.000	$BRACE = BRACE * 1.25$
910	910.000	$TWSSC = TWSSC * 1.25$
911	911.000	$AXLES = AXLES * 1.25$
912	912.000	$WP = WP * 1.25$
913	913.000	$MC9NTM = MC9NTM * 1.25$

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914 - 914.000      ATF = ATF*1.25
915 - 915.000      BRKWT = BRKWT * 1.25
916 - 915.000      TWTT = TWTT*1.25
917 - 917.000      TWH = TWH*1.25
918 - 918.000      WT = TWSSC+WP+BRKWT + TWTT+AXLES+ATF+TWH+MCOVTM
919 - 919.000      TWNT = TWNT*.80
920 - 920.000      WHN = WHN*.80
921 - 921.000      AXLN = AXLN*.80
922 - 922.000      STN = STN*.80
923 - 923.000      ATFV = ATFV*.80
924 - 924.000      NCONTN = NCONTN*.80
925 - 925.000      WING = TWNT+WHN+AXLN+STN+ATFV+NCONTN
926 - 925.000      VG1 = TWNT+WHN
927 - 927.000      VG2 = STN+AXLN+ATFV
928 - 928.000      VG3 = NCONTN
929 - 929.000      VGEAR = VG1+VG2+VG3
930 - 930.000      MG1 = (TWH+TWTT+BRKWT)*2.
931 - 931.000      MG2 = (TWSSC+AXLES+ATF+WP)*2.
932 - 932.000      MG3 = (MCOVTM)*2.
933 - 933.000      MGEAR = MG1+MG2+MG3
934 - 934.000      AX1 = 1.5*(1.82*(1.0074*(1.07528/(2.*32.2)*(1.6878+L3VSL)**2)**.57
935 - 935.000      5*(LGDIA+LGDIA+3.*LGDIA)+10.))
936 - 935.000      AX2 = AX2
937 - 937.000      AX3 = AX3
938 - 938.000      AXGEAR = AX1+AX2+AX3
939 - 939.000      LNDJK = VGEAR+MGEAR+AXGEAR+LNDJKK
940 - 940.000      RETJRN
941 - 941.000      END
  
```

4. EXTERNAL TANK MODULE

This module contains the analytical and empirical weight estimation relationships necessary to completely define the external tank. The basic sizing logic consists of three basic general arrangement options and three separate iteration techniques, i.e., solve for specific tank dimensions as a function of volume requirements with either input of fixed length, fixed diameter, or fixed L/D. Design features, such as separate and common bulkhead and an alternate forward section design are also included. A LOX aft option, which simply uses the generalized baseline LOX forward method, setting mixture ratio to its inverse and switching the hydrogen and oxygen densities, is also available.

The external tank module includes a design loads model which considers ullage and head pressure, interstage reactions, and axial load factors.

A multistation analysis method is included, whereby a number of body station cuts are examined to determine the effective unit load and corresponding material thickness required for pure unstiffened Monocoque structure. Alternate material allowables may be input to handle variations in design temperature and other candidate construction techniques. The resultant material thicknesses are integrated over the total body area using the dimensional data from the sizing routine, to determine the total sidewall weight. The bulkheads are sized to their representative loads, i.e., internal or external pressure, and meridional and hoop forces. Splice rings and attachment structure are treated as discrete items, with major attention given to the redistributions of point loads and manufacturing processes such as welding.

The external tank thermal protection system is based on detailed MDAC point design data with input unit weights for alternate design concepts.

Other external tank subsystems are expressed as either input constants for such systems as avionics, or simplified sizing equations, where, for example, plumbing weight is a function of engine flow rate and overall tank length/diameter.

Figure 4-1 is a flow diagram of the External Tank Module, followed by a detail listing of the program.

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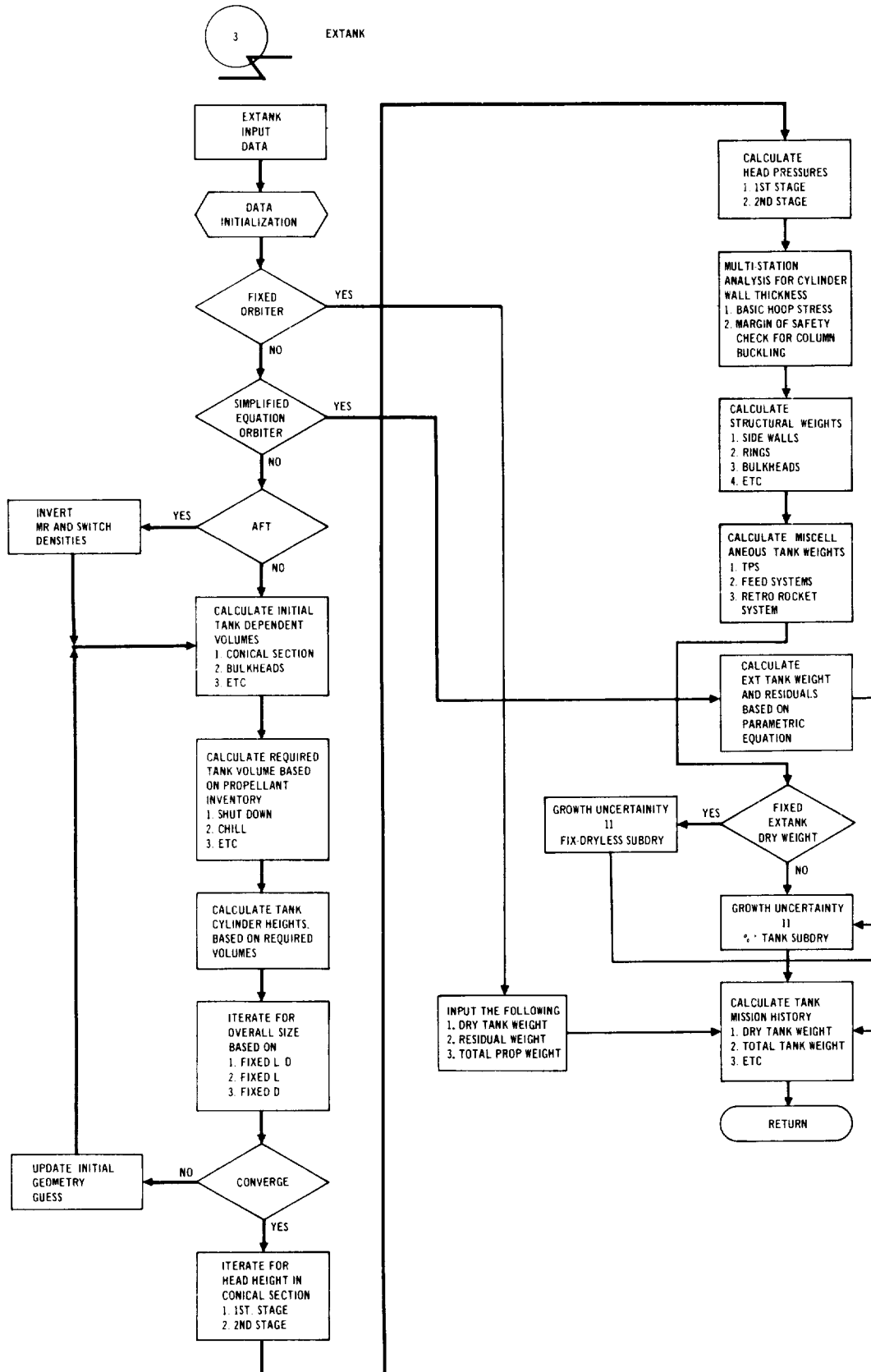


FIGURE 4-1 FLOW DIAGRAM

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COPY	ESUB	T ₃	P(K,VC)	
1	-	1.000	#FIXED	
2	-	2.000	C	
3	-	3.000	C	
4	-	4.000	C	EXTERNAL TANK SUBROUTINE
5	-	5.000	C	SUBROUTINE EXTANK
6	-	6.000	C	THIS PROGRAM COMPUTES EXTERNAL (L _{1X} /L _{1Z}) TANK DIMENSIONS
7	-	7.000	C	AND WEIGHT KNOWING MIXTURE RATIO, USEABLE PROPELLANT
8	-	8.000	C	LOAD AND EITHER REQUIRED TANK L/D, LENGTH OR DIAMETER.
9	-	9.000	C	IMP_LICIT REA_(A-Z)
10	-	10.000	C	INTEGER I
11	-	11.000	C	DIMENSION HFX(9),
12	-	12.000	C	SMCT(9), WLD(9), WLD9(9),
13	-	13.000	C	SMF(9), W9(9), FHCT(9), HX(9), TFT(9), TB(9), MF(9), M9(9)
14	-	14.000	C	
15	-	15.000	C	PERFORMANCE COMMON BLOCK
16	-	16.000	C	
17	-	17.000	C	COMMON/MAN/ PR9P3, PR9P9, BBT, BCANT, BCANT, BCANTY
18	-	18.000	C	1, BCANTP, NSENG9, NSENG9, TH9SL, TH9SL, TH9V, T9V, FL9AR
19	-	19.000	C	2, TF, FTW, FIXHRD
20	-	20.000	C	3, ISP3S, ISP3V, ISP3S, ISP3V, SCD, BTW
21	-	21.000	C	4, H, JVC9RR, INC, STAGV, JVC9V, JVC9ST
22	-	22.000	C	5, REL, TH9TC, TH9SL, TH9TC, ISP9, ISP3, PR9P3T
23	-	23.000	C	6, PR9P31, PR9P32, FX(2), JVN9C, JVB, JVT9TC, W9SCD, 91NWT, 9LANWT
24	-	24.000	C	7, 91NWT, 9L9WT, 9L9WT, 9L9WT, 9L9WT, T9TAL, S, P, MATCH, TL9SR, F9P3
25	-	25.000	C	8, 949LD, 9LL9L9, 9L9WL9, 9MSIS9, 9MSDVT, 9MSDVP, 9M2
26	-	26.000	C	9, L9V9P, T9W9, T9W9, SENS, GR9W, MINGLW
27	-	27.000	C	
28	-	28.000	C	SRM OUTPUT COMMON BLOCK
29	-	29.000	C	
30	-	30.000	C	COMMON/SRM/BB9WT, BDRYWT, 9L9W, LAM3, PW9I
31	-	31.000	C	1, BASSRM, WCASE, J9JINT, W9ZZ, WTTT, WINST, WIGN, 9SRMC
32	-	32.000	C	2, SRMISS, PAFS, PNAS_S, PNAS, PNF, PATN, PNAV, WNT9S, SRMIC
33	-	33.000	C	3, WREC9V, PPAR, PPI, PRR, PRRP, PWR, SRMRC
34	-	34.000	C	4, UNCERT, EXPINS, 99SLUN, SRML, SRM
35	-	35.000	C	5, P39SS, P39WT, P39P3, P39WT, P39SLJ
36	-	36.000	C	6, FIX999, SIMP39
37	-	37.000	C	
38	-	38.000	C	9RBITER OUTPUT COMMON BLOCK
39	-	39.000	C	
40	-	40.000	C	COMMON/9RB9/R1, R2, RL, WTAJX, WTACS, ACS9NG, ACS9YS, WTACTK
41	-	41.000	C	1, ACS9D, WT9MS, 9MS9NG, PR9PSY, WT9MTK, M9DJLE
42	-	42.000	C	1, SURFC, PPAR, ELEC, HYDR, AVI9N9, ECL9S, PR99V, 9JNCWT
43	-	43.000	C	2, 9RMIS, TAB99, 9JRFK
44	-	44.000	C	1, PER99N, 9RES9, 9RESV, P_9ADU, P_9ADD, ACS9R9, W9PR9P, 9JCLE
45	-	45.000	C	2, FIX9RB, FIX99R, 9DRYWT, 9RIFL
46	-	46.000	C	1, WNT, W9G, W9STR, W9RBE, W9RBC, LENA, WTE, WAIL, WAS, WADR, WAW
47	-	47.000	C	2, WAP, 9PR9V, PNINGK, TAIL, T9G, T9STR, T9R9B, TLE, W9JD, WRS
48	-	48.000	C	3, W9DR, W9H, W9P, PTAILK
49	-	49.000	C	1, G37, 31, 32, 33, 36, 37, 38, 39, 310, 311, 312, 315, 316
50	-	50.000	C	2, G17, 318, 319, 322, 323, 324, G25, G26, G27, G32, G33, 334
51	-	51.000	C	3, G35, 336
52	-	52.000	C	1, T9TTPS, T9WT, W9WT, W9LWT, TWT, TLEWT, BL9TPS
53	-	53.000	C	2, PASEWT, IBTW, PTP9CN, TTWT, BT9WT, M9SWT, LDTWT
54	-	54.000	C	3, PR9WT, P9PC, PH9C, SCWT
55	-	55.000	C	1, TAB99P, ENG9AC, ENG, TVC, CNTR, PR9UTL, PR9SYS
56	-	56.000	C	2, P9D, PRES, CHIL, PREVA, FEEDS, DISC, MISC
57	-	57.000	C	1, LND9K, NG1, NG2, NG3, NG9AR, M31, M32, M33, M99AR, AX1, AX2
58	-	58.000	C	2, AX3, AX99AR, LND9K
59	-	59.000	C	

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60	-	60.000	C	EXTERNAL TANK SUTPUT COMMON BLOCK
61	-	61.000	C	
62	-	62.000		C9M49N/EXT9,3P0GR2,T9T9S,FWDTK,FAIRT,FWDBLF,ECCTPS
63	-	63.000		1,C9NSCT,TPSIN,CYLSCT,SCYDM,AFTBLF,WINT,PROSY,AFTNK
64	-	64.000		2,FEOSYS,FWDBLA,PRSVNT,AFTCYL,SUMP,AFTBLA,P4PJ,T4INT
65	-	65.000		3,N9SFAR,AVI0NT,JM3PNL,WRETR0,TUNNEL,MISCT,BAFF,SJBDRY
66	-	66.000		4,GU,DRYWT,RESIDT,JNDRAN,FEEDTR,PR5JRT,FBIAS,INERT
67	-	67.000		5,GR9SSW,TLAMB,0TRAP,EXTL,EXTD,BLKHD,EXTH0,EXTH4,SIMPTK
68	-	68.000	C	
69	-	69.000	C	EXTERNAL TANK (EXT) INPUT DATA BLOCK
70	-	70.000	C	
71	-	71.000		NAMELIST
72	-	72.000		3,DI,LI,LD,NR,ND,THETA,HHI,MRI,UPER9,LA,F0PRES,9PRES
73	-	73.000		3,FUPRES,9UPRES,LF,DF,LC0N,BLKHD,BX,K,UPERF,
74	-	74.000		3,4BIAS,ES,NXL,NXS,FTU,E,R40,TMIN,
75	-	75.000		3,NC1PS,UCTPS,LCTPS,CYTPS,INTPS,DMTPS,FXDWT,GJP,
76	-	76.000		5,RET0V,RETISP,AVI0NT,MISCT,AFT,HRI,RX1,RX2,RX_
77	-	77.000		3,SIMPTK,INERT,DRYWT,RESIDT,PR0MIN
78	-	78.000	C	
79	-	79.000		IF(P.E0.2.0) G0 T9 1
80	-	80.000		INPJT(1)
81	-	81.000		L=LI
82	-	82.000	1	IF(FIX9RB.3T.0.0) G0 T9 400
83	-	83.000		IF(SIMPTK.3T.0.0) G0 T9 500
84	-	84.000		IF(PR0P9T.LE.PR0MIN.AND.DF.E3.0.0) G0 T0 600
85	-	85.000		IF(AFT.VE.0.) G9 T9 11
86	-	86.000		G9 T9 12
87	-	87.000	C	SET L9X AFT(INVERT MR & SWITCH DENSITIES)
88	-	88.000	11	MR=1./MRI
89	-	89.000		XFUPR=9JPRES
90	-	90.000		XF9PR=9PRES
91	-	91.000		X9JPR=FJPRES
92	-	92.000		X9PR=F9PRES
93	-	93.000		XPER9=JPERF
94	-	94.000		XPERF=UPER9
95	-	95.000		FDEN=71.
96	-	96.000		9DEN=4.4
97	-	97.000		G9 T9 13
98	-	98.000	C	BASELINE L9X FORWARD
99	-	99.000	12	FDEN=4.4
100	-	100.000		9DEN=71.
101	-	101.000		MR=MRI
102	-	102.000	C	INITIALIZE DIMENSIONS DF=FIXED DIAMETER,
103	-	103.000	C	LF=FIXED LENGTH,LD=FIXED L/D,LI,DI,HHI ARE
104	-	104.000	C	INITIAL GUESSES
105	-	105.000	13	H=HHI
106	-	106.000		FUEL=PR0PAT/(1.+MR)
107	-	107.000		9XID=FUEL*MR
108	-	108.000		IF(LF.E0.0.0) G9 T9 5
109	-	109.000		TV9L=FUEL/FDEN+9XID/9DEN
110	-	110.000		D=((TV9L*1728.)/(0.7854*LF))**.5
111	-	111.000	5	IF(DF.GT.0.0) D=DF
112	-	112.000		L=LI
113	-	113.000		IF(LF.GT.0.0) L=LF
114	-	114.000	10	IF(LD.GT.0.) D=L/LD
115	-	115.000		D=D-2.*K
116	-	116.000	C	CALCULATE DEPENDENT DIMENSIONS,THETA IS FWD
117	-	117.000	C	CORNE ANGLE INPUTTED IN DEGREES
118	-	118.000	15	IF(BLKHD.GT.2.) G9 T9 16
119	-	119.000		ND=2.*NR*C9S(THETA/57.2958)
120	-	120.000	16	HC=(.5*D-.5*ND)/TAN(THETA/57.2958)

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121 - 121.000      R=D/3.***5
122 - 122.000      HR=4R1*R
123 - 123.000      IF(RL<HD.GT.2.) G9 T9 17
124 - 124.000      HC9=HC*.1364/SIN(THETA/57.2958)
125 - 125.000      9D=7-2.**HC9*TAN(THETA/57.2958)
126 - 126.000      9R=9D/3.***5
127 - 127.000      49R=.5*9R
128 - 128.000      4N=9R-.5*(4.**9R**2-ND**2)***5
129 - 129.000      C
130 - 130.000      CALCULATE DEPENDENT VOLUMES
131 - 131.000      V9LF=.2612*HC9*(D**2+D*9D+9D**2)
132 - 132.000      V9LR=1.0472*49R**2*(3.**9R-49R)
133 - 133.000      G9 T9 18
134 - 134.000      17 V9LF=.2618*HC*(D**2+D*ND+ND**2)
135 - 135.000      18 V9LA=1.0472*4R**2*(3.**R-4R)
136 - 136.000      V9LC=.7854*D**2*4R-V9LA
137 - 137.000      IF(RL<HD.GT.1.0) V9LC=V9LA
138 - 138.000      V9LD=V9LA
139 - 139.000      C
140 - 140.000      CALCULATE PROPELLANT INVENTORY
141 - 141.000      9FL9WX=FL9WR/(1.+4R)
142 - 142.000      9FL9WY=FL9WR*4R/(1.+4R)
143 - 143.000      C
144 - 144.000      FUEL INVENTORY
145 - 145.000      FSTART=3.255*9FL9WX
146 - 146.000      IF(RX.NE.1.0) FSTART=.84*9FL9WX
147 - 147.000      FSHJT=.1965*9FL9WX
148 - 148.000      FEEDF=.00189*D*9FL9WX
149 - 149.000      FCHILL=.01355*9FL9WX
150 - 150.000      IF(RX.NE.1.0) FCHILL=.0435*9FL9WX
151 - 151.000      FENG=.16941*9FL9WX
152 - 152.000      FBIAS=.0025*FUEL
153 - 153.000      IF(4BIAS.GT.0.) FBIAS=4BIAS
154 - 154.000      FDRAIN=100.
155 - 155.000      F9FL9W=FEEDF+FCHILL+FENG
156 - 156.000      DISPVF=.0000952*(4H-4R)*9FL9WY
157 - 157.000      IF(RL<HD.GT.1.0) DISPVF=0.
158 - 158.000      IF(AFT.EQ.0.0) G9 T9 35
159 - 159.000      UPERF=XPERF
160 - 160.000      FUPRES=XFUPR
161 - 161.000      F9PRES=XF9PR
162 - 162.000      FPRESS=.001324*FUEL*FUPRES/18.
163 - 163.000      FRES=.00457*FUEL*(UPERF+LA-2.)*F9PRES/30.
164 - 164.000      G9 T9 36
165 - 165.000      35 FPRESS=.003635*FUEL*FUPRES/40.
166 - 166.000      FRES=.02667*FUEL*(UPERF+LA-2.)*F9PRES/40.
167 - 167.000      C
168 - 168.000      36 NOMFUEL=FUEL+FSTART+FSHJT+FEEDF+FCHILL+FENG+FBIAS+FDRAIN
169 - 169.000      +FPRESS
170 - 170.000      C
171 - 171.000      FUEL LOADING ALLOWANCE
172 - 172.000      FALL9W=NOMFUL*(LA-1.)
173 - 173.000      MAXFJL=NOMFUL+FALL9W
174 - 174.000      C
175 - 175.000      MAXIMUM FUEL IN TANK
176 - 176.000      MAXFIT=MAXFJL-F9FL9W
177 - 177.000      C
178 - 178.000      FUEL VOLUME
179 - 179.000      FUV9L=MAXFIT/FDEN
180 - 180.000      C
181 - 181.000      ADD FUEL ULLAGE VOLUME
182 - 182.000      TFVFL=FUV9L*JPERF
183 - 183.000      C
184 - 184.000      ADD VBL DISPLACED BY L9X LINE IF COMMON BLKHJ DES
185 - 185.000      TFVIT=TFVFL+DISPVF
186 - 186.000      C
187 - 187.000      OXYGEN INVENTORY
188 - 188.000      9START=2.7912*9FL9WY
189 - 189.000      IF(RX.NE.1.0) 9START=.382*9FL9WY
190 - 190.000      9SHJT=.0565*9FL9WY

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182 - 182.000 FEEDB=.3454*9FL9WY
183 - 183.000 9CHILL=.05044*9FL9WY
184 - 184.000 IF(3X*NE+1.0) 9CHILL=.1025*9FL9WY
185 - 185.000 9ENG=.40358*9FL9WY
186 - 186.000 9DRAIN=0.
187 - 187.000 IF(9L<HD*.GT.1.) 9DRAIN=300.
188 - 188.000 9LINE=.0046*(HH+HR)*9FL9WY
189 - 189.000 IF(9L<HD*.GT.1.0) 9LINE=.0046*(HH+.5*D+LC9N)*9FL9WY
190 - 190.000 9BEL9W=9LINE+FEEDB+9CHILL+9ENG
191 - 191.000 IF(AFT*EQ.0.0) G9 T9 37
192 - 192.000 9PER9=XPER9
193 - 193.000 9UPRES=X8UPR
194 - 194.000 9PRES=X8PR9
195 - 195.000 9PRESS=.003635*9XID+9JPRES/40.
196 - 196.000 9RES=.02567*9XID*(9PER9+LA-2.)*9PRES/40.
197 - 197.000 G9 T9 38
198 - 198.000 37 9PRESS=.001326*9XID+9JPRES/15.
199 - 199.000 9RES=.00457*9XID*(9PER9+LA-2.)*9PRES/30.
200 - 200.000 C NOMINAL 9XYGEN L9AD
201 - 201.000 38 9M9XL=9XID*9START+9SHUT+FEEDB+9CHILL+9ENG+9PRES+9DRAIN
202 - 202.000 C 9XYGEN L9ADING ALLOWANCE
203 - 203.000 9ALL9W=9M9XL*(LA-1.)
204 - 204.000 9MAX9XL=9M9XL+9ALL9W
205 - 205.000 C MAXIMUM 9XYGEN IN TANK
206 - 206.000 9MAX9IT=9MAX9XL-9BEL9W
207 - 207.000 C 9XYGEN V9LUME
208 - 208.000 9XV9L=9MAX9IT/9DEN
209 - 209.000 C ADD 9XYGEN ULLAGE V9LUME
210 - 210.000 9TV9L=9XV9L*9PER9
211 - 211.000 C FUEL TANK HEIGHT AS FUNCTION 9F T9TAL FUEL TANK V9L
212 - 212.000 C REQJRED LESS PREVIOUSLY CALC DEPENDENT V9LUMES
213 - 213.000 9H=(9TV9L+1728.-9V9LA-9V9LC)/(0.7854*9D**2)+9R
214 - 214.000 IF(9H<LT+9R) 9H=9R
215 - 215.000 IF(9L<HD*.GT.2.) 9V9LG=0.
216 - 216.000 C 9XY TANK CYL HEIGHT AS FUNCTION 9F T9T 9XY TANK V9L
217 - 217.000 C REQJRED LESS PREV CALC DEP V9LS;IF C9NE IS 9IG
218 - 218.000 C ENRJGH CYL HEIGHT (9H9) IS SET EQUAL T9 Z9R9.
219 - 219.000 9H9=(9TV9L+1728.-9V9LD-9V9LF-9V9LG)/(0.7854*9D**2)
220 - 220.000 IF(9H9<LT+9D.) 9H9=0.
221 - 221.000 IF(9L<HD*.GT.2.) 9H9=0.
222 - 222.000 C CALCULATE 9VERALL TANK LENGTH
223 - 223.000 9L1=9H+9C+9H+9R+9H9
224 - 224.000 IF(9L<HD*.GT.1.0) 9L1=9L1+9R+9LC9N
225 - 225.000 C ITERATE T9 REQJRED DIMENSIONAL C9NSTRANTS
226 - 226.000 IF(9ABS(9L1-9L)*9LT+1.) G9 T9 20
227 - 227.000 IF(9DF.GT.0.) 9L=9L1
228 - 228.000 IF(9DF.GT.0.) G9 T9 15
229 - 229.000 IF(9LF.GT.0.) 9D=9D*(9L1/9LF)
230 - 230.000 IF(9LD.GT.0.) 9L=(9L1+9L)/2.
231 - 231.000 G9 T9 10
232 - 232.000 20 9L=9L1
233 - 233.000 C CALCULATE PR9P INVENT9RY S9BT9TALS
234 - 234.000 9UNDRAN=9DRAIN+9FDRAIN
235 - 235.000 9FEEDTR=9FEEDF*.3333+9FEEDB*.2418
236 - 236.000 9PRSJRT=9PRESS+9RES+9PRESS+9RES
237 - 237.000 9RESIDT=9UNDRAN+9FEEDTR+9PRSJRT+9FBIAS
238 - 238.000 C CALC RESULTING V9LS 9FR C9HECK 9GAINST REQD V9LS
239 - 239.000 9TRAP=9FEEDB+9ENG+9CHILL+9FEEDF+9ENG+9CHILL-9FEEDTR
240 - 240.000 9XV9LF=(9V9LD+9V9LF+9V9LG+9H9*.7854*9D**2)/1728.
241 - 241.000 9TV9LF=(9V9LA+9V9LC+(9H+9R)*.7854*9D**2)/1728.
242 - 242.000 C CALCULATE LIFT-9FF 9XYGEN HEAD HEIGHT;IS HEAD 9B9VE

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242	-	243.000	C	9R BELOW CONE/CYL CONTOUR BREAK
244	-	244.000		$H91 = (9XV9L * 172R - V9LA) / (.7854 * D ** 2)$
245	-	245.000		IF (H91 * GT * H9) G9 T9 21
246	-	246.000		G9 T9 24
247	-	247.000	C	IF YES ITERATE FOR HEAD HEIGHT IN CONICAL SECTION
248	-	248.000	21	$H91 = H91 - H9$
249	-	249.000		$9XV9L1 = 9XV9L * 172R - V9LA - H9 * .7854 * D ** 2$
250	-	250.000	22	$D1 = D - 2 * H9 * H1 * TAN(THETA / 57.2958)$
251	-	251.000		$V91 = .2518 * H0 * H1 * (D ** 2 + D1 * D1 ** 2)$
252	-	252.000		IF (ABS(9XV9L1 - V91) * LT * 100.) G9 T9 23
253	-	253.000		$H91 = (9XV9L1 * H9 * H1) / V91$
254	-	254.000		G9 T9 22
255	-	255.000	23	$H9H = H9H1 + H9$
256	-	256.000		G9 T9 25
257	-	257.000	24	$H9H = H91$
258	-	258.000	C	CALCULATE LIFT-OFF FUEL HEAD HEIGHT
259	-	259.000	25	IF (H * EQ * HR) G9 T9 51
260	-	260.000		$HFH = (V9LA - 172R * FUV9L) / (172R * DISPVF / (H * HR) - .7854 * D ** 2)$
261	-	261.000		G9 T9 52
262	-	262.000	51	$HFH = (V9LA - 172R * FUV9L) / (.7854 * D ** 2)$
263	-	263.000	C	9XY ULT ULLAGE PRESSURE
264	-	264.000	52	$PULL9 = FS * DPRES$
265	-	265.000	C	FUEL ULT ULLAGE PRESSURE
266	-	266.000		$PULLF = FS * FPRES$
267	-	267.000	C	9XY AFT DOME ULT LIFT-OFF HEAD PRESSURE
268	-	268.000		$9HDM1 = (H9H + HR) * 9DEN * NXL * FS / 172R$
269	-	269.000	C	FUEL AFT DOME ULT LIFT-OFF HEAD PRESSURE
270	-	270.000		$FDM1 = (HFH + HR) * FDEN * NXL * FS / 172R$
271	-	271.000	C	2ND STAGE FUEL LBAO
272	-	272.000		$FUEL2 = PR9992 / (1 + HR)$
273	-	273.000	C	2ND STAGE 9XYGEN LBAO
274	-	274.000		$9XID2 = FUEL2 * MR$
275	-	275.000		$XFUL2 = FUEL2 * MAXFIT - FUEL - FSTART - FCHILL$
276	-	276.000		$9X9D2 = 9XID2 + MAX9IT - 9XID - 9START - 9CHILL$
277	-	277.000	C	2ND STAGE FUEL VOLUME
278	-	278.000		$VXF2 = XFUL2 / FDEN$
279	-	279.000	C	2ND STAGE 9XYGEN VOLUME
280	-	280.000		$VX92 = 9X9D2 / 9DEN$
281	-	281.000	C	2ND STAGE FUEL HEAD HEIGHT
282	-	282.000		IF (H * EQ * HR) G9 T9 53
283	-	283.000		$HFH2 = (V9LA - 172R * VXF2) / (172R * DISPVF / (H * HR) - .7854 * D ** 2)$
284	-	284.000		G9 T9 54
285	-	285.000	53	$HFH2 = (V9LA - 172R * VXF2) / (.7854 * D ** 2)$
286	-	286.000	54	IF (HFH2 * LE * 0.0) HFH2 = 0.0
287	-	287.000	C	CALCULATE 2ND STAGE 9XYGEN HEAD HEIGHT/IS HEAD
288	-	288.000	C	9R BELOW CONE/CYL CONTOUR BREAK
289	-	289.000		$H92 = (VX92 * 172R - V9LA) / (.7854 * D ** 2)$
290	-	290.000		IF (H92 * GT * H9) G9 T9 26
291	-	291.000		G9 T9 29
292	-	292.000	C	IF YES ITERATE FOR HEAD HEIGHT IN CONICAL SECTION
293	-	293.000	26	$H9HX = H92 - H9$
294	-	294.000		$9XV9L2 = VX92 * 172R - V9LA - H9 * .7854 * D ** 2$
295	-	295.000	27	$D2 = D - 2 * H9HX * TAN(THETA / 57.2958)$
296	-	296.000		$V92 = .2518 * H9HX * (D ** 2 + D2 * D2 ** 2)$
297	-	297.000		IF (ABS(9XV9L2 - V92) * LT * 100.) G9 T9 28
298	-	298.000		$H9HX = (9XV9L2 * H9HX) / V92$
299	-	299.000		G9 T9 27
300	-	300.000	28	$H9H2 = H9HX + H9$
301	-	301.000		G9 T9 50
302	-	302.000	29	$H9H2 = H92$
303	-	303.000	C	9XY AFT DOME ULT 2ND STAGE HEAD PRESSURE

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304	-	304.000	50	$9HDM2 = (H9H2 + H9) * 8DEN * NXS * FS / 1728.$
305	-	305.000	C	FUEL AFT D9ME ULT 2ND STAGE HEAD PRESSURE
306	-	306.000		$FHD2 = (HFH2 + H8) * FDEN * NXS * FS / 1728.$
307	-	307.000	C	ULT 9XY AFT D9ME ULLAGE+HEAD PRES EITHER LIFT-
308	-	308.000	C	9FF 9R 2ND STAGE WHICH EVER IS GREATER
309	-	309.000		$P9D9M = PULL9 + 9HDM1$
310	-	310.000		$IF(9HDM2 > 9HDM1) P9D9M = PULL9 + 9HDM2$
311	-	311.000	C	ULT FUEL AFT D9ME ULLAGE+HEAD PRES EITHER LIFT-
312	-	312.000	C	9FF 9R 2ND STAGE WHICH EVER IS GREATER
313	-	313.000		$PFD9M = PULLF + FHD1$
314	-	314.000		$IF(FHD2 > FHD1) PFD9M = PULLF + FHD2$
315	-	315.000	C	INITIALLY SET WT'S & T'S TO ZERO BEFORE BEGINNING
316	-	316.000	C	MULTI-STATION ANALYSIS
317	-	317.000		$WFX = 0.$
318	-	318.000		$W9X = 0.$
319	-	319.000		$WLD9X = 0.$
320	-	320.000		$WLD9X = 0.$
321	-	321.000		$TAF = 0.$
322	-	322.000		$TAG = 0.$
323	-	323.000	C	MULTI-STATION ANALYSIS (FUEL TANK REFERS TO AFT TANK
324	-	324.000	C	AND 9XY TANK REFERS TO FWD TANK) THE REVERSE IS LITERALLY
325	-	325.000	C	TRUE FOR THE L9X AFT 9PTION BECAUSE OF LINE 18.5
326	-	326.000	C	AT BEGINNING OF PROGRAM; THE FWD AND AFT TANKS ARE
327	-	327.000	C	THEREFORE ANALYZED IDENTICALLY IN THE EVENT THAT THE FWD
328	-	328.000	C	TNK IS LARGE AND THE AFT TNK IS SMALL AND VICE VERSA)
329	-	329.000		$D9 R4 I = 1,9$
330	-	330.000		$HF = H + H9$
331	-	331.000	C	SET STATION LOCATIONS FOR FUEL TANK CYL WALL ANALYSIS
332	-	332.000		$HFX(I) = .125 * (I - 1) * HF$
333	-	333.000	C	CALCULATE FUEL TNK CYL WALL HEAD PRES @ HFX(I)
334	-	334.000	C	ABOVE CYL BASE BY COMPARING WITH LIFT-9FF AND
335	-	335.000	C	2ND STAGE HEAD HEIGHTS AS CALCULATED PREVIOUSLY
336	-	336.000		$FHC2 = (HFH2 - HFX(I)) * FDEN * NXS * FS / 1728.$
337	-	337.000		$FHC1 = (HFH - HFX(I)) * FDEN * NXL * FS / 1728.$
338	-	338.000		$IF(FHC1 < FHC2) 99 TO 59$
339	-	339.000		$FHCX = FHC1$
340	-	340.000		$99 TO 60$
341	-	341.000	59	$FHCX = FHC2$
342	-	342.000	60	$IF(FHCX < LE * 0.) FHCX = 0.$
343	-	343.000	C	ADD FUEL ULLAGE PRESS TO RESULTING HEAD PRESSURE
344	-	344.000		$FHCT(I) = FHCX + PULLF$
345	-	345.000	C	SET STATION LOCATIONS FOR 9XY TANK CYL WALL ANALYSIS
346	-	346.000		$H9X(I) = .125 * (I - 1) * H9$
347	-	347.000	C	CALCULATE 9XY TNK CYL WALL HEAD PRES @ H9X(I)
348	-	348.000	C	ABOVE CYL BASE BY COMPARING WITH LIFT-9FF AND
349	-	349.000	C	2ND STAGE HEAD HEIGHTS AS CALCULATED PREVIOUSLY
350	-	350.000		$9HC2 = (H9H2 - H9X(I)) * 8DEN * NXS * FS / 1728.$
351	-	351.000		$9HC1 = (H9H - H9X(I)) * 9DEN * NXL * FS / 1728.$
352	-	352.000		$IF(9HC1 < 9HC2) 99 TO 63$
353	-	353.000		$9HCX = 9HC1$
354	-	354.000		$99 TO 64$
355	-	355.000	63	$9HCX = 9HC2$
356	-	356.000	64	$IF(9HCX < LE * 0.) 9HCX = 0.$
357	-	357.000	C	ADD 9XY ULLAGE PRESS TO RESULTING HEAD PRESSURE
358	-	358.000		$9HCT(I) = 9HCX + PULL9$
359	-	359.000	C	CALCULATE FUEL TANK BENDING MOMENTS
360	-	360.000		$M(I) = 0.$
361	-	361.000	C	CALCULATE 9XYGEN TANK BENDING MOMENTS
362	-	362.000		$M9(I) = 0.$
363	-	363.000	C	CALCULATE FUEL TNK THICKNESS REQUIRED DUE TO ULT PRES
364	-	364.000		$TFT(I) = FHCT(I) * 3 * .5 / FTU$

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365 -	365.000	C	CALCULATE 9XY TANK THICKNESS REQUIRED DUE TO JLT PRES
366 -	366.000		T9(I)=9HCT(I)*D*.5/FTJ
367 -	367.000	C	CHECK FUEL TANK THICKNESS & SET = 9R GREATER THAN TMIN
368 -	368.000		IF(TFT(I).LT.TMIN) TFT(I)=TMIN
369 -	369.000	C	CHECK 9XY TANK THICKNESS & SET = 9R GREATER THAN TMIN
370 -	370.000		IF(T9(I).LT.TMIN) T9(I)=TMIN
371 -	371.000	C	CALCULATE JLT LIFT- 9FF & 2ND STAGE AXIAL LOAD USE
372 -	372.000	C	WHICH EVER IS GREATER
373 -	373.000		AL1=MAX9IT*FS*NXL
374 -	374.000		AL2=X3XDP*FS*NXS
375 -	375.000		AL=AL1
376 -	376.000		IF(AL2.GT.AL1) AL=AL2
377 -	377.000	C	CHECK MARGIN OF SAFETY FOR COLUMN BUCKLING FOR 3.M.'S
378 -	378.000	C	AND AXIAL LOAD WITH INTERNAL PRESSURE STABILIZATION
379 -	379.000		FR9T=.5*D/TFT(I)
380 -	380.000		FL9R=(L-HC+HR-HN-HFX(I))/(.5*D)
381 -	381.000		RXT=FR9T
382 -	382.000		LXR=FL9R
383 -	383.000		TX=TFT(I)
384 -	384.000		TPRES=FUPRES
385 -	385.000		MX=MF(I)
386 -	386.000		G9 T9 70
387 -	387.000	69	RXT=RR9T
388 -	388.000		LXR=BL9R
389 -	389.000		TX=T9(I)
390 -	390.000		TPRES=RJPRES
391 -	391.000		MX=MR(I)
392 -	392.000		AL=0.
393 -	393.000	C	CURVE FIT 9F BRUHNS GRAPHS
394 -	394.000	70	IF(LXR.GT.1.0) G9 T9 73
395 -	395.000		A=7.34127+.269862*LXR
396 -	396.000		IF(LXR.GT..26) G9 T9 71
397 -	397.000		F=7.26403+7.93752*LXR
398 -	398.000		G9 T9 70
399 -	399.000	71	IF(LXR.GT..5) G9 T9 72
400 -	400.000		F=9.34345
401 -	401.000		G9 T9 70
402 -	402.000	72	F=9.63181+.59176*LXR
403 -	403.000		G9 T9 70
404 -	404.000	73	IF(LXR.GT.4.0) G9 T9 74
405 -	405.000		A=8.30526+.671566*LXR
406 -	406.000		IF(LXR.LT.2.0) G9 T9 72
407 -	407.000	75	F=8.88855+.212134*LXR
408 -	408.000		G9 T9 70
409 -	409.000	74	IF(LXR.GT.6.0) G9 T9 76
410 -	410.000		A=5.61685
411 -	411.000		G9 T9 75
412 -	412.000	76	IF(LXR.GT.16.0) G9 T9 77
413 -	413.000		A=6.47239+.144808*LXR
414 -	414.000		IF(LXR.LT.9.0) G9 T9 75
415 -	415.000	78	F=8.25156+.133275*LXR
416 -	416.000		G9 T9 70
417 -	417.000	77	A=5.14063+.061365*LXR
418 -	418.000		G9 T9 78
419 -	419.000	79	B=LXR/(-.624947*LXR+.007487)
420 -	420.000		G=LXR/(-.626078*LXR+.008016)
421 -	421.000	C	CRITICAL STRESS CALCULATION
422 -	422.000	80	FCRE=A*RXT**3
423 -	423.000		FCR=FCRE#E
424 -	424.000		FHRE=F*RXT**3
425 -	425.000		FHR=FHRE#E

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426 - 426.000 C CORRECT FOR INTERNAL PRESSURE STABILIZATION
427 - 427.000 PXE=TPRES*RXT**2/E
428 - 428.000 DFLAX=PXE/(4.41405*PXE+.603563)
429 - 429.000 DLFCR=DFLAX*E*TX/.5*D
430 - 430.000 FPT=TPRES*.5*D/(2.*TX)
431 - 431.000 PA=(FCR+DLFCR+FPT)*2.98451*D*TX
432 - 432.000 DELRM=.376601*PXE**.210*92
433 - 433.000 DLFBM=DELRM*E*TX/(.5*D)
434 - 434.000 MA=(FCR+DLFBM+FPT)*.74612*TX*D**2
435 - 435.000 C CALCULATE MARGIN OF SAFETY AND INCREASE T IF INADEQUATE
436 - 436.000 RCR=AL/PA+MX/MA
437 - 437.000 IF(RCR<LT.1.0) G9 T9 81
438 - 438.000 TX=TX+.001
439 - 439.000 RXT=.5*D/TX
440 - 440.000 G9 T9 82
441 - 441.000 R1 IF(PL9R.E9.LXR) G9 T9 82
442 - 442.000 IF(PL9R.E9.LXR) G9 T9 83
443 - 443.000 R2 TFT(I)=TX
444 - 444.000 C SUM FUEL TANK T'S FOR AVERAGE CALCULATION
445 - 445.000 TAF=TAF+TFT(I)
446 - 446.000 9RRT=.5*D/TB(I)
447 - 447.000 9LBR=(49-H9X(I))/(.5*D)
448 - 448.000 G9 T9 89
449 - 449.000 R3 T9(I)=TX
450 - 450.000 C SUM 9XY TANK T'S FOR AVERAGE CALCULATION
451 - 451.000 T99=T99+T9(I)
452 - 452.000 C CALC FUEL TANK CYL WALL WT ADD .005 TO T FOR MATL TOLERANCE
453 - 453.000 WF(I)=(TFT(I)+.005)*3.14159*D*.125*HF*RH9
454 - 454.000 WFX=WFX+WF(I)
455 - 455.000 C CALC FUEL TANK CIRCUMFERENTIAL WELD @ 3.5 WIDE
456 - 456.000 WLD9(I)=(TFT(I)+.005)*3.14159*D*3.5*RH9
457 - 457.000 WLD9X=WLD9X+WLD9(I)
458 - 458.000 C CALC 9XY TANK CYL WALL WT ADD .005 TO T FOR MATL TOLERANCE
459 - 459.000 W9(I)=(T9(I)+.005)*3.14159*D*.125*H9*RH9
460 - 460.000 W9X=W9X+W9(I)
461 - 461.000 C CALC 9XY TANK CIRCUMFERENTIAL WELDS @ 3.5 WIDE
462 - 462.000 WLD9(I)=(T9(I)+.005)*3.14159*D*3.5*RH9
463 - 463.000 WLD9X=WLD9X+WLD9(I)
464 - 464.000 R4 CONTINUE
465 - 465.000 C DELETE MID CIRC WELDS IF TANK IS SHORT I.E. L9X AFT/FWD
466 - 466.000 IF(49*GT.44) G9 T9 85
467 - 467.000 WLD9T=WLD9(1)+WLD9(9)
468 - 468.000 WLD9T=WLD9X
469 - 469.000 G9 T9 86
470 - 470.000 R5 WLD9T=WLD9X
471 - 471.000 WLD9T=WLD9(1)+WLD9(9)
472 - 472.000 C RING MINIMUM GAUGE
473 - 473.000 R6 AMIN=14.*TMIN
474 - 474.000 C AVERAGE FUEL TANK T
475 - 475.000 AVFT=TAF/9.
476 - 476.000 C AVERAGE 9XYGEN TANK T
477 - 477.000 AV9T=T99/9.
478 - 478.000 C CALC NR. OF LONGITUDINAL WELDS BASED ON 156 WIDE SHEETS
479 - 479.000 CIR=3.14159*D
480 - 480.000 D9 R7 I=1,100
481 - 481.000 SX=156.*I
482 - 482.000 IF(SX*GT.CIR) G9 T9 88
483 - 483.000 R7 CONTINUE
484 - 484.000 R8 SEG=SX/156.
485 - 485.000 C CALCULATE INTER-TANK SECTION WEIGHT
486 - 486.000 TINT=T9(1)

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487	-	487.000	IF(T9(1).LT.TFT(9)) TINT=TFT(9)
488	-	488.000	WINT=(3.14159*D+3.5*SEG)*(TINT+.005)*(2.*HR+LC9N)*RH9
489	-	489.000	IF(BLKHD.EQ.1.0) WINT=D
490	-	490.000	C CALCULATE FUEL TNK LONGITUDINAL WELD WEIGHT
491	-	491.000	LWLD9=HF*SEG*3.5*(AVFT+.005)*RH9
492	-	492.000	IF(BLKHD.EQ.1.0) LWLD9=44*SEG*3.5*(AVFT+.005)*RH9
493	-	493.000	C CALCULATE 9XY TNK LONGITUDINAL WELD WEIGHT
494	-	494.000	LWLD9=49*SEG*3.5*(AVFT+.005)*RH9
495	-	495.000	C AFT FUEL BLKHD THICKNESS
496	-	496.000	TAFB=PFD9M*R/(2.*FTU)
497	-	497.000	IF(TAFB.LT.TMIN) TAFB=TMIN
498	-	498.000	C AFT FUEL BLKHD RING AREA SIZED FOR ELASTIC STABILITY
499	-	499.000	NAFR=(PFD9M*R/2.)*SIN(30./57.2958)
500	-	500.000	AAFR=(NAFR*(.5*D)**3/(3.*E))**.5
501	-	501.000	IF(AAFR.LT.AMIN) AAFR=AMIN
502	-	502.000	C AFT 9XY BLKHD THICKNESS
503	-	503.000	TA93=P9D9M*R/(2.*FTU)
504	-	504.000	IF(TA93.LT.TMIN) TA93=TMIN
505	-	505.000	C AFT 9XY BLKHD RING AREA SIZED FOR ELASTIC STABILITY
506	-	506.000	NA93=(P9D9M*R/2.)*SIN(30./57.2958)
507	-	507.000	AA93=(NA93*(.5*D)**3/(3.*E))**.5
508	-	508.000	IF(AA93.LT.AMIN) AA93=AMIN
509	-	509.000	C FWD FUEL BLKHD THICKNESS
510	-	510.000	TFFB=PULLF*R/(2.*FTU)
511	-	511.000	IF(TFFB.LT.TMIN) TFFB=TMIN
512	-	512.000	C FWD FUEL BLKHD RING AREA SIZED FOR ELASTIC STABILITY
513	-	513.000	NFFB=(PULLF*R/2.)*SIN(30./57.2958)
514	-	514.000	AFFB=(NFFB*(.5*D)**3/(3.*E))**.5
515	-	515.000	IF(AFFB.LT.AMIN) AFFB=AMIN
516	-	516.000	C WEIGHT OF AFT 9XY BLKHD RING AND WELD
517	-	517.000	WA93=(TA93+.005)*2.*3.14159*R*HR*RH9
518	-	518.000	WA93=3.14159*D*RH9*AA93
519	-	519.000	WA93=RH9*3.5*(TA93+.005)*3.14159*(.333*R*SEG+D)
520	-	520.000	C WEIGHT OF AFT FUEL BLKHD RING AND WELD
521	-	521.000	WAF3=(TAFB+.005)*2.*3.14159*R*HR*RH9
522	-	522.000	WAF3=3.14159*D*RH9*AAFR
523	-	523.000	WAF3=RH9*3.5*(TAFB+.005)*3.14159*(.333*R*SEG+D)
524	-	524.000	C WEIGHT OF FWD FUEL BLKHD RING AND WELD
525	-	525.000	WFFB=(TFFB+.005)*2.*3.14159*R*HR*RH9
526	-	526.000	WFFB=3.14159*D*RH9*AFFB
527	-	527.000	WFFB=RH9*3.5*(TFFB+.005)*3.14159*(.333*R*SEG+D)
528	-	528.000	IF(BLKHD.EQ.1.0) G9 T9 90
529	-	529.000	G9 T9 91
530	-	530.000	C COMMON BLKHD T-BAR BASED ON REVERSE FUEL ULLAGE
531	-	531.000	C PRESSURE AND ISS-GRID MATL.
532	-	532.000	90 TCFB=(.000514+(.0000206*FBPRES))*R
533	-	533.000	C WEIGHT OF COMMON FUEL BLKHD AND WELD
534	-	534.000	WCFB=TCFB*2.*3.14159*R*HR*RH9
535	-	535.000	WCFB=RH9*3.5*TCFB*3.14159*(.333*R*SEG+D)
536	-	536.000	C CHECK WITH AFT 9XY BLKHD TENSION LOAD REQMTS
537	-	537.000	IF(WCFB.LT.WARB) WCFB=WARB
538	-	538.000	IF(WCFB.LT.WABW) WCFB=WABW
539	-	539.000	WFFB=WCFB
540	-	540.000	WFFB=WCFW
541	-	541.000	WABW=D
542	-	542.000	WA93=D
543	-	543.000	WFFB=WABW
544	-	544.000	WA93=D
545	-	545.000	C FWD CONE AND FAIRING ANALYSIS
546	-	546.000	91 IF(BLKHD.GT.2.0) G9 T9 92
547	-	547.000	C UPR CONE WALL THICKNESS

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548	-	548.000	TUCN=PULL9*BR/FTU
549	-	549.000	IF(TJCN*LT*TMIN) TUCN=TMIN
550	-	550.000	C FWD 9XY BLKHD THICKNESS
551	-	551.000	TF93=PULL9*BR/(2.*FTU)
552	-	552.000	IF(TF93*LT*TMIN) TF93=TMIN
553	-	553.000	C FWD 9XY BLKHD RING AREA SIZED FOR ELASTIC STABILITY
554	-	554.000	WF93=ABS((PULL9/2.)*(BR*SIN(30./57.2958))-5*9D*TAN(THETA/
555	-	555.000	57.2958)))
556	-	556.000	AF93=(WF93*(.5*9D)**3/(3.*E))**.5
557	-	557.000	IF(AF93*LT*AMIN) AF93=AMIN
558	-	558.000	C WEIGHT OF FWD 9XY BLKHD RING AND WELD
559	-	559.000	WF93=3.14159*9D*RH9*AF93
560	-	560.000	WF93=(TF93+.005)*2.*3.14159*BR*RH9*RH9
561	-	561.000	WF93=RH9*3.5*(TF93+.005)*3.14159*(.333*BR*SEG*9D)
562	-	562.000	C WEIGHT OF FWD FAIRING USING MINIMUM GAUGE PLUS WELDS
563	-	563.000	WFAIR=RH9*(TMIN+.005)*3.14159*(2.*NR*HN+(.5*9D+.5*ND)*
564	-	564.000	5((HC-HC9)**2+(.5*9D-.5*ND)**2)**.5)
565	-	565.000	WFAIR=RH9*3.5*(TMIN+.005)*(3.14159*ND*SEG*(HC-HC9)/
566	-	566.000	5C95(THETA/57.2958))
567	-	567.000	C WEIGHT OF FWD C9NE 9XY TANK WALL AND WELDS
568	-	568.000	WC9N=RH9*3.14159*.5*((TUCN+.005)*9D+(T9(9)+.005)*D)*HC9/
569	-	569.000	5C95(THETA/57.2958))
570	-	570.000	WC9N=RH9*3.5*((TUCN+T9(9))*.5+.005)*SEG*HC9/C95(THETA/
571	-	571.000	57.2958))+3.14159*(TUCN+.005)*9D)
572	-	572.000	9D T9 93
573	-	573.000	C ALTERNATE FWD SECTION WITHOUT FAIRING
574	-	574.000	C FWD 9XY BLKHD THICKNESS
575	-	575.000	92 TF93=PULL9*.5*ND/(2.*FTU)
576	-	576.000	IF(TF93*LT*TMIN) TF93=TMIN
577	-	577.000	C UPR C9NE WALL THICKNESS
578	-	578.000	TUCN=PULL9*.5*ND/FTU
579	-	579.000	IF(TJCN*LT*TMIN) TUCN=TMIN
580	-	580.000	C FWD 9XY BLKHD RING AREA SIZED FOR ELASTIC STABILITY
581	-	581.000	WF93=ABS((PULL9/2.)*(5*ND*SIN(30./57.2958))-5*ND*TAN(
582	-	582.000	5THETA/57.2958)))
583	-	583.000	AF93=(WF93*(.5*ND)**3/(3.*E))**.5
584	-	584.000	IF(AF93*LT*AMIN) AF93=AMIN
585	-	585.000	C WEIGHT OF FWD 9XY BLKHD RING AND WELD
586	-	586.000	WF93=3.14159*ND*RH9*AF93
587	-	587.000	WF93=RH9*(TF93+.005)*2.*3.14159*(.5*ND)**2
588	-	588.000	WF93=RH9*3.5*(TF93+.005)*3.14159*ND
589	-	589.000	WFAIR=0.
590	-	590.000	WFAIR=0.
591	-	591.000	C WEIGHT OF FWD C9NE 9XY TANK WALL AND WELDS
592	-	592.000	WC9N=RH9*3.14159*.5*((TUCN+.005)*ND+(T9(9)+.005)*D)*HC/
593	-	593.000	5C95(THETA/57.2958))
594	-	594.000	WC9N=RH9*3.5*((TUCN+T9(9))*.5+.005)*SEG*HC/C95(THETA/
595	-	595.000	57.2958))+3.14159*(TUCN+.005)*ND)
596	-	596.000	C FWD C9NE/CYL RING AREA SIZED FOR ELASTIC STABILITY
597	-	597.000	93 NCCR=9HCT(9)*(.5*ND)*TAN(THETA/57.2958)/2.
598	-	598.000	ACCR=(NCCR*(.5*ND)**3/(3.*E))**.5
599	-	599.000	IF(ACCR*LT*AMIN) ACCR=AMIN
600	-	600.000	C WEIGHT OF FWD C9NE/CYL RING AND WELDS
601	-	601.000	WC9N=3.14159*ND*RH9*ACCR
602	-	602.000	WC9N=3.14159*ND*RH9*(T9(9)+.005)*3.5
603	-	603.000	C WEIGHT OF MISC STR COMPONENTS; UMBILICAL PANELS;
604	-	604.000	C TUNNEL AND BAFFLES
605	-	605.000	JM93=0.
606	-	606.000	TUNNEL=200.*L/1694.
607	-	607.000	BAFF=0*(H0+HC0)/343.
608	-	608.000	IF(BLKHD*GT.2.) BAFF=0*(H0+HC)/343.

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609	-	609.000	IF(H9.GT.HH) RAFF=D*HF/343.
610	-	610.000	C STRUCTURAL WEIGHT SUBTOTALS
611	-	611.000	FWD BLF=WFBF+WFB3+WFBW
612	-	612.000	CNSCT=WC9N+WC9NW+WCCR+WCCW
613	-	613.000	CYLSCT=WBX+WLD9T+LWLD9
614	-	614.000	AFT BLF=WABF+WABR+WABW
615	-	615.000	FWD T=C*FWD BLF+CNSCT+CYLSCT+AFT BLF
616	-	616.000	FWD BLA=WFBF+WFB3+WFBW
617	-	617.000	AFT CYL=WFX+WLDFT+LWLD
618	-	618.000	AFT BLA=WABF+WABR+WABW
619	-	619.000	AFT N=C*FWD BLA+AFT CYL+AFT BLA
620	-	620.000	NBSE FAIR=WFAIR+WFAW
621	-	621.000	C SFT D=D.D.JRE-DEFINE L/D
622	-	622.000	D=D+P.00
623	-	623.000	L/D=L/D
624	-	624.000	C CALCULATE INDUCED ENVIRON PROT WITH 10% NON OPT
625	-	625.000	C INTER TANK TPS
626	-	626.000	TPSIN=(P.*HR+LC9N)*3.14159*D*INTPS/144.
627	-	627.000	C NBSE FAIRING TPS
628	-	628.000	TPSFA=3.14159*.5*(UCTPS*ND+LCTPS*D)*(HC-HC0)/
629	-	629.000	5(C95(THETA/57.2958)*144.)
630	-	630.000	C NBSE CAP TPS
631	-	631.000	TPSNC=NCTPS*3.14159*2.*NR*HN/144.
632	-	632.000	IF(H9.GT.HH) GO TO 97
633	-	633.000	C LFX FWD TPS
634	-	634.000	C AFT DRME TPS
635	-	635.000	TPSDM=D*TPS*2.*3.14159*R*HR/144.
636	-	636.000	C AFT CYLINDER TPS
637	-	637.000	TPSCY=3.14159*D*HF*CYTPS/144.
638	-	638.000	TPSCN=0.
639	-	639.000	TPSCJ=0.
640	-	640.000	IF(3L<HD.EQ.1.) GO TO 94
641	-	641.000	GO TO 95
642	-	642.000	C AFT CYLINDER TPS FOR COMMON BLKHD CASE
643	-	643.000	94 TPSCY=3.14159*D*HD*CYTPS/144.
644	-	644.000	TPSIN=0.
645	-	645.000	95 IF(3L<HD.GT.2.) GO TO 96
646	-	646.000	GO TO 101
647	-	647.000	C LFX AFT TPS
648	-	648.000	C FWD CONE TPS
649	-	649.000	96 TPSFA=0.
650	-	650.000	TPSNC=0.
651	-	651.000	GO TO 101
652	-	652.000	97 TPSCN=3.14159*.5*(LCTPS*ND+CYTPS*D)*HC0/
653	-	653.000	5(C95(THETA/57.2958)*144.)
654	-	654.000	C FWD CYLINDER TPS
655	-	655.000	TPSCJ=3.14159*CYTPS*D*HD/144.
656	-	656.000	TPSDM=0.
657	-	657.000	TPSCY=0.
658	-	658.000	IF(3L<HD.EQ.1.) GO TO 98
659	-	659.000	GO TO 99
660	-	660.000	98 TPSIN=0.
661	-	661.000	99 IF(3L<HD.GT.2.) GO TO 100
662	-	662.000	GO TO 101
663	-	663.000	C ALTERNATE FWD SECTION WITHOUT FAIRING
664	-	664.000	100 TPSFA=0.
665	-	665.000	TPSNC=0.
666	-	666.000	C FWD CONE TPS
667	-	667.000	TPSCN=3.14159*.5*(UCTPS*ND+LCTPS*D)*HC/
668	-	668.000	5(C95(THETA/57.2958)*144.)
669	-	669.000	C TPS WEIGHT SUBTOTALS WITH 10% NON OPTIMUM

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670	-	670.000	101	FAIRT=TPSFA+TPSVC
671	-	671.000		FCCTPS=TPSCN+TPSCJ
672	-	672.000		ACYDM=TPSDM+TPSCY
673	-	673.000		TOTPS=TPSIN+FAIRT+FCCTPS+ACYDM
674	-	674.000	C	INTERSTAGE ANALYSIS
675	-	675.000	C	LR=SPACE BETWEEN BOOSTER ATTACH PRINTS
676	-	676.000		LR=44+LCBN+HR
677	-	677.000		IF(RX1.GT.0.0) R1=RX1
678	-	678.000		IF(RX2.GT.0.0) R2=RX2
679	-	679.000		IF(RXL.GT.0.0) RL=RXL
680	-	680.000		IF(3LKHD.EQ.1.) L3=44
681	-	681.000	C	BOOSTER INDUCED MOMENT AND REACTIONS
682	-	682.000		IF(49.GT.44) L8=49+44
683	-	683.000		M6=(T4BSLT/N8ENGB)*C95(BCANT/57.2958)*78.
684	-	684.000		S=(T4BSLT/N8ENGB)*SIN(BCANT/57.2958)*27.
685	-	685.000		R4=(M6/LB)*FS
686	-	686.000		R5=((T4BSLT/N8ENGB)*SIN(BCANT/57.2958)-R6)*FS
687	-	687.000		R8=((T4BSLT/N8ENGB)*C95(BCANT/57.2958)-BGL9W/N8ENGB)*FS
688	-	688.000	C	GENERALIZED WT EQ FOR RING CAPS, WEBS AND BEAM
689	-	689.000	C	CAPS, WEBS(.94*FTU KNICK DOWN FACTOR FOR COMP STAB
690	-	690.000	C	.3125*FTU FOR SHEAR ALLOWABLE)
691	-	691.000		WIT=(R49*1.10/(2.*FTU))*(3.14159*(D/.94+40./3125)
692	-	692.000		S+D*.2/(40.*.94)+D/.3125)
693	-	693.000	C	WEIGHT OF BOOSTER ATTACH RINGS-CHECK AGAINST 3LKHD
694	-	694.000	C	RINGS AND ADD INTERSTAGE BEEP UP REQMTS
695	-	695.000		W6=WIT*N8ENGB*R6*1.01
696	-	696.000		W5=WIT*N8ENGB*R5*.514
697	-	697.000	C	ADD SEPARATE BOOSTER ATTACH RINGS BASED ON BOOSTER
698	-	698.000	C	REACTION LOADS FROM BOOSTER MODULE
699	-	699.000		W2=WIT*R2*.714
700	-	700.000		W1=WIT*R1*.2055
701	-	701.000	C	ADD SPECIAL INCREMENTS FOR SWAY BRACES DOUBLERS
702	-	702.000	C	D BAG LINKS AND FITTINGS ADD 10% STR NGN OPT
703	-	703.000		W3L=45.
704	-	704.000		W3B=(R1*12.*(5*D*.5774)**2/(E*3.14159**2))**.5
705	-	705.000		W3B=ASB*.5*D*.5774*R49*2*.1.34*1.05
706	-	706.000		W3F=8.284*(R6*3./(.3125*FTU))*.1.5*2.*RH0*1.10
707	-	707.000		W3DUB=150.*.5*3.14159*D*RH9*.071*1.10
708	-	708.000		W3DRAG=.5*100.*R49*1.10*(N8ENGB*R8+RL)/(.94*FTU)
709	-	709.000		W3ADUB=100.*.5*3.14159*D*RH9*.055*1.10
710	-	710.000		W3LL=42*39.*2.*R49*1.34*1.10/FTU
711	-	711.000		W3LS=35.
712	-	712.000		W3LF=55.
713	-	713.000		W3RL=R5*1.5*7R.*4.*R49*1.34*1.10/FTU
714	-	714.000	C	TOTAL INTERSTAGE WEIGHT
715	-	715.000		TWINT=W6+W5+W2+W1+W3L+W3B+W3F+W3DUB+W3DRAG+W3ADUB
716	-	716.000		S+W3LL+W3LS+W3LF+W3LL
717	-	717.000	C	TOTAL STRUCTURE WEIGHT
718	-	718.000		9003RP=FWDTK+WINT+AFTVK+N8SFAR+TWINT+UM9PNL+TUNNEL+BAFF
719	-	719.000	C	PROPELLANT SYSTEMS-BASED ON DETAIL POINT DESIGN WITH
720	-	720.000	C	SCALLING LAWS FOR BOOSTER ENGINE FLOW RATE, MIXTURE
721	-	721.000	C	RATIO AND TANK DIMENSIONS
722	-	722.000		IF(3LKHD.GT.1.0) G9 T9 103
723	-	723.000	C	CHMM9N 3LKHD INTERNAL L9X LINE
724	-	724.000		9XVENT=564.
725	-	725.000		HVENT=427.
726	-	726.000		PNEJ=25.5+30.5*L/1694.
727	-	727.000		IF(49.GT.44) G9 T9 102
728	-	728.000	C	L9X FORWARD
729	-	729.000		9XPRES=122.+109.*L/1694.
730	-	730.000		9XFEEB=(19.5+.01222*4F)*9FLOWY*.5

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731	-	731.000		HPRES=61.+.83.+.HF/R98.
732	-	732.000		HFEED=(31.59+.03176*D)*9FL9WX**5
733	-	733.000		RX=.5*(7.+.33*9FL9WY**5)
734	-	734.000		GO TO 105
735	-	735.000	C	L9X AFT
736	-	736.000	102	9XPRES=122.+.109.+.HF/1594.
737	-	737.000		9XFEEED=(19.5+.01222*.5*D)*9FL9WX**5
738	-	738.000		HPRES=61.+.83.+.L/R98.
739	-	739.000		HFEED=(31.59+.03176*HF)*9FL9WY**5
740	-	740.000		RX=.5*(7.+.76*9FL9WY**5)
741	-	741.000		GO TO 105
742	-	742.000	C	SEPARATE BLK HDS EXTERNAL L9X LINES
743	-	743.000	103	PNEJ=P5.5+18.5*L/1470.
744	-	744.000		WJCKT=0.
745	-	745.000		RX=0.
746	-	746.000		9XVENT=522.
747	-	747.000		HCIR=68.+.100.+.D/314.
748	-	748.000		HVENT=622.
749	-	749.000		IF (49.9T.44) GO TO 104
750	-	750.000	C	L9X FORWARD
751	-	751.000		9XPRES=126.+.132.+.L/1470.
752	-	752.000		9XFEEED=(18.1+.01465*(44+LC9N))*9FL9WY**5
753	-	753.000		HPRES=69.+.115.+.44/703.
754	-	754.000		HFEED=(34.21+.01333*D)*9FL9WX**5
755	-	755.000		GO TO 106
756	-	756.000	C	L9X AFT
757	-	757.000	104	9XPRES=128.+.132.+.44/1470.
758	-	758.000		9XFEEED=(18.1+.01465*.5*D)*9FL9WX**5
759	-	759.000		HPRES=69.+.115.+.L/703.
760	-	760.000		HFEED=(34.21+.01333*(44+LC9N))*9FL9WY**5
761	-	761.000		GO TO 104
762	-	762.000	C	COMMON BLK HD INTERNAL L9X LINE JACKET UNDER EXTERNAL PRES
763	-	763.000	105	TT9P=(FHCT(9)*10.+.RX**1.5/(E*.88157))**.4
764	-	764.000		IF (TT9P.LT.TMIN) TT9P=TMIN
765	-	765.000		TR9T=(FHCT(1)*10.+.RX**1.5/(E*.88157))**.4
766	-	766.000		IF (TR9T.LT.TMIN) TR9T=TMIN
767	-	767.000		WJACK=(.5*(TT9P+TR9T)+.005)*3.14159*2.+.RX*1.25
768	-	768.000		K*RH9*(HF-100.)
769	-	769.000		TUPR=(FHCT(9)*10.+.*(RX+3.))**1.5/(E*.88157))**.4
770	-	770.000		IF (TUPR.LT.TMIN) TUPR=TMIN
771	-	771.000		TLWR=(FHCT(1)*10.+.*(RX+3.))**1.5/(E*.88157))**.4
772	-	772.000		IF (TLWR.LT.TMIN) TLWR=TMIN
773	-	773.000		WEND=(TUPR+TLWR+.01)*50.*3.14159*(RX+3.)*2.
774	-	774.000		K*1.25*RH9
775	-	775.000		WJCKT=1.10*(WJACK+WEND)
776	-	776.000		HCIR=0.
777	-	777.000	C	MISC PR9P SYS C9MP9NENTSJSJMP,P9SYS
778	-	778.000	106	SUMP=220.
779	-	779.000		P9SYS=185.
780	-	780.000	C	PROPELLANT SYSTEMS SJBTOTALS
781	-	781.000		FEDSYS=9XFEEED+HFEED+WJCKT+HCIR
782	-	782.000		PRSVNT=HPRES+HVENT+9XPRES+9XVENT
783	-	783.000		P9P=PNEU+P9SYS
784	-	784.000		PR9SY=FEDSYS+PRSVNT+P9PU+SJMP
785	-	785.000	C	ESTIMATED TANK INERT WT FOR RET99 SYS CALCULATION
786	-	786.000		XDRY=(99DGRP+T9TPS+PR9SY+AVI9NT+MISCT)*(1.+GJP)
787	-	787.000		XINERT=XDRY+RESIDT
788	-	788.000	C	RET99 99CKET SIZING
789	-	789.000		DELX=EXP(RET9V/(32.17*RETISP))-1.
790	-	790.000		WR99P=XINERT*DELX/(1.+(1.+GJP)*.365*DELX)
791	-	791.000		WRET99=1.365*WR99P

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792	-	792.000	C	TANK SUBTOTAL DRY WEIGHT
793	-	793.000		SUBDRY=890GRP+TSTPS+PR9SY+AVIGNT+MISCT+WRETR9
794	-	794.000	C	GR9WT/UNCERTAINTY AS PERCENT 9R DELTA TO A FIXED
795	-	795.000	C	DRY WEIGHT
796	-	796.000		GU=SJBDRY*GU
797	-	797.000		IF(FIXDWT.GT.0.) GU=FIXDWT-SJBDRY
798	-	798.000	C	TANK TOTAL DRY WEIGHT
799	-	799.000		DRYWT=SUBDRY+GU
800	-	800.000	C	TANK TOTAL INERT WEIGHT
801	-	801.000		INERT=DRYWT+RESIDT
802	-	802.000	C	EXTERNAL TANK GROSS WEIGHT
803	-	803.000		GR9SSW=INERT+PR9P9T
804	-	804.000	C	EXTERNAL TANK MASS FRACTION
805	-	805.000		TLAMB=PR9P9T/GR9SSW
806	-	806.000		EXTL=L
807	-	807.000		EXTD=0
808	-	808.000		EXT49=49
809	-	809.000		EXT44=44
810	-	810.000		GR T9 700
811	-	811.000	C	
812	-	812.000	C	FIXED WEIGHT EXTERNAL TANK CALCULATIONS
813	-	813.000	C	
814	-	814.000	400	DRYWT=DRYWT
815	-	815.000		RESIDT=RESIDT
816	-	816.000		INERT=DRYWT+RESIDT
817	-	817.000		GR9SSW=INERT+PR9P9T
818	-	818.000		TLAMB=PR9P9T/GR9SSW
819	-	819.000		GR T9 700
820	-	820.000	C	
821	-	821.000	C	EXTERNAL TANK SIMPLIFIED EQUATION CALCULATIONS
822	-	822.000	C	
823	-	823.000	500	RATPR9=PR9P9T/PR9P9T
824	-	824.000		IF(RATPR9.LT..50) RATPR9=.50
825	-	825.000		CFB=213.777+10.690*RATPR9
826	-	826.000		CFA=-31957.6-2444.00*RATPR9
827	-	827.000		CFC=.0478364+.0214184*RATPR9
828	-	828.000		CFD=-.000104847-.00001502*RATPR9
829	-	829.000		CFF=CFC+CFD*DF
830	-	830.000		CFE=CFA+CFB*DF
831	-	831.000		DRYWT=CFE+CFF*PR9P9T
832	-	832.000		IF (PR9P9T.LT.1000000.) DRYWT=DRYWT*(1.11520+.0000001452*PR9P9T)
833	-	833.000		IF (PR9P9T.GT.1000000.) DRYWT=DRYWT*(.908317+.0000000567*PR9P9T)
834	-	834.000		DRYWT=DRYWT/1.075
835	-	835.000		GU=GU*DRYWT
836	-	836.000		DRYWT=DRYWT+GU
837	-	837.000		RESIDT=2206+.001972*PR9P9T
838	-	838.000		INERT=DRYWT+RESIDT
839	-	839.000		GR9SSW=INERT+PR9P9T
840	-	840.000		TLAMB=PR9P9T/GR9SSW
841	-	841.000		GR T9 700
842	-	842.000	C	
843	-	843.000	C	FIXED LAMBDA EXTERNAL TANK CALCULATIONS
844	-	844.000	C	
845	-	845.000	400	DRYWT=PR9P9T*((1.0+.954)/.954)
846	-	846.000		RESIDT=2206+.001972*PR9P9T
847	-	847.000		INERT=DRYWT+RESIDT
848	-	848.000		GR9SSW=INERT+PR9P9T
849	-	849.000		TLAMB=PR9P9T/GR9SSW
850	-	850.000	700	CONTINUE
851	-	851.000		RETURN
852	-	852.000		END

5. SOLID ROCKET MOTOR BOOSTER MODULE

This module contains the analytical and empirical weight estimation relationships necessary to completely define the solid rocket motor (SRM) booster system. The NASA weight report and design data, coupled with a three-view drawing of the SRM, supplies all inputs necessary to analyze the configuration. Here again, it is important to note that the velocity correlation coefficients described in Option 1 must be calculated or known before this option can be executed. The primary purpose of this option is to provide the capability of optimizing the SRM by inputting a diameter and iterating on propellant load and engine characteristics. The iteration calculates SRM burnout weight and dry weight, which, in turn, modifies retro and parachute system weights, which, in turn, is rippled through the other weights. This entire module continues the iteration until a completely balanced system exists. This option also has the capability of inputting constants, which allows the user to input weight changes without modifying the program. The SRM option contains four distinct modes of operation which are as follows:

1. iterative analysis
2. iterative analysis (fixed dry weight)
3. simplified equation
4. fixed booster.

Figure 5-1 is the flow diagram of the SRM Module, followed by a detail listing of the program.

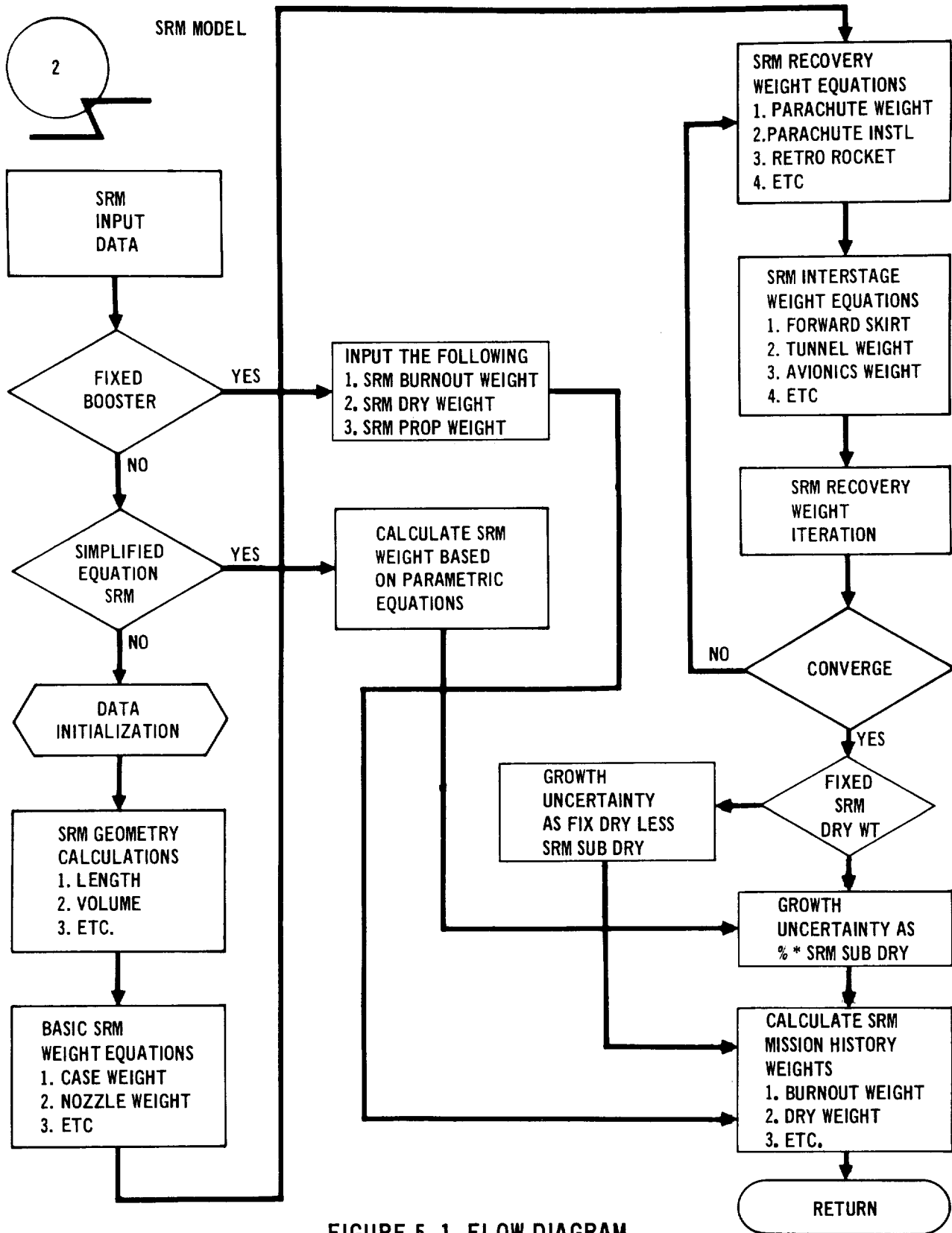


FIGURE 5-1 FLOW DIAGRAM

FIGURE 5-1

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COPY SUB TO LP(K,NC)		
1	1.000	*FIXED
2	2.000	C
3	3.000	C
4	4.000	C
5	5.000	C
6	6.000	C
7	7.000	C
8	8.000	C
9	9.000	C
10	10.000	C
11	11.000	C
12	12.000	C
13	13.000	C
14	14.000	C
15	15.000	C
16	16.000	C
17	17.000	C
18	18.000	C
19	19.000	C
20	20.000	C
21	21.000	C
22	22.000	C
23	23.000	C
24	24.000	C
25	25.000	C
26	26.000	C
27	27.000	C
28	28.000	C
29	29.000	C
30	30.000	C
31	31.000	C
32	32.000	C
33	33.000	C
34	34.000	C
35	35.000	C
36	36.000	C
37	37.000	C
38	38.000	C
39	39.000	C
40	40.000	C
41	41.000	C
42	42.000	C
43	43.000	C
44	44.000	C
45	45.000	C
46	46.000	C
47	47.000	C
48	48.000	C
49	49.000	C
50	50.000	C
51	51.000	2
52	52.000	C
53	53.000	C
54	54.000	C
55	55.000	C
56	56.000	C
57	57.000	C
58	58.000	C
59	59.000	C

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60	60.000		THRSLR=THRSLT/N9ENGR
61	61.000		VPC=(PW91/RH9P)-(292574*DIA*DIA*DIA*(MIAX/MAAX))
62	62.000		TCYL=(ME9P*DIA*FS/(2.0*ETU))+INT
63	63.000		ACS=(3.14159/4.0)*(DIA-TCYL)*(DIA-TCYL)
64	64.000		LTH=VPC/(ACS-AP)
65	65.000		VCASE=(3.14159/6.0)*DIA*DIA*DIA*(MIAX/MAAX)
66	66.000		1+(3.14159/4.0)*DIA*DIA*(VPC/(ACS-1.3*AT))
67	67.000		PLE=PA91/(RH9P*VCASE)
68	68.000	C	CASE WEIGHT
69	69.000		CASE1=R99M*(PW91/(RH9P*NP))*95
70	70.000		CASE2=ME9P*.7*FS*.7/FTJ*.9
71	71.000		CASE3=(LTH/DIA)*((.153*MIAX/MAAX)-.114)
72	72.000		CASE4=(MIAX/MAAX)*.315
73	73.000		WCASE=11.14*(CASE1*CASE2*(CASE3/CASE4))*1.013
74	74.000	C	CASE JSINT WEIGHT
75	75.000		WJ9INT=7.7*DIA*DIA*(ME9P*FS*NJ/FTU)
76	76.000	C	N9ZZLE WEIGHT
77	77.000	C	FIXED N9ZZLE
78	78.000		N9ZZ1=BBT*.6*THBSLS*.2*NER*.7
79	79.000		N9ZZ2=CF*.2*PC*.8*(TAN(ND4A/57.29578))*4
80	80.000		IF(WN9Z>GT*0.0) G9 T9 10
81	81.000		WN9Z*.003505*(N9Z1/N9Z2)*.916
82	82.000		G9 T9 20
83	83.000	C	SCRAMALLED N9ZZLE
84	84.000	10	KGN=2.11/NER*.116
85	85.000		WN9Z*.003505*KGN*(N9Z1/N9Z2)*.916
86	86.000	C	THRUST TERMINATION WEIGHT
87	87.000	20	WTT9*.03518*(THBSLS/(CF*PC))*1.45
88	88.000	C	INSULATION WEIGHT
89	89.000	C	CASE
90	90.000		INSC1=(PW91/(RH9P*NP))*80
91	91.000		INSC2=BBT*.5*PC*.117*(TC/1000.)*(TC/1000.)
92	92.000		INSC3=(LTH/DIA)*.1*TCES*.2
93	93.000		WINSC=.000602*(INSC1*(INSC2/INSC3))*86
94	94.000	C	JSINT
95	95.000		DP=((AP/AT)*(4.0*THBSLS/(3.14159*CF*PC))*5
96	96.000		WII=.00054*(DIA/DP)*DIA*BBT
97	97.000		WII=.000178*(DIA-DP)*((2.0*DIA+DP)*BBT+80.0*DIA)
98	98.000		IF(WEI>GT*0.0) G9 T9 33
99	99.000		WINSJ=2.0*WII*NJ
100	100.000		G9 T9 35
101	101.000	33	WINSJ=(WII+WII)*NJ
102	102.000	35	WINST=WINSJ+WINSJ
103	103.000	C	IGNITER WEIGHT
104	104.000		WIGN=.33658*DIA*.45
105	105.000		EXPINS=.005*PA91
106	106.000		BASSRM=WCASE+WJ9INT+WN9Z+WTT9+WINST+WIGN+BSRMC
107	107.000		PR9SLU=BASSRM+SRMISS+WRECBV
108	108.000		UNCERT=PR9SLU*RJNC1
109	109.000		IF(FIXDWT>GT*0.0) UNCERT=FIXDWT-PR9SLU
110	110.000		RR9WT=BASSRM+SRMISS+WRECBV+UNCERT+EXPINS
111	111.000		BL9WT=RR9WT+PR9PB-EXPINS
112	112.000	30	TR99WT=RR9WT
113	113.000	C	
114	114.000	C	RECOVERY SYSTEM WEIGHT
115	115.000	C	
116	116.000	C	PARACHUTE WEIGHT
117	117.000		WPAR=175.0+498.0*(BB9WT/(VRI*VRI))
118	118.000		PWPAR=WPAR
119	119.000	C	PARACHUTE INST WEIGHT
120	120.000		WPI=.6916*WPAR

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121	121.000		PWP1=API
122	122.000	C	RETEN BRACKET WEIGHT
123	123.000		WRR=.0R19*BB9WT*(VRI-VSD)/RRISP
124	124.000		PWRR=WRR
125	125.000	C	PROPELLANT WEIGHT
126	126.000		WPP=.475*WRR
127	127.000		PWPP=WPP
128	128.000	C	WATER RECOVERY HDW WEIGHT
129	129.000		WWR=350.
130	130.000		PWWR=WWR
131	131.000	C	
132	132.000	C	SRM BODY ADAPTER WEIGHT
133	133.000	C	
134	134.000	C	FORWARD SKIRT
135	135.000		WFS=13.65*DIA
136	136.000		PWFS=WFS
137	137.000	C	AFT SKIRT/LAUNCH STRUCTURE WEIGHT
138	138.000		ASLS1=(BGL9W+(P.0*BL9WT))/4.0
139	139.000		ASLS2=.65*TH9SL*CGS(AA9E/57.292578)*(LF+(DIA/2.))
140	140.000		WASLS=.00454*(ASLS1+(ASLS2/DIA))
141	141.000		PWASLS=WASLS
142	142.000	C	ATTACH SEP/STRUCTURE WEIGHT
143	143.000		WAS=.952.0*TH9SL/BB9WT
144	144.000		PWAS=WAS
145	145.000	C	NRSE FAIRING
146	146.000		WNF=.0607*DIA*DIA
147	147.000		PWNF=WNF
148	148.000	C	TUNNEL WEIGHT
149	149.000		WTN=.114*LTH
150	150.000		PWTN=WTN
151	151.000	C	AVIONICS WEIGHT
152	152.000		WAV=152.0
153	153.000		PWAV=WAV
154	154.000	C	TPS WEIGHT
155	155.000		WNC TPS=.019*DIA*DIA
156	156.000		SRMISS=WFS+WASLS+WAS+WNF+WTN+WAV+WNC TPS+SRMIC
157	157.000		WRECBV=WPAR+WPI+WRR+WPP+WWR+SRMRC
158	158.000		PR9SLU=BASSRM+SRMISS+WRECBV
159	159.000		UNCERT=PR9SLU*BJNC1
160	160.000		IF(FIXDWT.GT.0.0) UNCERT=FIXDWT-PR9SLU
161	161.000		BB9WT=BASSRM+SRMISS+WRECBV+UNCERT+EXPINS
162	162.000		BL9WT=BB9WT+PR9PB-EXPINS
163	163.000		BGL9W=BL9WT
164	164.000		IF(ABS(TBB9WT-BB9WT).LE.10.) GO TO 50
165	165.000		GO TO 30
166	166.000	30	PR9WT=PR9WT
167	167.000		PR9PR=PR9PB/N9ENGB
168	168.000		PR9WT=PR9WT-EXPINS
169	169.000		PR9SS=PR9WT+PR9PB
170	170.000		BR9WT=BR9WT+N9ENGB
171	171.000		BR9LJN=BR9WT-(UNCERT*N9ENGB)
172	172.000		BR9WT=BR9WT-(EXPINS*N9ENGB)
173	173.000		BGL9W=BR9WT+PR9PB
174	174.000		PWBT=PWP1*N9ENGB
175	175.000		LAMB=PR9PR/BGL9W
176	176.000		SRML=LTH
177	177.000		SRMD=DIA
178	178.000		GO TO 80
179	179.000	C	
180	180.000	C	FIXED BOOSTER CALCULATIONS
181	181.000	C	

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182	-	182.000	50	BRWT=RRWT
183	-	183.000		BDRWT=BRWT
184	-	184.000		BGLW=PRPB+BRWT
185	-	185.000		PWBI=PRPB/1.005
186	-	186.000		LAMB=PRPB/BGLW
187	-	187.000		GO TO 80
188	-	188.000	C	
189	-	189.000	C	SIMPLIFIED BPPSTER EQUATIONS
190	-	190.000	C	
191	-	191.000	70	PWBI=PRPB/(1.005*NBENB)
192	-	192.000		THBSLS=THBSLT/NBENB
193	-	193.000		EXPINS=-.005*PWBI
194	-	194.000		CRFSE=29453.3+(PWBI*.0773335)
195	-	195.000		BRWT=CRFSE+(THBSLS*.01887863)
196	-	196.000		RRWT=BRWT/1.035
197	-	197.000		JNCERT=RRWT*BUVC1
198	-	198.000		BRWT=RRWT+JNCERT
199	-	199.000		RRWT=RRWT*NBENB
200	-	200.000		BDRWT=RRWT-(EXPINS*NBENB)
201	-	201.000		BGLW=RRWT+PRPB
202	-	202.000		PWBI=PWBI*NBENB
203	-	203.000		LAMB=PRPB/BGLW
204	-	204.000	80	CONTINUE
205	-	205.000		RETRN
206	-	206.000		END

6. TRAJECTORY MODULE

The trajectory module contains the curve fits of an optimized trajectory, established by MDAC during the Phase B Shuttle program. These curve fit equations determine the total required velocity by defining the velocity losses. This is accomplished in several distinct steps:

- a. The ideal required velocity is determined as a function of first stage velocity, first and second stage thrust to weight ratios and the ascent drag parameter.
- b. The velocity losses attributable to the launch site altitude and the required mission inclination.
- c. A delta velocity correction factor which allows the curve fit equations to translate through the defined losses of an analyzed point design.

The equations are empirical relationships derived from parametric ascent trajectory shaping studies, and are intended to be used for ideal staging velocities in the range of 8,000 to 12,000 ft/sec.

Ascent losses have been shown to be a strong function of thrust/weight at lift-off (T/W_1), and thrust/weight immediately after staging, (T/W_2). Other significant correlation factors in the velocity loss equation are staging velocity (V_S), first stage drag parameter (W/SC_D), and launch site altitude (H). All of the above parameters are self-explanatory with the exception of SC_D . The SC_D value used is between Mach numbers 1.2 and 1.5.

The velocity losses were curve fit for ease of interpolation when used for sizing studies. The coefficients of the multivariate, polynomial fit were evaluated by a least-squares technique. Each coefficient of the initial polynomial was tested for significance, and the least significant term was eliminated. This procedure was repeated until a minimum term polynomial was determined which had accuracy essentially equal to the original. The accuracy of the curve fit was then improved by conditioning the independent variables with natural logarithmic functions. However, if new data is curve fit, other functions may be more appropriate.

The curve fits are predicated on limiting values of the thrust to weight ratios and the ascent drag coefficient. These limits are:

- a. First stage thrust to weight is less than 1.60 or greater than 1.18.
- b. Second stage thrust to weight is less than 2.0 or greater than 0.70.
- c. First stage drag parameter is less than 12,000 or greater than 1,000.

If these limits are exceeded, the program selects the applicable limiting parameter and outputs a warning that the results are outside the bounds of the curve fit equation and the validity is questionable.

Figure 6-1 is a flow diagram of the Trajectory Module, followed by a detail listing of the program.

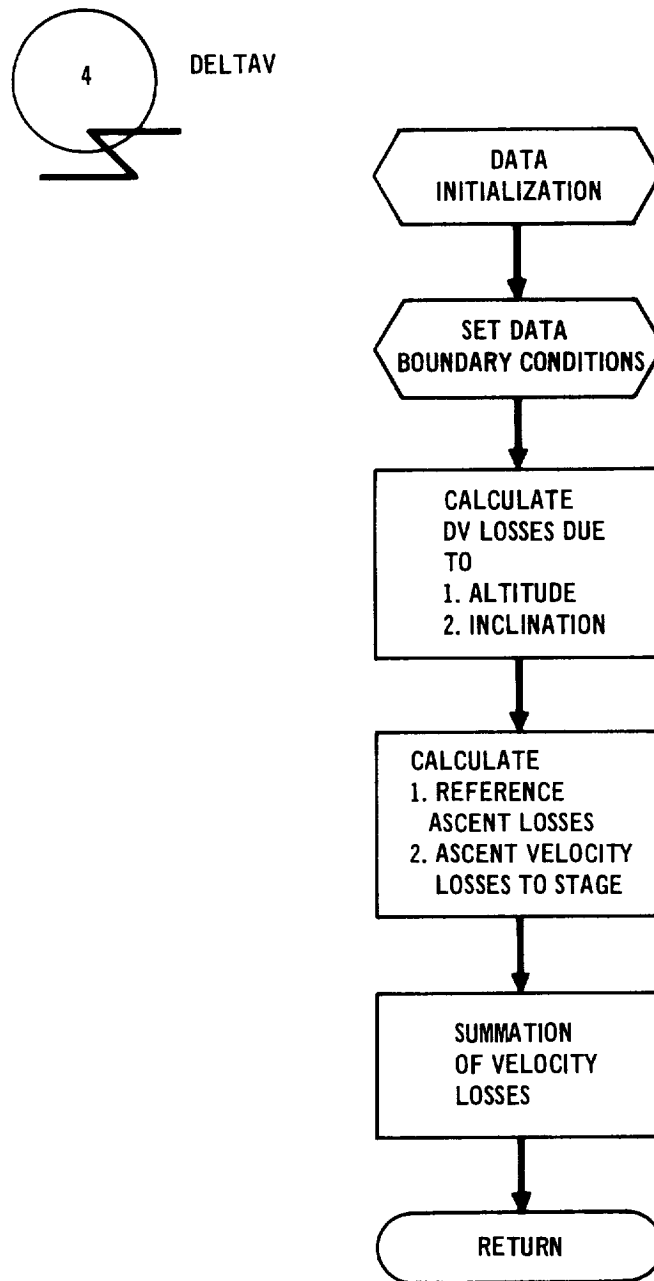


FIGURE 6-1 FLOW DIAGRAM

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COPY DVNJA TO LP(4,NC)

1	1.000	*FIXED
2	2.000	C
3	3.000	C
4	4.000	C
5	5.000	C
6	6.000	C
7	7.000	C
8	8.000	C
9	9.000	C
10	10.000	C
11	11.000	C
12	12.000	C
13	13.000	C
14	14.000	C
15	15.000	C
16	16.000	C
17	17.000	C
18	18.000	C
19	19.000	C
20	20.000	C
21	21.000	C
22	22.000	C
23	23.000	C
24	24.000	C
25	25.000	C
26	26.000	C
27	27.000	C
28	28.000	C
29	29.000	C
30	30.000	C
31	31.000	C
32	32.000	C
33	33.000	C
34	34.000	C
35	35.000	C
36	36.000	C
37	37.000	C
38	38.000	C
39	39.000	C
40	40.000	C
41	41.000	C
42	42.000	C
43	43.000	C
44	44.000	C
45	45.000	C
46	46.000	C
47	47.000	C
48	48.000	C
49	49.000	C
50	50.000	C
51	51.000	C
52	52.000	C
53	53.000	C
54	54.000	C
55	55.000	C
56	56.000	C
57	57.000	C
58	58.000	C
59	59.000	C

DELTA SUBROUTINE

SUBROUTINE DELTA

THIS PROGRAM CONTAINS THE CURVE FITS OF AN OPTIMIZED TRAJECTORY, ESTABLISHED BY MDAC DURING THE PHASE 3 SHUTTLE PROGRAM. THESE CURVE FIT EQUATIONS DETERMINE THE TOTAL REQUIRED VELOCITY BY DEFINING THE VELOCITY LOSSES.

THIS IS ACCOMPLISHED IN SEVERAL DISTINCT STEPS:

1. THE IDEAL REQUIRED VELOCITY IS DETERMINED AS A FUNCTION OF FIRST STAGE VELOCITY, FIRST AND SECOND STAGE THRUST TO WEIGHT RATIOS AND THE ASCENT DRAG PARAMETERS.

2. THE VELOCITY LOSSES ATTRIBUTABLE TO THE LAUNCH SITE ALTITUDE AND THE REQUIRED MISSION INCLINATION.

3. A DELTA VELOCITY CORRECTION FACTOR WHICH ALLOWS THE CURVE FIT EQUATIONS TO TRANSLATE THROUGH THE DEFINED LOSSES OF AN ANALYZED POINT DESIGN.

THE EQUATIONS ARE EMPIRICAL RELATIONSHIPS DERIVED FROM PARAMETRIC ASCENT TRAJECTORY SHAPING STUDIES, AND ARE INTENDED TO BE USED FOR IDEAL STAGING VELOCITIES IN THE RANGE OF 8,000. TO 12,000. FT/SEC. IMPLICIT REAL(A-Z)

PERFORMANCE COMMON BLOCK

COMMON/MAIN/ PRBP, PRBP1, PRBP2, BCANT, BCANT, BCANTY
1, MCANT, NBENGR, NBENGR, THBSL, THSSL, THSV, TSV, FLOWR
2, FE, FIE, FIEHRD
3, ISPRS, ISPRV, ISPRS, ISPRV, SCD, RTW
4, H, DVCHR, INC, STAGV, DVCHN, DVCHST
5, REL, THRT, THRS, THST, ISP, ISPB, PRBPST
6, PRBP1, PRBP2, FW(2), DVANC, DVB, DVTST, WSCD, INWT, PLANWT
7, INJWT, BLWT, GLWT, GLWT, TATL, S, P, MATCH, TLSSR, FPRP
8, THALO, ALLPL, BLALO, MSISP, MSOVT, MSOVP, MR
9, LNSP, TWS, TWS, SENS, GRW, MINGLW

DELTA OUTPUT COMMON BLOCK

COMMON/DV/DVT, DVANC, DVB, DVRR, DVBRP, X2, X3
1, DVPR, TATLSS, DVNR, DVALT

THE CURVE FITS ARE PREDICATED ON LIMITING VALUES OF THE THRUST TO WEIGHT RATIOS AND ASCENT DRAG COEFFICIENT. THESE LIMITS ARE AS FOLLOWS:

1. FIRST STAGE THRUST TO WEIGHT IS LESS THAN 1.60 OR GREATER THAN 1.18.

2. SECOND STAGE THRUST TO WEIGHT IS LESS THAN 2.0 OR GREATER THAN 0.70.

3. FIRST STAGE DRAG PARAMETER IS LESS THAN 12,000. OR GREATER THAN 1,000.

IF(FW(1).LE.1.18) FW(1)=1.18

IF(FW(1).GE.1.60) FW(1)=1.60

IF(FW(2).LE.0.70) FW(2)=0.70

IF(FW(2).GE.2.0) FW(2)=2.0

IF(WSCD.LE.1000.) WSCD=1000.

IF(WSCD.GE.12000.) WSCD=12000.

ALTITUDE VELOCITY LOSS CALCULATIONS

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60	-	60.000	DVALT=(.327+6.723E-2+4-3.6191E-6+H+H+2.222E-10+4*
61	-	61.000	5+H)*(-1.0)
62	-	62.000	IF(4.EQ.0.0) DVALT=0.0
63	-	63.000	DVC9RR=DVC9RR
64	-	64.000	C MISSION INCLINATION VELOCITY LOSS CALCULATIONS
65	-	65.000	IF(INC.GT.90.0) G9 T9 5
66	-	66.000	X1=24279.5+5.160*INC+0.1466R*INC*INC
67	-	67.000	S9 T9 6
68	-	68.000	5 X1=21003.2+57.9*INC-0.1466R*INC*INC
69	-	69.000	6 Y2=-43.594-0.3961*INC+0.00977*INC*INC
70	-	70.000	IF(INC.EQ.90.0) X2=0.0
71	-	71.000	X3A=AL99(DVB)
72	-	72.000	X3B=AL99(F#(1))
73	-	73.000	X3C=AL99(F#(2))
74	-	74.000	X3D=AL99(W9SCD)
75	-	75.000	C REFERENCE ASCENT VELOCITY LOSSES UP TO STAGING
76	-	76.000	X3=20.26+0.4240.8*X3B-2631.0*X3C-347.4*X3A*X3A
77	-	77.000	5+535R.7*X3C*X3C+2R.5*X3A*X3A*X3A-1622R0.0*X3B*X3B
78	-	78.000	5-A34R.7*X3C*X3C*X3C-705.9*X3A*X3A*X3B+18842.0
79	-	79.000	5*X3B*X3B*X3A+140R9.47-2930.7156*X3D+148.6349*X3D*X3D
80	-	80.000	DVR=X1+X2+X3+DVALT+DVC9RR
81	-	81.000	T9TLSS=X3+DVC9RR
82	-	82.000	DVT=DVR*(1.+DVC9N)
83	-	83.000	DVB9=DVT-DVB
84	-	84.000	DVF9R=DVT-DVR
85	-	85.000	C ASCENT VELOCITY LOSSES UP TO STAGING
86	-	86.000	7 X4=DVCNST-1152757.0*X3A+51852B.7*X3B+131715.9
87	-	87.000	5*X3A*X3A-2R4199.2*X3B*X3B-91690.6*X3A*X3B-631.23
88	-	88.000	5*X3A*X3D-4743.76*X3A*X3A*X3A+3725.35*X3A*X3A*X3B
89	-	89.000	5+16.94*X3A*X3A*X3D+31700.56*X3B*X3B*X3A+26.20*X3D
90	-	90.000	5*X3D*X3A+47.44-566.27*X3C+521.99*X3C*X3C
91	-	91.000	5-5729.4+14R6.12*X3D-95.874*X3D*X3D
92	-	92.000	DVB9=X4/1000.
93	-	93.000	DVB9R=DVB9
94	-	94.000	DVB9P=DVB-X4
95	-	95.000	RET JRN
96	-	96.000	END

7. FIXED HARDWARE MODULE

This optional performance module determines the payload capability for a given configuration and physical characteristics through the use of the rocket equation ($\Delta V = gISP \ln (\text{MASS FRACTION})$). In this option, the configuration weights and propellant loadings, as well as the ascent engine characteristics, are input into ESPER. To complete the analysis, the configuration velocity losses ($\Delta V_{\text{CONFIG}} = \Delta V_{\text{ORB}} + \Delta V_{\text{SRM}} + \Delta V_{\text{LOSSES}}$) are determined from an empirical relationship derived from parametric-ascent trajectory shaping studies. These velocity losses were curve fit for ease of interpolation when running ESPER. When the configuration velocity correlation constants needed for the interpolation routine (DVCORR and DVCNST) are known, the velocity losses are calculated by ESPER. This option gives the user an invaluable tool by which the user can measure the impact on payload due to changes to a FIXED HARDWARE DESIGN. (For example, what is the change to the deliverable payload due to a 1-sec increase in orbiter ascent ISP.) Generally, however, these velocity correlation constants (DVCORR and DVCNST) are not known, but the staging velocity and the total losses are usually readily available. A matching routine, based on a simplified newtonian iteration technique, is provided in the FIXED HARDWARE OPTION that will internally modify the existing velocity loss curve fits. This routine solves for the correct DVCORR and DVCNST that will satisfy the total losses and staging velocity constraints. Since DVCORR and DVCNST are required input parameters, this solution serves a dual purpose for the user, it not only allows ESPER to compute the velocity losses, but it also opens the door to the other options offered by ESPER.

Figure 7-1 is a flow diagram of the Fixed Hardware option followed by a detail listing of the program.

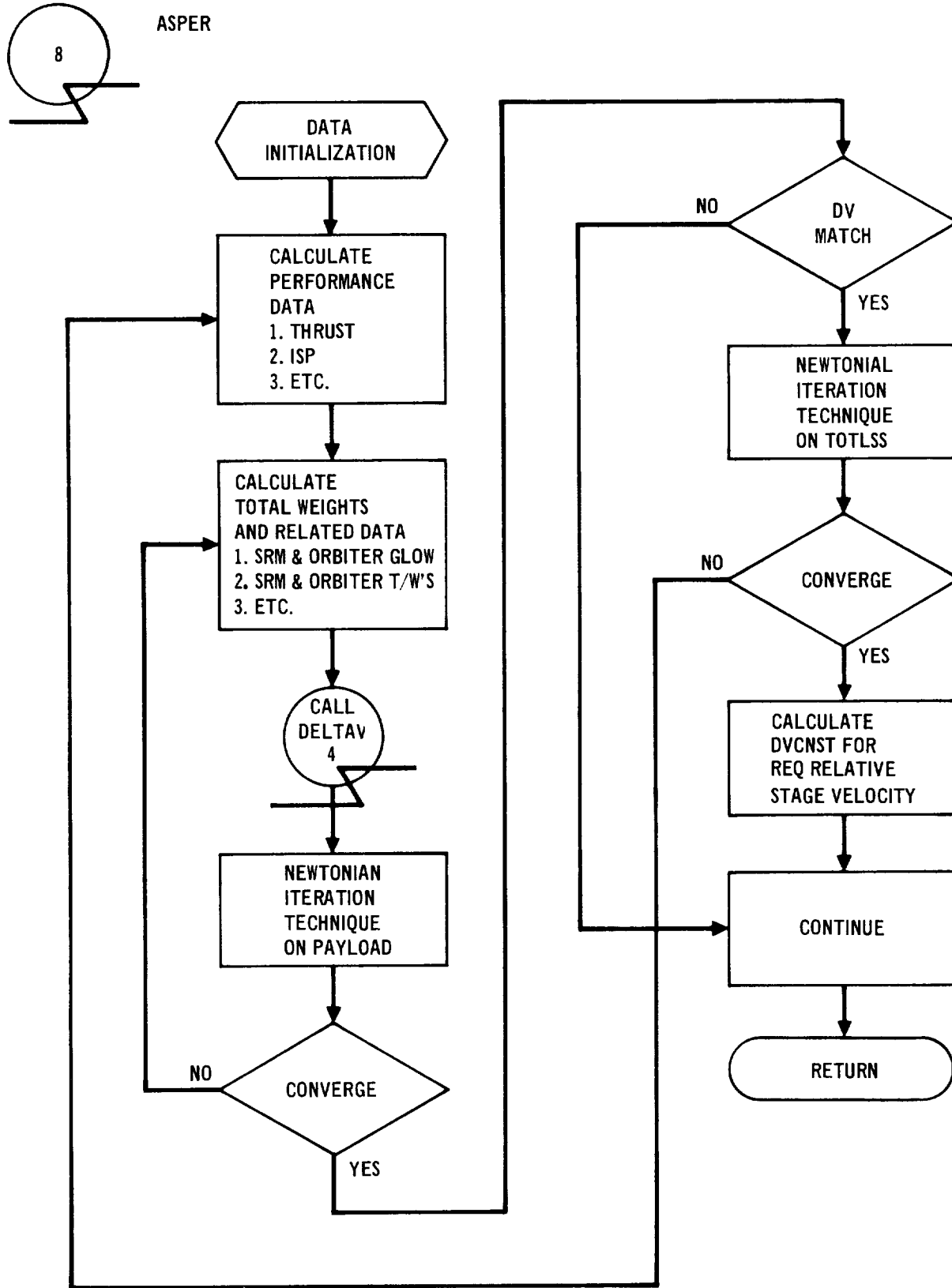


FIGURE 7-1 FLOW DIAGRAM

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COPY PAGE TO PAGE		
1	1.000	FIXED
2	2.000	C
3	3.000	C
4	4.000	C
5	5.000	C
6	6.000	C
7	7.000	C
FIXED HARDWARE SUBROUTINE		
8	8.000	C
9	9.000	C
10	10.000	C
11	11.000	C
12	12.000	C
13	13.000	C
14	14.000	C
15	15.000	C
16	16.000	C
17	17.000	C
18	18.000	C
19	19.000	C
SUBROUTINE ASPER		
THIS PROGRAM DETERMINES THE PAYLOAD CAPABILITY FOR A GIVEN CONFIGURATION AND PHYSICAL CHARACTERISTICS THROUGH THE USE OF THE ROCKET EQUATION. IN THIS OPTION THE CONFIGURATION WEIGHTS AND PROPELLANT LOADINGS, AS WELL AS THE ASCENT ENGINE CHARACTERISTICS, ARE INPUT INTO ASPER. TO COMPLETE THE ANALYSIS, THE CONFIGURATION VELOCITY LOSSES ARE DETERMINED FROM AN EMPIRICAL RELATIONSHIP DERIVED FROM PARAMETRIC-ASCENT TRAJECTORY STUDIES.		
DIMENSION RAT(2), PAY(2), DVM(2), RATM(2)		
IMPLICIT REAL(A-Z)		
PERFORMANCE COMMON BLOCK		
20	20.000	C
21	21.000	C
22	22.000	C
23	23.000	C
24	24.000	C
25	25.000	C
26	26.000	C
27	27.000	C
28	28.000	C
29	29.000	C
30	30.000	C
31	31.000	C
32	32.000	C
COMMON/MAIN/PR9PB, PR9PB, BHT, BCANT, SCANT, SCANTY		
1, BCANTP, NBENGR, NBENGR, THBSL, THBSL, THOV, TGV, FLWR		
2, TF, FT, FIXHRD		
3, ISPRS, ISPRV, ISPRS, ISPRV, SCD, BTW		
4, H, DVCRR, INC, STAGV, DVCBN, DVCNST		
5, PEL, THRTC, THRSLT, THSTC, ISPB, ISPB, PR9PT		
6, PR9P1, PR9P2, FW(2), DV8NC, DV8, DVT9TC, W9SCD, 9INWT, 9LANWT		
7, 9INJT, 9L9WT, 9GL9W, 9L9W, T9TAL, S, P, MATCH, TLSSR, FPRP		
8, 9H9LD, 9LL9L9, 9L9WLG, 9MSISP, 9MSDVT, 9MSDVP, 9MR		
9, L9NGP, T9A9, T9WB, SENS, 9R9W, MINGLW		
SRM OUTPUT COMMON BLOCK		
33	33.000	C
34	34.000	C
35	35.000	C
36	36.000	C
37	37.000	C
38	38.000	C
39	39.000	C
40	40.000	C
41	41.000	C
42	42.000	C
43	43.000	C
COMMON/SRM/9R9WT, 9DRYWT, 9R9L9W, LAMB, PW9I		
1, 9ASSRM, 9CASE, 9J9INT, 9NBZZ, 9WTER, 9WINT, 9WIGN, 9SRMC		
2, 9SRMIS, 9WFS, 9WASLS, 9WAS, 9WNF, 9WTN, 9WAV, 9WCTPS, 9RMIC		
3, 9RECIV, 9PAR, 9API, 9WR, 9WRP, 9WR, 9SRMC		
4, 9UNCERT, 9XPINS, 99SLUN, 9RML, 9RMD		
5, 9R9SS, 9R9WT, 9R9PB, 9DRYWT, 9R9SLJ		
6, 9FIX99, 9IMP99		
WRITER OUTPUT COMMON BLOCK		
44	44.000	C
45	45.000	C
46	46.000	C
47	47.000	C
48	48.000	C
49	49.000	C
50	50.000	C
51	51.000	C
52	52.000	C
53	53.000	C
54	54.000	C
55	55.000	C
56	56.000	C
57	57.000	C
58	58.000	C
59	59.000	C
COMMON/WR/9R1, 9R2, 9L, 9TJX, 9TACS, 9ACSENG, 9ACSSYS, 9TACTK		
1, 9ACSHD, 9T9MR, 9MSENG, 9R9PSY, 9T9MTK, 9M9DULE		
1, 9SURFC, 9PAR, 9ELEC, 9HYDR, 9AVIB9, 9ECLS9, 9PR9V, 9UNCWT		
2, 9R9MIS, 9TABPR9, 9SURFK		
1, 9PERS9, 9RESO, 9RESV, 9L9ADU, 9L9ADD, 9ACSPR9, 9SPR9P, 9UDLE		
2, 9FIX9R, 9FIX9R, 9DRYWT, 9RIFL		
1, 9WT, 9SG, 9RSTR, 9TRBE, 9TR9BC, 9LW, 9TE, 9WAIL, 9WAS, 9ADR, 9WAW		
2, 9WAP, 9PR9V, 9WINGK, 9TAIL, 9SG, 9BSTR, 9TR9QB, 9TLE, 9RJD, 9RS		
3, 9RDR, 9RH, 9RP, 9TAILK		
1, 9G17, 91, 9G2, 9G3, 9G6, 9G7, 9G8, 9G9, 9G10, 9G11, 9G12, 9G15, 9G16		
2, 9G17, 918, 9G19, 9G22, 9G23, 9G24, 9G25, 9G26, 9G27, 9G32, 9G33, 9G34		
3, 9G35, 9G36		
1, 9T9TPS, 9T9WT, 9WWT, 9BLEWT, 9TWT, 9TLEWT, 9LBTPS		
2, 9PASEWT, 9HTWT, 9TPSCN, 9TTWT, 9TTPSWT, 9MCSWT, 9LDTWT		
3, 9PR9T, 9PPC, 9PHYC, 9SCWT		
1, 9APR9P, 9EN9PAC, 9E9, 9TVC, 9CONTR, 9RPUTL, 9R9SYS		
2, 9FA9, 9PRES, 9CHIL, 9PREVAL, 9FEEDS, 9DISC, 9MISC		

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60	=	60.000	1, LVDDK, NG1, N32, NG3, NGEAR, M31, MG2, M33, MGEAR, AX1, AX2
61	=	61.000	2, AX3, AXGEAR, LVDDK
62	=	62.000	C
63	=	63.000	C EXTERNAL TANK OUTPUT COMMON BLOCK
64	=	64.000	C
65	=	65.000	COMMON/EXTS/39DGR, T9TFS, FWDTK, FAIRT, FWDBLE, FCCTPS
66	=	66.000	1, CNSCT, TPSIN, CYLSCT, ACYDM, AFTBLE, NINT, PR0SY, AFTNK
67	=	67.000	2, FE0SYS, FWDBLA, PRSVNT, AFTCYL, SUMP, AFTBLA, PNPJ, TWIN
68	=	68.000	3, N4SFAR, AVI9NT, JM3PNL, RET99, TUNNEL, MISCT, BAF, SUBDRY
69	=	69.000	4, GJ, DRYWT, RESIDT, JNDRAN, FEEDTR, PRSURT, FBIAS, INERT
70	=	70.000	5, GR96SW, TLAMB, STRAP, EXTL, EXT0, BLKHD, EXTH0, EXTH4, SIMPTK
71	=	71.000	C
72	=	72.000	C DELTAV OUTPUT COMMON BLOCK
73	=	73.000	C
74	=	74.000	COMMON/DV0/DVT, DV9N, DVR, DVBR, DVBRP, X2, X3
75	=	75.000	1, DVFR, T8TLSS, DV8NR, DVALT
76	=	76.000	C
77	=	77.000	T=0.0
78	=	78.000	M=0.0
79	=	79.000	N=0.0
80	=	80.000	W9PR9P=5000.
81	=	81.000	1 PL9ADU=1000.
82	=	82.000	RAT(2)=0.0
83	=	83.000	PAY(2)=0.0
84	=	84.000	PAY(1)=PL9ADU
85	=	85.000	THRSLC=THRSL*CRS(BCANT/57.2958)
86	=	86.000	TH9TC=TH9V*N9ENG9
87	=	87.000	TH9TC=(THRSLC+N9ENG9)+(N9ENG9*TH0SL)
88	=	88.000	TH9SLT=THRSL*N9ENG9
89	=	89.000	RBT=(PR9P3*ISP9S)/TH9SLT
90	=	90.000	IF(TF.NE.0.0) RBT=RBT/TF
91	=	91.000	PR991=RBT*FL9WR*N9ENG9
92	=	92.000	PR992=PR998+PR991
93	=	93.000	ISP9=(PR993*IS9BV+PR991*ISP9BV)/PR992
94	=	94.000	ISP9=ISP9RV
95	=	95.000	PR992=PR990+PR991
96	=	96.000	PR991=PR998
97	=	97.000	PR992=PR998
98	=	98.000	10 9L9WT=9LLPLB+W9PR9P+PL9ADU
99	=	99.000	9TEMP=EXP(9MSDVP/(32.174*845ISP))
100	=	100.000	W9PR9P=9L9WT*(1-(1/9TEMP))
101	=	101.000	9L9WT=9LLPLB+W9PR9P+PL9ADU
102	=	102.000	INERT=DRYWT+RESIDT
103	=	103.000	9GL9W=9L9WT+PR992+INERT
104	=	104.000	9GL9W=PR993+9L9WT
105	=	105.000	9L9W=9GL9W+9GL9W
106	=	106.000	W9SCD=9L9W/SCD
107	=	107.000	TOTAL=9L9W+949LD
108	=	108.000	LAMB=PR993/9GL9W
109	=	109.000	TLAMB=PR998/(INERT+PR992)
110	=	110.000	P991=PR993/1.005
111	=	111.000	T9WR=TH9TC/9GL9W
112	=	112.000	T9WR=TH9TC/(9GL9W-PR991)
113	=	113.000	FW(1)=T9WR
114	=	114.000	FW(2)=T9WR
115	=	115.000	DVR=32.174*ISP9*AL93(9L9W/(9L9W-PR991))
116	=	116.000	DV9NC=32.174*ISP9*AL93((9GL9W-PR991)/
117	=	117.000	1(9GL9W-PR991))
118	=	118.000	DVT9TC=DVB+DV9NC
119	=	119.000	CALL DELTAV
120	=	120.000	RAT195=DVT/DVT9TC

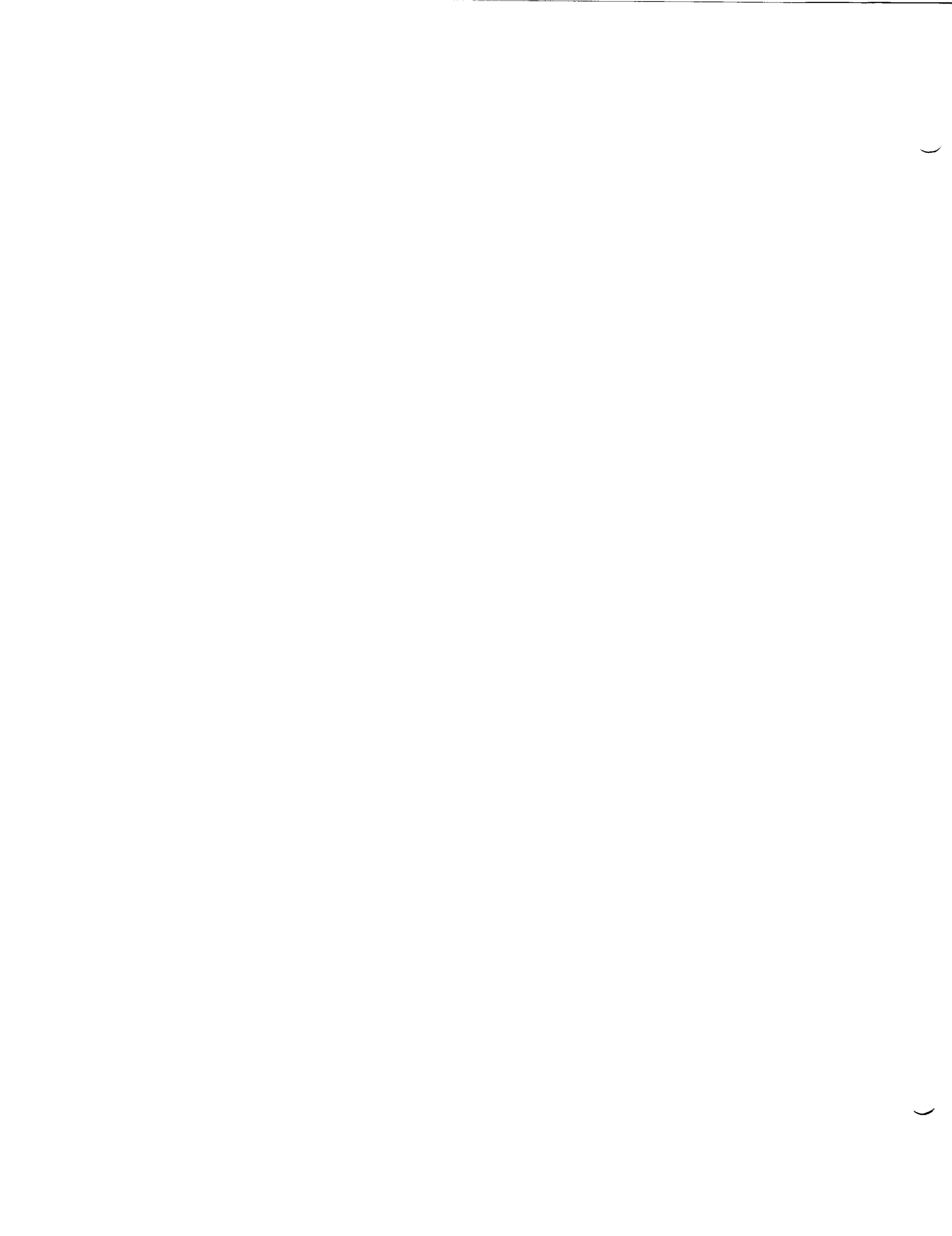
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121 - 121.000      RAT(1)=RATIO9
122 - 122.000      IF(ABS(DVT-DVT9TC).LT..1) GO TO 100
123 - 123.000      PL9ADJ=PAY(1)+(PAY(1)-PAY(2))*
124 - 124.000      1*(1.-RAT(1))/(RAT(1)-RAT(2))
125 - 125.000      PAY(2)=PAY(1)
126 - 126.000      RAT(2)=RAT(1)
127 - 127.000      PAY(1)=PL9ADJ
128 - 128.000      GO TO 10
129 - 129.000      100 IF(N.EQ.1.0) GO TO 200
130 - 130.000      C
131 - 131.000      C      DELTAV CORRELATION COEFFICIENT MATCHING ROUTINE
132 - 132.000      C
133 - 133.000      IF(MATCH.EQ.0.0) GO TO 200
134 - 134.000      IF(T.GT.0.0) GO TO 130
135 - 135.000      RAIM(2)=0.0
136 - 136.000      DVM(2)=0.0
137 - 137.000      DVM(1)=DVC9RR
138 - 138.000      RATIO9=TLSSR/T9TLSS
139 - 139.000      IF(T9TLSS.GT.TLSSR) RATIO9=T9TLSS/TLSSR
140 - 140.000      IF(T9TLSS.GT.TLSSR) M=1.0
141 - 141.000      GO TO 140
142 - 142.000      130 RATIO9=TLSSR/T9TLSS
143 - 143.000      IF(M.EQ.1.0) RATIO9=T9TLSS/TLSSR
144 - 144.000      140 RAIM(1)=RATIO9
145 - 145.000      IF(ABS(T9TLSS-TLSSR).LT..1) GO TO 150
146 - 146.000      DVC9RR=DVM(1)+(DVM(1)-DVM(2))
147 - 147.000      1*(1.-RAIM(1))/(RAIM(1)+RAIM(2))
148 - 148.000      DVM(2)=DVM(1)
149 - 149.000      RAIM(2)=RAIM(1)
150 - 150.000      DVM(1)=DVC9RR
151 - 151.000      T=T+1.0
152 - 152.000      GO TO 1
153 - 153.000      150 DVBRR=STAGV
154 - 154.000      DIFFRV=DVBRR-DVBRR
155 - 155.000      IF(DIFFRV.LE.0.0) GO TO 170
156 - 156.000      DVCNST=DVCNST-DIFFRV
157 - 157.000      GO TO 190
158 - 158.000      170 DVCNST=DVCNST+DIFFRV
159 - 159.000      190 N=1.0
160 - 160.000      GO TO 1
161 - 161.000      200 CONTINUE
162 - 162.000      RETURN
163 - 163.000      END

```



8. SENSITIVITIES MODULE

The Fixed Hardware Sensitivities Module was developed for the specific purpose of automating the task of assessing vehicle sensitivities. Theoretically, any sensitivity evaluation can be made by simply making two back-to-back runs through ESPER with the individual sensitivity element adjusted by the desired increment for the second case, and simply subtracting the resulting payloads and/or gross liftoff weights, and dividing by this increment.

Since this option is a part of ESPER, it utilizes the same ascent performance logic and ascent velocity equations. Thus, any output case from ESPER can take advantage of this option. The basic equations within this part of ESPER, however, are modified to contain discrete sensitivity increments (i.e., delta booster inert weight, delta Orbiter inert weight, delta booster ISP, etc.).

The first input case is treated as a fixed hardware configuration and initializes and varies the basic configuration performance capability. The various sensitivity increments are applied one by one, and each sensitivity is calculated separately against the initial case. To save the user the time and money involved in inputting, these sensitivity increments have been fixed in the program. Since this option can be run with any ESPER option, the user need only set SENS equal to 1.0.

Figure 8-1 is a flow diagram of the Sensitivities Module followed by a detail listing of the program.

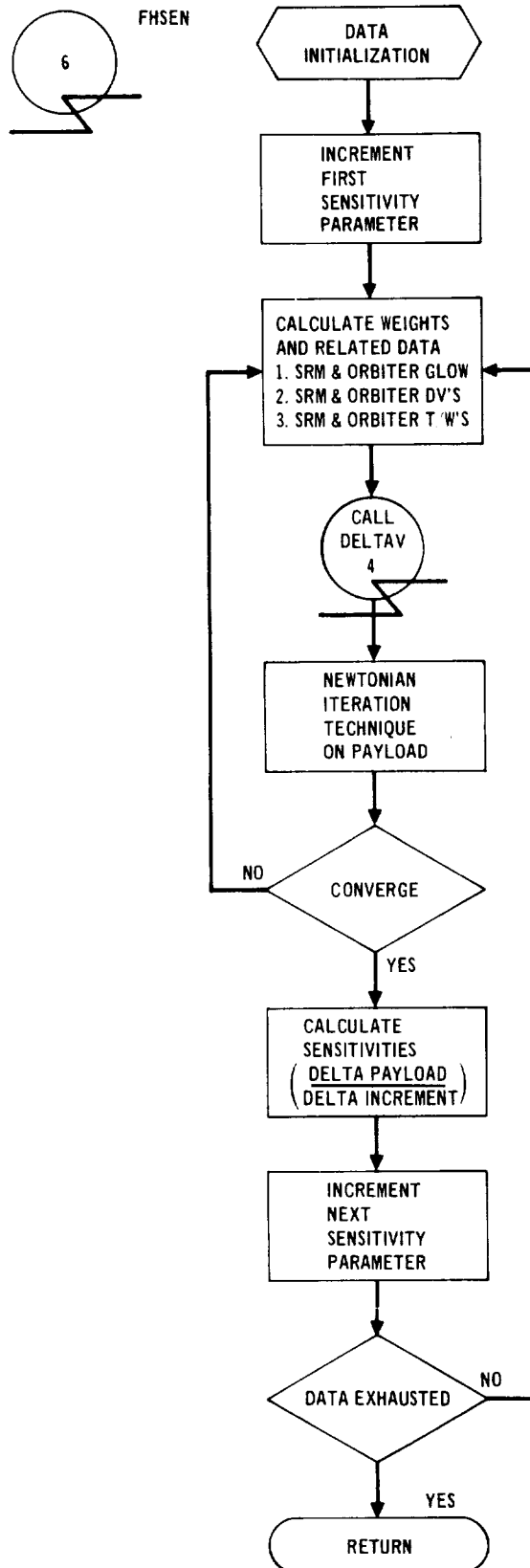


FIGURE 8-1 FLOW DIAGRAM

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COPY 5504 TO LP(K, NC)		
1 -	1.000	FIXED
2 -	2.000	C
3 -	3.000	C
4 -	4.000	C
5 -	5.000	C
6 -	6.000	C
7 -	7.000	C
8 -	8.000	C
9 -	9.000	C
10 -	10.000	C
11 -	11.000	C
12 -	12.000	C
13 -	13.000	C
14 -	14.000	C
15 -	15.000	C
16 -	16.000	C
17 -	17.000	C
18 -	18.000	C
19 -	19.000	C
20 -	20.000	C
21 -	21.000	C
22 -	22.000	C
23 -	23.000	C
24 -	24.000	C
25 -	25.000	C
26 -	26.000	C
27 -	27.000	C
28 -	28.000	C
29 -	29.000	C
30 -	30.000	C
31 -	31.000	C
32 -	32.000	C
33 -	33.000	C
34 -	34.000	C
35 -	35.000	C
36 -	36.000	C
37 -	37.000	C
38 -	38.000	C
39 -	39.000	C
40 -	40.000	C
41 -	41.000	C
42 -	42.000	C
43 -	43.000	C
44 -	44.000	C
45 -	45.000	C
46 -	46.000	C
47 -	47.000	C
48 -	48.000	C
49 -	49.000	C
50 -	50.000	C
51 -	51.000	C
52 -	52.000	C
53 -	53.000	C
54 -	54.000	C
55 -	55.000	C
56 -	56.000	C
57 -	57.000	C
58 -	58.000	C
59 -	59.000	C

SENSITIVITY SUBROUTINE

SUBROUTINE FROEN

THIS PROGRAM WAS DEVELOPED FOR THE SPECIFIC PURPOSE OF AUTOMATING THE TASK OF ASSESSING VEHICLE SENSITIVITIES.

THEORETICALLY, ANY SENSITIVITY EVALUATION CAN BE MADE BY SIMPLY MAKING TWO BACK-TO-BACK RUNS THROUGH ESPER WITH THE INDIVIDUAL SENSITIVITY ELEMENT ADJUSTED BY THE DESIRED INCREMENT FOR THE SECOND CASE, AND SIMPLY SUBTRACTING THE RESULTING PAYLOADS AND/OR LIFT-OFF WEIGHTS, AND DIVIDING BY THIS INCREMENT. THESE SENSITIVITY INCREMENTS HAVE BEEN FIXED IN THE PROGRAM.

IMPLICIT REAL (A-Z)
DIMENSION RAT(2), PAY(2)

PERFORMANCE COMMON BLOCK

COMMON/MAIN/ PRSP3, PRSP6, BRIT, BCANT, BCANT, BCANTY
1, SCANTP, NSENGR, NSENG9, THBSL, TH9SL, TH9V, T9V, FL9WR
2, TF, FTW, FIXHRD
3, ISPB5, ISPBV, ISPB9S, ISPB9V, SCD, BTW
4, H, DVCORR, INC, STAGV, DVCAN, DVCNST
5, REL, THBTC, THBSLT, TH9IC, ISPB, ISPB, PRSPBT
6, PRSP91, PRSP92, FW(2), DV9NC, DV9, DV9TC, W9SCD, 9INWT, 9LANWT
7, 9INJAT, 9L9WT, 9GL9W, 9L9W, T9TAL, S, P, MATCH, TLSSR, F9RP
8, 9H9LD, 9LL9L9, 9L9WL9, 9MSISP, 9MSDVT, 9MSDVP, 9MR
9, L9NGP, T9W9, T9WB, SENS, 9R9W, MINGLW

SPM OUTPUT COMMON BLOCK

COMMON/SRM9/BR9WT, RDR9WT, BGL9W, XLAMB, PW9I
1, RASRM, WCASE, WJ9INT, W9RZZ, WITER, WINST, WIGN, 9SRMC
2, SRMISS, PWFS, PWASLS, PWAS, PWNF, PATN, PWAV, WNCTPS, SRMIC
3, W9C9V, P9PAR, P9PI, P9RR, P9RP, P9WR, SRMRC
4, UNCERT, EXPINC, 99SLUN, SRML, SRMD
5, PR9SS, PR99WT, PR99PB, PDR9WT, PR9SLJ
6, FIX999, SJMP99

WRITER OUTPUT COMMON BLOCK

COMMON/WR99/R1, R2, RL, WTAJK, WTACS, ACSENG, ACSSYS, WTACTK
1, ACSMD, WTHMS, 9MSENG, PR9PSY, WT9MTK, M9DULE
1, SURFC, P9AR, ELEC, HYDR, AVI9N9, ECL99, P9R9V, 9JNCWT
2, 9R9MIS, TABPR9, SURFK
1, P9R9N, 9RESO, 9RESV, PLSADU, PLSADD, ACSPR9, W9PR9P, 9JUDLE
2, FIX999, FIX999, 9DR9WT, 9RIFL
1, WNT, 9SR, 9RSTR, WTR9RE, WTR9BC, LEW9TE, WAIL, WAS, WADR, WAH
2, WAP, 9PR9V, P9W9NK, TAIL, TSG, T9STR, TTR9GB, TLE, 9RJ, WRS
3, W9JR, 9RH, WRP, 9TAILK
1, G37, G1, G2, G3, G6, G7, G8, G9, G10, G11, G12, G15, G16
2, G17, G18, G19, G22, G23, G24, G25, G26, G27, G32, G33, G34
3, G35, G36
1, T9ITPS, T99WT, 99WT, 99LEWT, IWT, TLEWT, BL9T9S
2, BASEAT, 9RTWT, PTP9CN, TTWT, 9TP9WT, MCSWT, LDTWT
3, P9R9T, P9PC, PHYC, SCWT
1, TAP99P, EN9PAC, EN9, TVC, C9NTR, P9R9UTL, P9R9SYS
2, FAC, PRES, CHIL, PREVAL, FEEDS, 9ISC, MISC

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60	60.000	1, LNDCK, N01, N02, N03, NGEAR, M01, M02, M03, MGEAR, AX1, AX2
61	61.000	2, AX3, AXGEAR, LNDCK
62	62.000	C
63	63.000	C EXTERNAL TANK OUTPUT COMMON BLOCK
64	64.000	C
65	65.000	COMMON/EXTN/39DGRP, T9TPS, FWDTK, FAIRT, FWDBLE, FCCTPS
66	66.000	1, CNSCT, TPSIN, CYLSCT, ACYOM, AFTSLF, HINT, PRBSY, AFTNK
67	67.000	2, FEOSYS, FWDBLA, PRSVNT, AFTCYL, SUMP, AFTBLA, PNPJ, TWINT
68	68.000	3, NCSFAR, AVIGNT, JM3PNL, WRET39, TUNNEL, MISCT, BAFF, SJBDRY
69	69.000	4, GU, DRYWT, RESIDT, JNDRAN, FEEDTR, PRSURT, FBIAS, INERT
70	70.000	5, GR9SSW, TLAMB, STRAP, EXTL, EXTJ, BLKHD, EXTH0, EXTHH, SIMPTK
71	71.000	C
72	72.000	C DELTAV OUTPUT COMMON BLOCK
73	73.000	C
74	74.000	C COMMON/DV9/DVT, DV9N, DVR, DVBR, DVBRP, X2, X3
75	75.000	1, DVEPR, T9TLSS, DV9NR, DVALT
76	76.000	C
77	77.000	PAYL=PL9ADJ
78	78.000	PAYLX=PAYL
79	79.000	DVC9RX=DVC9RR
80	80.000	DVTX=DVT
81	81.000	DVMX=9M9DVP
82	82.000	LAMBX=TLAMB
83	83.000	BL9X=BL9W
84	84.000	C9REL=9LLPL9+W9PR9P
85	85.000	DELC9R=10000.
86	86.000	DEL3AT=0.
87	87.000	DEL3IS=0.
88	88.000	DEL3IS=0.
89	89.000	DELTHB=0.
90	90.000	DELTH9=0.
91	91.000	DELPR9=0.
92	92.000	DELPRB=0.
93	93.000	DELLAM=0.
94	94.000	DEL999=0.
95	95.000	DPR9I=0.
96	96.000	DPR9I=0.
97	97.000	DELPR3=0.
98	98.000	DELVT=0.
99	99.000	DELJ99=0.
100	100.000	DELJ9T=0.
101	101.000	DELJ9R=0.
102	102.000	DLT9IS=0.
103	103.000	DLT9IS=0.
104	104.000	XYZ=0.
105	105.000	1 PAYL=1000.
106	106.000	RAT(2)=0.0
107	107.000	PAY(2)=0.0
108	108.000	PAY(1)=PAYL
109	109.000	BLAM=(PR9PB/(R99WT+PR9PB))+DEL300
110	110.000	BR9WTX=PR9PR*(1.+DPR9I/100.)*(1.-BLAM)/BLAM
111	111.000	BR9DEL=BR9WTX-BR9WT
112	112.000	IF (DEL300.EQ.0.0.AND.DPR9I.EQ.0.0) BR9DEL=0.0
113	113.000	FL9WB=TH9SL*N9ENG9/ISP9S
114	114.000	NTH9B=FL9WB*(ISP9S+DLT9IS)
115	115.000	DLTAT9=NTH9B-TH9SL*N9ENG9
116	116.000	IF (DLT9IS.EQ.0.0) DLTAT9=0.0
117	117.000	TH9RT=TH9SL*N9ENG9*(1.+DELTHB/100.)+DLTAT9
118	118.000	CTH9B=TH9RT*CS(BCANT/57.2959)
119	119.000	BRT=((PR9PB+DELPRB+DPR9I*PR9PB/100.)*(ISP9S+DEL3IS
120	120.000	+DLT9IS))/TH9RT)/TF

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121 -	121.000		XLAMB=LAMBXX+JFLLAM
122 -	122.000		NTNKIN=(1.-XLAMB)*PR9P9T*(1.+DPR9I/100.)/XLAMB
123 -	123.000		DLTNK=NTNKIN-INERT
124 -	124.000		DTKDRY=DLTNK-RESIDT*DPR9I/100.
125 -	125.000		IF(DELAM.EQ.0.0.AND.DPR9I.EQ.0.0) DLTNK=0.0
126 -	126.000		JFLW3=T8V/ISP93V
127 -	127.000		JNTHR9=JFLW9*(ISP9BV+DLT9IS)
128 -	128.000		DLTAT9=JNTHR9-T9V
129 -	129.000		IF(DLT9IS.EQ.0.0) DLTAT9=0.0
130 -	130.000		JTH99=T9V*(1.+DELTH9/100.)*DLTAT9
131 -	131.000		IF(N9EN99.EQ.0.0) CT43V=(UTH99+UTH99*2.*C9S(9CANTY
132 -	132.000		8/57.2958))/N9EN99
133 -	133.000		IF(N9EN99.NE.0.0) CT43V=JTH99*C9S(9CANTY/57.2958)
134 -	134.000		CTH9SL=CT43V*C9S(9CANTP/57.2958)*(ISP9BS/ISP93V)
135 -	135.000		CTH9BT=CTH9V*N9EN99
136 -	136.000		TH99T=JTH99*N9EN99
137 -	137.000		TH91=CTH94+CTH9SL*N9EN99
138 -	138.000		PR9991=9RT*TH99T/(ISP93V+DEL9IS+DLT9IS)
139 -	139.000		PR9992=PR999T*(1.+DPR9I/100.)*PR9991+DELPR9
140 -	140.000	10	GL9W2=C9REL9+PAYL+INERT+DLTNK+PR9992+DELCO9
141 -	141.000		GL9W=GL9W2+PR9991+9999T+PR9993+DEL9WT+DELPR9+9999DEL
142 -	142.000		5+PR9993+DPR9I/100.
143 -	143.000		ISP1=((ISP93V+DEL9IS+DLT9IS)*(PR9993+DELPR9+DPR9I)+
144 -	144.000		5PR9993/100.)+(ISP93V+DEL9IS+DLT9IS)*PR9991)/
145 -	145.000		5(PR9993+DELPR9+DPR9I+PR9993/100.+PR9991)
146 -	146.000		DV9=32.174*ISP1*AL9G(GL9W/(GL9W-PR9993-PR9991-DELPR9
147 -	147.000		5-DPR9I-PR9993/100.))
148 -	148.000		DV9NC=32.174*(ISP93V+DEL9IS+DLT9IS)*AL9G(GL9W2/
149 -	149.000		5(GL9W2-PR9992))
150 -	150.000		DVT9TC=DV9+DV9NC
151 -	151.000		TW1=TH91/GL9W
152 -	152.000		TW2=CTH99T/GL9W2
153 -	153.000		Fw(1)=TW1
154 -	154.000		Fw(2)=TW2
155 -	155.000		9GL9W=GL9W2+PR9991
156 -	156.000		9GL9W=GL9W-9GL9W
157 -	157.000		DV99=32.174*9MSISP*AL9G((C9REL9+PAYLX)/(C9REL9+PAYLX-
158 -	158.000		5*(99999+DELPR9)))
159 -	159.000		W9SCD=GL9W/SCD
160 -	160.000		DVC9RR=DVC9RX+DELVT
161 -	161.000		CALL DELTAV(H,DVC9RR,INC,DVC9N,DVC9ST,Fw,W9SCD,DV9)
162 -	162.000		RAT199=DVT/DVT9TC
163 -	163.000		RAT(1)=RAT199
164 -	164.000		IF(ABS(DVT-DVT9TC).LT.0.1) G9 T9 100
165 -	165.000		PAYL=PAY(1)+(PAY(1)-PAY(2))*
166 -	166.000		1(1.-RAT(1))/RAT(1)-RAT(2))
167 -	167.000		PAY(2)=PAY(1)
168 -	168.000		RAT(2)=RAT(1)
169 -	169.000		PAY(1)=PAYL
170 -	170.000		G9 T9 10
171 -	171.000	100	CALL SENSIV (PAYLX,PAYL,DVTX,DVMX,DV93,LAMBX,DELCO9
172 -	172.000		1,DEL9AT,DEL9IS,DEL9IS,DELTH9,DELTH9,XYZ,DELPR9,DELPR9
173 -	173.000		2,DELAM,DEL930,DPR9I,DPR9I,DELVT,DELPR9,DEL930
174 -	174.000		3,DEL9ST,DEL9GR,GL9WX,DLT9IS,DLT9IS,DTKDRY,XLAMB)
175 -	175.000		IF(XYZ.EQ.1.) G9 T9 999
176 -	176.000		G9 T9 1
177 -	177.000	999	CONTINUE
178 -	178.000		RETRN
179 -	179.000		END
180 -	180.000		SUBROUTINE SENSIV (PAYLX,PAYL,DVTX,DVMX,DV93,LAMBX
181 -	181.000		1,DELCO9,DEL9AT,DEL9IS,DEL9IS,DELTH9,DELTH9,XYZ

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182 - 182.000	2, DELPR9, DELPR8, DELPR7, DELPR6, DPR91, DPR81, DELVT
183 - 183.000	3, DELPR3, DELU38, DELUGT, DELU39, GL9WX, DLT91S, DLT91S
184 - 184.000	4, DTCDRY, XLAMB
185 - 185.000	IMPLICIT REAL (A-Z)
186 - 186.000	COMMON/MATN/ PR9P3, PR9P9, BBT, BCANT, BCANT, BCANTY
187 - 187.000	1, BCANTP, N9ENG8, N9ENG9, TH9SL, TH9SL, TH9V, T9V, FL9WR
188 - 188.000	2, TF, FTW, FIXHRD
189 - 189.000	3, IS93S, IS93V, IS99S, IS99V, SCD, BTW
190 - 190.000	4, H, DVC9RR, INC, STAGV, DVC9N, DVCNST
191 - 191.000	5, REL, TH9TC, TH9SLT, TH9TC, IS99, IS9B, PR9P9T
192 - 192.000	6, PR9P91, PR9P92, FW(2), DV9NC, DV9, DVT9TC, W9SCO, 91NWT, 91ANWT
193 - 193.000	7, 91NJAT, 91LWT, 91L9W, 91L9W, T9TAL, S, P, MATCH, TLSSR, F9RP
194 - 194.000	8, 91HLD, 91LPL9, 91L9W, 91MSIS, 91MSDVT, 91MSDVP, 91MR
195 - 195.000	9, L9NGP, T9WR, T9WB, SENS, 919W, MINGLW
196 - 196.000	COMMON/SR49/ BR9WT, BDRYWT, BGL9W, LAMB, PW91
197 - 197.000	1, BR9SM, WCASE, WJ9INT, W9ZZ, WTER, WINST, WIGN, 91SMC
198 - 198.000	2, SRMISS, P9FS, P9ASLS, P9AS, P9NF, P9TN, P9AV, WNC9PS, SRMIC
199 - 199.000	3, W9EC9V, P9PAR, P9PI, P9RR, P9RP, P9WR, SRMRC
200 - 200.000	4, UNCERT, EXPINS, 91SLUN, SRML, SRM
201 - 201.000	5, P999SS, P999WT, P999P3, P999WT, P999SLJ
202 - 202.000	6, FIX999, SIMP99
203 - 203.000	COMMON/9999/R1, R2, RL, WTAJX, WTACS, ACSENG, ACSSYS, WTACTK
204 - 204.000	1, ACS900, WT9MS, 91MSENG, PR9PSY, WT9MTK, MODJLE
205 - 205.000	1, SURFC, P9WR, ELEC, HYDR, AVI9NR, ECL90, P999V, 91JNCWT
206 - 206.000	2, 919MIS, TAR9R, SURFK
207 - 207.000	1, PERSON, 91RES0, 91RESV, 91R9DU, PL9ADD, ACS9R9, W99R9P, SUDLE
208 - 208.000	2, FIX999, FIX999, 91DRYWT, 91IFL
209 - 209.000	1, WWT, W90, W9STR, W99RE, W99RBC, LEW, WTE, WAIL, WAS, W9DR, W9H
210 - 210.000	2, W9P, 9199V, P91NGK, TAIL, T9G, T9STR, T99R93, TLE, W9JC, W9S
211 - 211.000	3, W9DR, W9H, W9P, P9TAILK
212 - 212.000	1, G97, G91, G92, G93, G96, G97, G98, G99, G10, G11, G12, G15, G16
213 - 213.000	2, G17, G18, G19, G22, G23, G24, G25, G26, G27, G32, G33, G34
214 - 214.000	3, G35, G36
215 - 215.000	1, T9T9PS, T99T, W9WT, W9LEWT, TWT, TLEWT, BLBTPS
216 - 216.000	2, BASENT, I91WT, P9P9CN, T9WT, 91T9SWT, M9SWT, LD9WT
217 - 217.000	3, P99WT, P9PC, PHYC, SCWT
218 - 218.000	1, T999P, EN9PAC, EN9TVC, C9NTR, P9PUTL, P999S
219 - 219.000	2, FAJ, PRES, CHIL, PREVAL, FEEDS, DISC, MISC
220 - 220.000	1, L9D9K, NG1, NG2, NG3, NG9EAR, M31, M32, M33, M9EAR, AX1, AX2
221 - 221.000	2, AX3, AX9EAR, L9D9K
222 - 222.000	COMMON/EXT9/ 9199R, T9T9S, F9D9TK, FAIRT, F9D9BLE, F9C9T9S
223 - 223.000	1, C9V9CT, T9SIN, CYL9CT, ACY9M, AFT9BLE, WINT, P99S, AFT9K
224 - 224.000	2, FE9SYS, F9D9LA, P99VNT, AFT9CYL, SUMP, AFT9BLA, P9PJ, T9INT
225 - 225.000	3, W99FAR, AVI9NT, J93PNL, W9R9TR, TUNNEL, MISC, BAFF, S9B9RY
226 - 226.000	4, 91, 91DRYWT, RESI9T, J9DRAN, FEEDTR, P99SURT, FBIA9, INERT
227 - 227.000	5, GR9SSW, TL9MB, 91TRAP, EXT9, EXT9, BLK9D, EXT9, EXT9, SIMPTK
228 - 228.000	COMMON/DV9/DVT, DV9N, DV9, DV9R, DV9RP, X2, X3
229 - 229.000	1, DV9PR, T9TLSS, DV9NR, DV9LT
230 - 230.000	DEL9PAY=P9YL-P9YLX
231 - 231.000	IF (DEL9CR.EQ.0.0) G9 T9 10
232 - 232.000	IF (DEL9CR.LT.0.0) G9 T9 9
233 - 233.000	WRITE (108, 400)
234 - 234.000	SNC9RP=DEL9PAY/DEL9CR
235 - 235.000	WRITE (108, 410) DEL9CR, DEL9PAY, SNC9RP
236 - 236.000	DEL9CR=-1000.
237 - 237.000	G9 T9 43
238 - 238.000	9 SNC9RN=DEL9PAY/DEL9CR
239 - 239.000	WRITE (108, 410) DEL9CR, DEL9PAY, SNC9RN
240 - 240.000	SNC9RA=(SNC9RP+SNC9RN)/2.
241 - 241.000	WRITE (108, 500) SNC9RA
242 - 242.000	DEL9CR=0.

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243 -	243.000		DELRWT=20000.
244 -	244.000		GO TO 43
245 -	245.000	10	IF (DELRWT.EQ.0.0) GO TO 12
246 -	246.000		IF (DELRWT.LT.0.0) GO TO 11
247 -	247.000		SNBWTP=DELPAY/DELRWT
248 -	248.000		WRITE (108,411) DELRWT,DELPAY,SNBWTP
249 -	249.000		DELRWT=-20000.
250 -	250.000		GO TO 43
251 -	251.000	11	SNBWTN=DELPAY/DELRWT
252 -	252.000		WRITE (108,411) DELRWT,DELPAY,SNBWTN
253 -	253.000		SNBWA=(SNBWTP+SNBWTN)/2.
254 -	254.000		WRITE (108,501) SNBWA
255 -	255.000		DELRWT=0.
256 -	256.000		DELRIS=3.
257 -	257.000		GO TO 43
258 -	258.000	12	IF (DELRIS.EQ.0.0) GO TO 14
259 -	259.000		IF (DELRIS.LT.0.0) GO TO 13
260 -	260.000		SNBISP=DELPAY/DELRIS
261 -	261.000		WRITE (108,412) DELRIS,DELPAY,SNBISP
262 -	262.000		DELRIS=-3.
263 -	263.000		GO TO 43
264 -	264.000	13	SNBISN=DELPAY/DELRIS
265 -	265.000		WRITE (108,412) DELRIS,DELPAY,SNBISN
266 -	266.000		SNBISA=(SNBISP+SNBISN)/2.
267 -	267.000		WRITE (108,500) SNBISA
268 -	268.000		DELRIS=0.
269 -	269.000		DELRIS=3.
270 -	270.000		GO TO 43
271 -	271.000	14	IF (DELRIS.EQ.0.0) GO TO 39
272 -	272.000		IF (DELRIS.LT.0.0) GO TO 15
273 -	273.000		SNBISP=DELPAY/DELRIS
274 -	274.000		WRITE (108,413) DELRIS,DELPAY,SNBISP
275 -	275.000		DELRIS=-3.
276 -	276.000		GO TO 43
277 -	277.000	15	SNBISN=DELPAY/DELRIS
278 -	278.000		WRITE (108,413) DELRIS,DELPAY,SNBISN
279 -	279.000		SNBISA=(SNBISP+SNBISN)/2.
280 -	280.000		WRITE (108,500) SNBISA
281 -	281.000		DELRIS=0.
282 -	282.000		DLTRIS=3.
283 -	283.000		GO TO 43
284 -	284.000	39	IF (DLTRIS.EQ.0.0) GO TO 41
285 -	285.000		IF (DLTRIS.LT.0.0) GO TO 40
286 -	286.000		STBISP=DELPAY/DLTRIS
287 -	287.000		WRITE (108,435) DLTBIS,DELPAY,STBISP
288 -	288.000		DLTRIS=-3.
289 -	289.000		GO TO 43
290 -	290.000	40	STBISN=DELPAY/DLTRIS
291 -	291.000		WRITE (108,435) DLTBIS,DELPAY,STBISN
292 -	292.000		STBISA=(STBISP+STBISN)/2.
293 -	293.000		WRITE (108,500) STBISA
294 -	294.000		DLTRIS=0.
295 -	295.000		DLTRIS=3.
296 -	296.000		GO TO 43
297 -	297.000	41	IF (DLTRIS.EQ.0.0) GO TO 16
298 -	298.000		IF (DLTRIS.LT.0.0) GO TO 42
299 -	299.000		STBISP=DELPAY/DLTRIS
300 -	300.000		WRITE (108,436) DLTBIS,DELPAY,STBISP
301 -	301.000		DLTRIS=-3.
302 -	302.000		GO TO 43
303 -	303.000	42	STBISN=DELPAY/DLTRIS

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304	-	304.000	WRITE(108,436) DLT9IS,DELPAY,ST9ISN
305	-	305.000	ST9ISA=(ST9ISP+ST9ISN)/2.
306	-	306.000	WRITE(108,500) ST9ISA
307	-	307.000	DLT9IS=0.
308	-	308.000	DELTH3=2.
309	-	309.000	GO TO 43
310	-	310.000	16 IF(DELTH3.EQ.0.0) GO TO 18
311	-	311.000	IF(DELTH3.LT.0.0) GO TO 17
312	-	312.000	SNTH3P=DELPAY/DELTH3
313	-	313.000	WRITE(108,414) DELTH3,DELPAY,SNTH3P
314	-	314.000	DELTH3=-2.
315	-	315.000	GO TO 43
316	-	316.000	17 SNTH3N=DELPAY/DELTH3
317	-	317.000	WRITE(108,414) DELTH3,DELPAY,SNTH3N
318	-	318.000	SNTH3A=(SNTH3P+SNTH3N)/2.
319	-	319.000	WRITE(108,500) SNTH3A
320	-	320.000	DELTH3=0.
321	-	321.000	DELTH3=3.
322	-	322.000	GO TO 43
323	-	323.000	18 IF(DELTH3.EQ.0.0) GO TO 20
324	-	324.000	IF(DELTH3.LT.0.0) GO TO 19
325	-	325.000	SNTH3P=DELPAY/DELTH3
326	-	326.000	WRITE(108,415) DELTH3,DELPAY,SNTH3P
327	-	327.000	DELTH3=-3.
328	-	328.000	GO TO 43
329	-	329.000	19 SNTH3N=DELPAY/DELTH3
330	-	330.000	WRITE(108,415) DELTH3,DELPAY,SNTH3N
331	-	331.000	SNTH3A=(SNTH3P+SNTH3N)/2.
332	-	332.000	WRITE(108,500) SNTH3A
333	-	333.000	DELTH3=0.
334	-	334.000	DELPR3=10000.
335	-	335.000	GO TO 43
336	-	336.000	20 IF(DELPR3.EQ.0.0) GO TO 22
337	-	337.000	IF(DELPR3.LT.0.0) GO TO 21
338	-	338.000	SNPR3P=DELPAY/DELPR3
339	-	339.000	WRITE(108,416) DELPR3,DELPAY,SNPR3P
340	-	340.000	DELPR3=-10000.
341	-	341.000	GO TO 43
342	-	342.000	21 SNPR3N=DELPAY/DELPR3
343	-	343.000	WRITE(108,416) DELPR3,DELPAY,SNPR3N
344	-	344.000	SNPR3A=(SNPR3P+SNPR3N)/2.
345	-	345.000	WRITE(108,501) SNPR3A
346	-	346.000	DELPR3=0.
347	-	347.000	DELPR3=10000.
348	-	348.000	GO TO 43
349	-	349.000	22 IF(DELPR3.EQ.0.0) GO TO 24
350	-	350.000	IF(DELPR3.LT.0.0) GO TO 23
351	-	351.000	SNPR3P=DELPAY/DELPR3
352	-	352.000	WRITE(108,417) DELPR3,DELPAY,SNPR3P
353	-	353.000	DELPR3=-10000.
354	-	354.000	GO TO 43
355	-	355.000	23 SNPR3N=DELPAY/DELPR3
356	-	356.000	WRITE(108,417) DELPR3,DELPAY,SNPR3N
357	-	357.000	SNPR3A=(SNPR3P+SNPR3N)/2.
358	-	358.000	WRITE(108,501) SNPR3A
359	-	359.000	DELPR3=0.
360	-	360.000	DELLAM=.01
361	-	361.000	GO TO 43
362	-	362.000	24 IF(DELLAM.EQ.0.0) GO TO 26
363	-	363.000	IF(DELLAM.LT.0.0) GO TO 25
364	-	364.000	SNLAMP=DELPAY

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365 - 365.000		WRITE(108,418) DELLAM,DELPAY,SNLAMP
366 - 366.000		DELLAM=-.01
367 - 367.000		GO TO 43
368 - 368.000	25	SNLAMN=-DELPAY
369 - 369.000		WRITE(108,418) DELLAM,DELPAY,SNLAMN
370 - 370.000		SNLAMA=(SNLAMP+SNLAMN)/2.
371 - 371.000		WRITE(108,500) SNLAMA
372 - 372.000		DELLAM=0.
373 - 373.000		DELB99=-.01
374 - 374.000		GO TO 43
375 - 375.000	26	IF(DELB99.EQ.0.0) GO TO 28
376 - 376.000		IF(DELB99.LT.0.0) GO TO 27
377 - 377.000		SNB99P=DELPAY
378 - 378.000		WRITE(108,419) DELB99,DELPAY,SNB99P
379 - 379.000		DELB99=-.01
380 - 380.000		GO TO 43
381 - 381.000	27	SNB99N=-DELPAY
382 - 382.000		WRITE(108,419) DELB99,DELPAY,SNB99N
383 - 383.000		SNB99A=(SNB99P+SNB99N)/2.
384 - 384.000		WRITE(108,500) SNB99A
385 - 385.000		DELB99=0.
386 - 386.000		OPR91=10.
387 - 387.000		GO TO 43
388 - 388.000	28	IF(OPR91.EQ.0.0) GO TO 30
389 - 389.000		IF(OPR91.LT.0.0) GO TO 29
390 - 390.000		SNP91P=DELPAY/OPR91
391 - 391.000		DELGL9W=GL9W-GL9WX
392 - 392.000		OPDP=DELGL9W/DELPAY
393 - 393.000		P=SIGN(1.,OPDP)
394 - 394.000		OLP99=OPDP91*OPR91/100.
395 - 395.000		OPDP=OLP99/DELPAY
396 - 396.000		OPWP=OPDP*P
397 - 397.000		OTOP=OTOP9Y/DELPAY
398 - 398.000		WRITE(108,420) OPR91,DELPAY,SNP91P
399 - 399.000		OPR91=-10.
400 - 400.000		GO TO 43
401 - 401.000	29	SNP91N=DELPAY/OPR91
402 - 402.000		WRITE(108,420) OPR91,DELPAY,SNP91N
403 - 403.000		SNP91A=(SNP91P+SNP91N)/2.
404 - 404.000		WRITE(108,500) SNP91A
405 - 405.000		OPR91=0.
406 - 406.000		OPR91=10.
407 - 407.000		GO TO 43
408 - 408.000	30	IF(OPR91.EQ.0.0) GO TO 32
409 - 409.000		IF(OPR91.LT.0.0) GO TO 31
410 - 410.000		SNP93P=DELPAY/OPR91
411 - 411.000		WRITE(108,421) OPR91,DELPAY,SNP93P
412 - 412.000		OPR91=-10.
413 - 413.000		GO TO 43
414 - 414.000	31	SNP93N=DELPAY/OPR91
415 - 415.000		WRITE(108,421) OPR91,DELPAY,SNP93N
416 - 416.000		SNP93A=(SNP93P+SNP93N)/2.
417 - 417.000		WRITE(108,500) SNP93A
418 - 418.000		OPR91=0.
419 - 419.000		DELVT=100.
420 - 420.000		GO TO 43
421 - 421.000	32	IF(DELVT.EQ.0.0) GO TO 34
422 - 422.000		DLVTX=DVT-DVTX
423 - 423.000		IF(DELVT.LT.0.0) GO TO 33
424 - 424.000		SNVTP=DELPAY/DLVTX
425 - 425.000		WRITE(108,422) DLVTX,DELPAY,SNVTP

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426	-	426.000		DELVT=-100.
427	-	427.000		GO TO 43
428	-	428.000	33	SNVTN=DELPAY/DLVTX
429	-	429.000		WRITE(108,422) DLVTX,DELPAY,SNVTN
430	-	430.000		SNVTA=(SNVTP+SNVTN)/2.
431	-	431.000		WRITE(108,500) SNVTA
432	-	432.000		DELVT=0.
433	-	433.000		DELPR3=1000.
434	-	434.000		GO TO 43
435	-	435.000	34	IF(DELPR3.EQ.0.0) GO TO 36
436	-	436.000		DLVM=DV93-DVMX
437	-	437.000		DELPAY=-DELPR3
438	-	438.000		IF(DELPR3.LT.0.0) GO TO 35
439	-	439.000		SNPR3P=DELPAY/DLVM
440	-	440.000		WRITE(108,423) DLVM,DELPAY,SNPR3P
441	-	441.000		DELPR3=-1000.
442	-	442.000		GO TO 43
443	-	443.000	35	SNPR3N=DELPAY/DLVM
444	-	444.000		WRITE(108,423) DLVM,DELPAY,SNPR3N
445	-	445.000		SNPR3A=(SNPR3P+SNPR3N)/2.
446	-	446.000		WRITE(108,500) SNPR3A
447	-	447.000		DELPR3=0.
448	-	448.000		IF(FIXRRR.GT.0.0.9R.SIMPRB.GT.0.0
449	-	449.000		1.9R.FIXRRR.GT.0.0.9R.FIXWR.GT.0.0
450	-	450.000		2.9R.SIMPTX.GT.0.0.9R.FIXWR.GT.0.0) GO TO 44
451	-	451.000		DELJG9=.01*SUJLE
452	-	452.000		GO TO 43
453	-	453.000	36	IF(DELUG9.EQ.0.0) GO TO 37
454	-	454.000		SNJG9=-DELJG9
455	-	455.000		WRITE(108,450) DELUG9,SNJG9
456	-	456.000		DELJG9=0.
457	-	457.000		DELJGT=.01*SUJDRY
458	-	458.000		GO TO 43
459	-	459.000	37	IF(DELJGT.EQ.0.0) GO TO 38
460	-	460.000		SNJGT=-DELJGT
461	-	461.000		WRITE(108,451) DELJGT,SNJGT
462	-	462.000		DELJGT=0.
463	-	463.000		DELJGR=.01*BSLJN
464	-	464.000		GO TO 43
465	-	465.000	38	DELPAY=-DELUG9*SNBWTN
466	-	466.000		SNJGB=-DELPAY
467	-	467.000		WRITE(108,452) DELPAY,SNJGB
468	-	468.000	C	GL9W SENSITIVITIES WITH STRETCHED HB TANK
469	-	469.000	44	D19W=(DWD9*SNCR9P-P)
470	-	470.000		D19W=(DWD9*SNBWT9-P)
471	-	471.000		D199=DWD9*SNB19N
472	-	472.000		D193=DWD9*SNB19N
473	-	473.000		D194=DWD9*SN199N
474	-	474.000		D194=DWD9*SN199N
475	-	475.000		DLVT=(DWD9*SNVTP)
476	-	476.000		DLVM=(DWD9*SNPR3P)
477	-	477.000		WRITE(108,425)
478	-	478.000		WRITE(108,426) DGD9,D19W
479	-	479.000		WRITE(108,427) D199,D193
480	-	480.000		WRITE(108,428) D194,D194
481	-	481.000		WRITE(108,429) DLVT
482	-	482.000		WRITE(108,430) DLVM
483	-	483.000		WRITE(108,431) D19W
484	-	484.000		WRITE(108,432) DGD9
485	-	485.000		WRITE(108,434) D19P
486	-	486.000		XYZ=1.

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487 -	487.000	43	CONTINUE
488 -	488.000		RETURN
489 -	489.000	400	FORMAT('1',///24X,'VEHICLE SENSITIVITIES'//
490 -	490.000		59X,'ITEM',9X,'INCREMENT',6X,'DELTA PAYLOAD',
491 -	491.000		87X,'SENSITIVITY'//)
492 -	492.000	410	FORMAT(1X,'ORBITER INERT WT',3X,F10.2,
493 -	493.000		81' LB',F13.1,' LB',F13.1,' LB/LB')
494 -	494.000	411	FORMAT(1X,'BOOSTER INERT WT',3X,F10.2,
495 -	495.000		81' LB',F13.1,' LB',F13.5,' LB/LB')
496 -	496.000	412	FORMAT(1X,'RSTR ISP(CNST THRUST)',F7.2,
497 -	497.000		81' SEC',F12.1,' LB',F13.1,' LB/SEC')
498 -	498.000	413	FORMAT(1X,'ORPT ISP(CNST THRUST)',F7.2,
499 -	499.000		81' SEC',F12.1,' LB',F13.1,' LB/SEC')
500 -	500.000	414	FORMAT(1X,'BOOSTER THRUST',5X,F10.2,
501 -	501.000		81' X',F13.1,' LB',F13.1,' LB/X')
502 -	502.000	415	FORMAT(1X,'ORBITER THRUST',5X,F10.2,
503 -	503.000		81' X',F13.1,' LB',F13.1,' LB/X')
504 -	504.000	416	FORMAT(1X,'ORBITER PROPELLANT',1X,F10.2,
505 -	505.000		81' LB',F13.1,' LB',F13.5,' LB/LB')
506 -	506.000	417	FORMAT(1X,'BOOSTER PROPELLANT',1X,F10.2,
507 -	507.000		81' LB',F13.1,' LB',F13.5,' LB/LB')
508 -	508.000	418	FORMAT(1X,'ORBITER TANK LAMBDA',F10.2,
509 -	509.000		81' LB/LB',F10.1,' LB',F13.1,' LB/.01')
510 -	510.000	419	FORMAT(1X,'BOOSTER LAMBDA',5X,F10.2,
511 -	511.000		81' LB/LB',F10.1,' LB',F13.1,' LB/.01')
512 -	512.000	420	FORMAT(1X,'ORBITER PRP+INERT WT',F8.2,
513 -	513.000		81' X',F13.1,' LB',F13.1,' LB/X')
514 -	514.000	421	FORMAT(1X,'BOOSTER PRP+INERT WT',F8.2,
515 -	515.000		81' X',F13.1,' LB',F13.1,' LB/X')
516 -	516.000	422	FORMAT(1X,'TOTAL DELTA V',6X,F10.2,
517 -	517.000		81' FPS',F12.1,' LB',F13.1,' LB/FPS')
518 -	518.000	423	FORMAT(1X,'ORBITER MANUEV DELTA V',F7.2,
519 -	519.000		81' FPS',F12.1,' LB',F13.1,' LB/FPS')
520 -	520.000	425	FORMAT('1',///26X,'GLOW SENSITIVITIES'//
521 -	521.000		540X,'ORBITER/TANK',5X,'BOOSTER'//
522 -	522.000		85X,'+ DELTA GLOW (LB) DUE TO:'//)
523 -	523.000	426	FORMAT(7X,'+ DELTA INERT WT (LB)',15X,F6.1,9X,F6.1//)
524 -	524.000	427	FORMAT(7X,'- DELTA ISP (SEC)',17X,F7.0,9X,F7.0//)
525 -	525.000	428	FORMAT(7X,'- DELTA THRUST (X)',16X,F7.0,9X,F7.0//)
526 -	526.000	429	FORMAT(7X,'+ DELTA V TOTAL (FPS)',13X,F7.0,10X,
527 -	527.000		81'----//)
528 -	528.000	430	FORMAT(7X,'+ DELTA V MANUEVER (FPS)',10X,F7.0,10X,
529 -	529.000		81'----//)
530 -	530.000	431	FORMAT(5X,'DELTA GLOW/DELTA PAYLOAD (LB/LB)',13X,F6.1//)
531 -	531.000	432	FORMAT(5X,'DELTA HS-PRP/DELTA PAYLOAD',18X,F6.1//)
532 -	532.000	434	FORMAT(5X,'DELTA HS-TANK(DRY)/DELTA PAYLOAD',13X,F6.3//)
533 -	533.000	435	FORMAT(1X,'BOOSTER ISP(CNST FLOW)',F6.2,
534 -	534.000		81' SEC',F12.1,' LB',F13.1,' LB/SEC')
535 -	535.000	436	FORMAT(1X,'ORBITER ISP(CNST FLOW)',F6.2,
536 -	536.000		81' SEC',F12.1,' LB',F13.1,' LB/SEC')
537 -	537.000	450	FORMAT(1X,'ORBITER GRWTH/JNCER.',2X,
538 -	538.000		81' = 1.',3X,' X',F13.1,' LB',F13.1,' LB/X')
539 -	539.000	451	FORMAT(1X,'HS-TANK GRWTH/JNCER.',2X,
540 -	540.000		81' = 1.',3X,' X',F13.1,' LB',F13.1,' LB/X')
541 -	541.000	452	FORMAT(1X,'BOOSTER GRWTH/JNCER.',2X,
542 -	542.000		81' = 1.',3X,' X',F13.1,' LB',F13.1,' LB/X')
543 -	543.000	500	FORMAT(49X,'AVG',F10.1)
544 -	544.000	501	FORMAT(49X,'AVG',F10.5)
545 -	545.000		END



9. OUTPUT MODULE

The output module contains two basic options, either a simplified printout or a detailed printout.

The simplified weight statement supplies the user with total vehicle weights and performance parameters, such as, TW's, GLOW's and ΔV 's.

The detailed weight statement exists in the form of the NASA Phase B functional weight grouping. This coding gives a direct line-by-line comparison of ESPER's data with the weight status report of the mainline Shuttle program.

Combinations of these two mainline options are numerous. For example, if the user is running a fixed SRM and wishes to see details on the Orbiter, or if the user is running a fixed Orbiter and wishes to see details on the SRM, etc.). Figure 9-1 is a flow diagram of the Output Module followed by a detailed listing of the program.

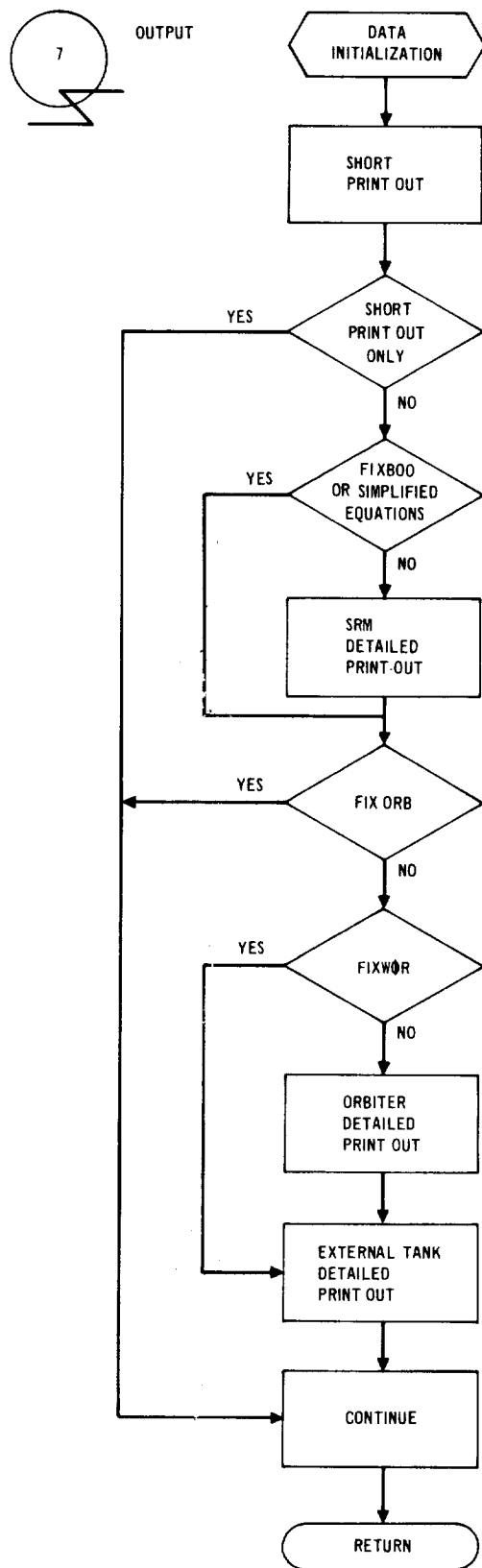


FIGURE 9-1 FLOW DIAGRAM

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COPY 9PSJ3 T9 LP(K,NC)		
1 -	1.000	FIXED
2 -	2.000	C
3 -	3.000	C
4 -	4.000	C
5 -	5.000	C
6 -	6.000	C
7 -	7.000	C
8 -	8.000	C
9 -	9.000	C
10 -	10.000	C
11 -	11.000	C
12 -	12.000	C
13 -	13.000	C
14 -	14.000	C
15 -	15.000	C
16 -	16.000	C
17 -	17.000	C
18 -	18.000	C
19 -	19.000	C
20 -	20.000	C
21 -	21.000	C
22 -	22.000	C
23 -	23.000	C
24 -	24.000	C
25 -	25.000	C
26 -	26.000	C
27 -	27.000	C
28 -	28.000	C
29 -	29.000	C
30 -	30.000	C
31 -	31.000	C
32 -	32.000	C
33 -	33.000	C
34 -	34.000	C
35 -	35.000	C
36 -	36.000	C
37 -	37.000	C
38 -	38.000	C
39 -	39.000	C
40 -	40.000	C
41 -	41.000	C
42 -	42.000	C
43 -	43.000	C
44 -	44.000	C
45 -	45.000	C
46 -	46.000	C
47 -	47.000	C
48 -	48.000	C
49 -	49.000	C
50 -	50.000	C
51 -	51.000	C
52 -	52.000	C
53 -	53.000	C
54 -	54.000	C
55 -	55.000	C
56 -	56.000	C
57 -	57.000	C
58 -	58.000	C
59 -	59.000	C

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60	-	60.000	C	EXTERNAL TANK OUTPUT COMMON BLOCK
61	-	61.000	C	
62	-	62.000	C	COMMON/EXT9/BROGRP, T9TPS, F4DTK, FAIRT, F4DBLF, ECCTPS
63	-	63.000	C	1, CNSCT, TPSIN, CYLSCT, ACYDM, AFTBLF, WINT, PRDSY, AFTNK
64	-	64.000	C	2, FECSYS, F4DBLA, PRSVNT, AFTCYL, SUMP, AFTBLA, PNPJ, TWINT
65	-	65.000	C	3, N9SFAR, AVIBNT, JM3PNL, WRETR8, TUNNEL, MISCT, BAFF, SJ8DRY
66	-	66.000	C	4, GJ, DRYWT, RESIDT, JNDRAN, FEEDTR, PRSJRT, FBIAS, INERT
67	-	67.000	C	5, GR9SSW, TLAMB, 9TRAP, EXTL, EXTD, BLKHD, EXTH8, EXTHH, SIMPTK
68	-	68.000	C	
69	-	69.000	C	DELTAV OUTPUT COMMON BLOCK
70	-	70.000	C	
71	-	71.000	C	COMMON/DVR/DVT, DV9N, DVR, DVBR, DVBRP, X2, X3
72	-	72.000	C	1, DVFR, T9TLSS, DV9NR, DVALT
73	-	73.000	C	
74	-	74.000	C	SIMPLIFIED WEIGHT STATEMENT
75	-	75.000	C	
76	-	76.000	C	WRITE(108,100)
77	-	77.000	C	IF(FIX4RD.GT.0.0) WRITE(108,120)
78	-	78.000	C	IF(FIX4RD.GT.0.0) GO TO 9
79	-	79.000	C	IF(MINGLW.GT.0.0) WRITE(108,125)
80	-	80.000	C	IF(MINGLW.GT.0.0) GO TO 9
81	-	81.000	C	IF(FIX9RH.GT.0.0) WRITE(108,130)
82	-	82.000	C	IF(FIX9RH.GT.0.0) WRITE(108,131)
83	-	83.000	C	IF(FIX4DR.GT.0.0) WRITE(108,140)
84	-	84.000	C	IF(SIMPR9.GT.0.0) WRITE(108,142)
85	-	85.000	C	IF(SIMPTK.GT.0.0) WRITE(108,143)
86	-	86.000	C	IF(FT.GT.0.0) GO TO 8
87	-	87.000	C	WRITE(108,150)
88	-	88.000	C	GO TO 8
89	-	89.000	8	WRITE(108,160)
90	-	90.000	9	WRITE(108,110)
91	-	91.000	9	WRITE(108,115)
92	-	92.000	9	IF(ABS(DV9NR-DV9NC).GT.1.) GO TO 10
93	-	93.000	9	GO TO 20
94	-	94.000	10	WRITE(108,190)
95	-	95.000	10	WRITE(108,200)
96	-	96.000	10	WRITE(108,210)
97	-	97.000	20	IF(T9WR.LT..7.9R.T9WB.GT.2.0.9R.T9WB.LT.1.18
98	-	98.000	20	5.9R.T9WR.GT.1.6) WRITE(108,220)
99	-	99.000	20	IF(DVRRP.LT.3000..9R.DVRRP.GT.9000.) WRITE(108,230)
100	-	100.000	20	WRITE(108,240) INC
101	-	101.000	20	WRITE(108,250) T9TLSS
102	-	102.000	20	WRITE(108,260) DVC9RR, DVCNST
103	-	103.000	20	WRITE(108,270) X3
104	-	104.000	20	WRITE(108,280) X2
105	-	105.000	20	WRITE(108,290) DVALT
106	-	106.000	20	WRITE(108,300) W9SCD, SCD
107	-	107.000	20	WRITE(108,310)
108	-	108.000	20	WRITE(108,320) BCANT
109	-	109.000	20	WRITE(108,330) B99WT
110	-	110.000	20	WRITE(108,340) BDRYWT
111	-	111.000	20	WRITE(108,360) PR9PB, PW9T
112	-	112.000	20	WRITE(108,350) LAMB
113	-	113.000	20	WRITE(108,370) ISP9V, ISP9V, ISP9
114	-	114.000	20	WRITE(108,390) TH3TC, THBSLT
115	-	115.000	20	WRITE(108,410) BBT
116	-	116.000	20	WRITE(108,420)
117	-	117.000	20	WRITE(108,430) 9CANTY, 9CANTP
118	-	118.000	20	WRITE(108,460) 9LLPL9
119	-	119.000	20	WRITE(108,440) PL9ADJ
120	-	120.000	20	WRITE(108,470) W9PR8P

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121 - 121.000		WRITE(10R,400)
122 - 122.000		WRITE(10R,480) DRYWT
123 - 123.000		WRITE(10R,760) RESIDT
124 - 124.000		WRITE(10R,530)
125 - 125.000		WRITE(10R,540) PR0P01,PR0P02
126 - 126.000		WRITE(10R,750) TLAMB
127 - 127.000		WRITE(10R,610) ISP0
128 - 128.000		WRITE(10R,620) TH9TC,T9V,NBENG0
129 - 129.000		WRITE(10R,810) FL9NR
130 - 130.000		WRITE(10R,630) BGL9W
131 - 131.000		WRITE(10R,640) BGL0W
132 - 132.000		WRITE(10R,650) GL9W
133 - 133.000		IF(9*PLD.GT.0.0) WRITE(10R,660) TOTAL,0H0LD
134 - 134.000		WRITE(10R,670) T9WR
135 - 135.000		WRITE(10R,680) T9WB
136 - 136.000		WRITE(10R,690) DV0,DVFP0
137 - 137.000		WRITE(10R,700) DVBRP,FR0P
138 - 138.000		WRITE(10R,710) DV0
139 - 139.000		WRITE(10R,720) DVC0N,DVT
140 - 140.000		IF(FIX9RB.GT.0.0) WRITE(10R,730) DVC0N,DVT0TC
141 - 141.000		WRITE(10R,740) DV9NR
142 - 142.000		WRITE(10R,750) DV9NC
143 - 143.000	810	FORMAT(6X,'FLOW RATE',9X,F12.2)
144 - 144.000	800	FORMAT(/4X,'EXT TANK PARAMETERS')
145 - 145.000	470	FORMAT(6X,'BAMS PR0P WEIGHT',2X,F12.2)
146 - 146.000	760	FORMAT(6X,'EXT. TANK RESID.',2X,F12.2)
147 - 147.000	430	FORMAT(6X,'(CANT ANGLE YAW=',F4.1,')',/6X,
148 - 148.000		1,'(CANT ANGLE PITCH=',F4.1,')')
149 - 149.000	115	FORMAT(21X,'BOOSTER - SOLID ROCKET MOTOR')
150 - 150.000	320	FORMAT(6X,'(CANT ANGLE=',F4.1,')')
151 - 151.000	130	FORMAT(20X,'FIXED ORBITER')
152 - 152.000	131	FORMAT(27X,'FIXED WT. ORBITER')
153 - 153.000	300	FORMAT(24X,'T/W/SCD',12X,F7.1,2X,'SCD',2X,F7.1)
154 - 154.000	230	FORMAT(/15X,'***** WARNING LOOK AT DVBRP *****')
155 - 155.000	460	FORMAT(6X,'LIFT OFF-PAY-BAMS',1X,F12.2)
156 - 156.000	440	FORMAT(6X,'PAYLOAD',11X,F12.2)
157 - 157.000	120	FORMAT(25X,'FIXED HARDWARE (ASPER)')
158 - 158.000	125	FORMAT(23X,'MINIMUM GLOW VEHICLE')
159 - 159.000	370	FORMAT(6X,'ISP AV (F5.1, ',F5.1,')',4X,F6.2)
160 - 160.000	380	FORMAT(6X,'SEA LEVEL THRUST',2X,F12.2)
161 - 161.000	140	FORMAT(29X,'FIXED BOOSTER')
162 - 162.000	142	FORMAT(27X,'SIMPLIFIED BOOSTER')
163 - 163.000	143	FORMAT(27X,'SIMPLIFIED EXTANK')
164 - 164.000	150	FORMAT(27X,'FIXED THR BOOSTER')
165 - 165.000	160	FORMAT(27X,'FIXED T/W BOOSTER')
166 - 166.000	100	FORMAT(/11,/,29X,'PARALLEL BURN')
167 - 167.000	110	FORMAT(15X,'PARAMETRIC STUDY EXTERNAL (H2-O2) ORBITER')
168 - 168.000	120	FORMAT(/26X,'INQ VALID SOLUTION')
169 - 169.000	200	FORMAT(26X,'ORBITER TOO LARGE')
170 - 170.000	210	FORMAT(21X,'FOR THE PARAMETERS SELECTED')
171 - 171.000	220	FORMAT(/15X,'***** WARNING LOOK AT T/W *****')
172 - 172.000	240	FORMAT(/17X,'INCLINATION OF ORBITER',F7.2,' DEGREES')
173 - 173.000	250	FORMAT(/24X,'DV TOTAL LOSSES',1X,'(F7.1,')')
174 - 174.000	280	FORMAT(/24X,'DV INC',11X,F7.1)
175 - 175.000	290	FORMAT(24X,'DV ALT',11X,F7.1)
176 - 176.000	260	FORMAT(24X,'DV CORRECTION',4X,F7.1,2X,'DVCNST',2X,F9.1)
177 - 177.000	270	FORMAT(24X,'DV CURVE LOSSES',2X,F7.1)
178 - 178.000	310	FORMAT(/4X,'BOOSTER PARAMETERS')
179 - 179.000	330	FORMAT(6X,'BURN OUT WEIGHT',3X,F12.2)
180 - 180.000	340	FORMAT(6X,'DRY WEIGHT',9X,F12.2)
181 - 181.000	360	FORMAT(6X,'PROPELLANT WEIGHT',1X,F12.2,2X,'PROPS W01',1X,F12.2)

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182	-	182.000	350	FORMAT(2X,'LAMBDA=',F5.4)
183	-	183.000	390	FORMAT(4X,'SEA LEVEL THRUST',2X,F12.2
184	-	184.000		3,2X,'S.L. T.399',F12.2)
185	-	185.000	410	FORMAT(5X,'BURN TIME',9X,F12.2)
186	-	186.000	420	FORMAT(/4X,'ORBITER PARAMETERS')
187	-	187.000	480	FORMAT(6X,'EXT. TANK WT (DRY)',F12.2)
188	-	188.000	530	FORMAT(6X,'PROPELLANT WEIGHT',4X,'ORB PROP',4X,
189	-	189.000		1)1STSTAG PRBP',2X,'2NDSTAG PRBP')
190	-	190.000	540	FORMAT(24X,F12.2,2X,F12.2,2X,F12.2)
191	-	191.000	550	FORMAT(6X,'3STG 9AMS ASC PRBP',F12.2)
192	-	192.000	610	FORMAT(4X,'ISP',15X,F12.2)
193	-	193.000	620	FORMAT(6X,'VACUUM THRUST',5X,F12.2,2X,'THRUST/EN3'
194	-	194.000		3,FR.0,2X,'W ENGI',F4.0)
195	-	195.000	630	FORMAT(/4X,'BGLSW',2X,F12.3)
196	-	196.000	640	FORMAT(4X,'BGLSW',2X,F12.3)
197	-	197.000	650	FORMAT(4X,'GLAW',2X,F12.3)
198	-	198.000	650	FORMAT(4X,'TSTAL',2X,F12.3,2X,
199	-	199.000		3)('INCLUDES H9LD DRWN PRBP',F7.1,1)1)
200	-	200.000	670	FORMAT(4X,'T/W1',2X,F12.3)
201	-	201.000	680	FORMAT(4X,'T/WP',2X,F12.3)
202	-	202.000	690	FORMAT(/4X,'IDEAL STAGING VELOCITY',5X,F12.2
203	-	203.000		3,2X,'F.P.R. DELTA V',F9.2)
204	-	204.000	700	FORMAT(4X,'REAL STAGING VELOCITY',6X,F12.2
205	-	205.000		3,2X,'F.P.R. PRBP',3X,F9.2)
206	-	206.000	710	FORMAT(4X,'MINIMAL REQUIRED VELOCITY',2X,F12.2)
207	-	207.000	720	FORMAT(4X,'TOTAL VELOCITY('F5.4,'X FPR)',1X,F12.2)
208	-	208.000	730	FORMAT(4X,'TOTAL VEL(CAL)('F5.4,'X FPR)',1X,F12.2)
209	-	209.000	740	FORMAT(4X,'ORBITER VELOCITY(CALC)',5X,F12.2)
210	-	210.000	750	FORMAT(4X,'ORBITER VELOCITY(ACT)',6X,F12.2)
211	-	211.000	490	FORMAT(6X,'(COMMON BULKHEAD)')
212	-	212.000	500	FORMAT(6X,'(SEPARATE BULKHEAD)')
213	-	213.000	510	FORMAT(6X,'ALT. SEP. BULKHEAD)')
214	-	214.000		IF(L9NGP.F9.0.0) 39 T9 9999
215	-	215.000		IF(FIX999.GT.0.0.99.SIMP99.GT.0.0
216	-	216.000		1.AN9.L9NGP.GT.0.0) 39 T9 30
217	-	217.000		WRITE(108,1000) SRML,SRMD
218	-	218.000		WRITE(108,1010) BASSRM
219	-	219.000		WRITE(108,1020) WCASE,WJ9INT,W9DZZ,WITER,WINST,WIGN,BSRMC
220	-	220.000		WRITE(108,1030) WREC9V
221	-	221.000		WRITE(108,1040) PWPAP,PWPI,PWRR,PWRP,PWWR,SRMRC
222	-	222.000		WRITE(108,1050) SRMISS
223	-	223.000		WRITE(108,1060) PWFS,PWASLS,PWAS,PWNF,PWTN,PWAV,WCTPS,SRMIC
224	-	224.000		WRITE(108,1065)
225	-	225.000		WRITE(108,1070) P39SLJ,UNCERT
226	-	226.000		WRITE(108,1065)
227	-	227.000		WRITE(108,1080) PORYAT,EXPINS
228	-	228.000		WRITE(108,1065)
229	-	229.000		WRITE(108,1090) P399WT,PPR9PB
230	-	230.000		WRITE(108,1065)
231	-	231.000		WRITE(108,1100) P399SS
232	-	232.000		WRITE(108,1110) LAMB
233	-	233.000		WRITE(108,1120) N9ENG3
234	-	234.000	C	
235	-	235.000	C	DETAILED SRM WEIGHT STATEMENT
236	-	236.000	C	
237	-	237.000		1000 FORMAT('1',15X,'SOLID ROCKET MOTOR (SRM) WEIGHT SUMMARY'
238	-	238.000		1,/,30X,'(PER SRM)',/,/,28X,'LENGTH=',2X,F5.0,/,28X,
239	-	239.000		DIA METER=',F5.0)
240	-	240.000	1010	FORMAT(/,6X,'BASIC SRM WEIGHT',16X,'('F9.0,')')
241	-	241.000	1020	FORMAT(9X,'CASE WEIGHT',19X,F9.0,
242	-	242.000		1/,9X,'JOINT WEIGHT',19X,F9.0,

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243	-	243.000	2//9X,'IN9Z7LE WEIGHT',17X,F9.0,
244	-	244.000	3//9X,'THRUST TERM WT.',15X,F9.0,
245	-	245.000	4//9X,'INSULATION WEIGHT',13X,F9.0,
246	-	246.000	5//9X,'IGNITER WEIGHT',16X,F9.0,
247	-	247.000	6//9X,'RASIC SRM WT.C9N.',13X,F9.0)
248	-	248.000	1030 FORMAT(6X,'SRM RECOVERY WEIGHT',13X,'(,F9.0,')')
249	-	249.000	1040 FORMAT(9X,'PARACHUTE WEIGHT',14X,F9.0,
250	-	250.000	1//9X,'PARACHUTE INSTAL.',13X,F9.0,
251	-	251.000	2//9X,'RETRO ROCKET',13X,F9.0,
252	-	252.000	3//9X,'PROPELLANT WEIGHT',13X,F9.0,
253	-	253.000	4//9X,'WATER REC. HWD.',15X,F9.0,
254	-	254.000	5//9X,'SRM REC.WT.C9NST.',13X,F9.0)
255	-	255.000	1050 FORMAT(6X,'SRM INTERSTAGE STRJ.',12X,'(,F9.0,')')
256	-	256.000	1060 FORMAT(9X,'FORWARD SKIRT',17X,F9.0,
257	-	257.000	1//9X,'AFT SKIRT STRUCT',14X,F9.0,
258	-	258.000	2//9X,'ATTACH/SEP STRUCT',13X,F9.0,
259	-	259.000	3//9X,'INRSE FAIRING',13X,F9.0,
260	-	260.000	4//9X,'TUNNEL WEIGHT',17X,F9.0,
261	-	261.000	5//9X,'AVIONICS WEIGHT',15X,F9.0,
262	-	262.000	6//9X,'TPS WEIGHT',20X,F9.0,
263	-	263.000	7//9X,'SRM INTERS.C9NST.',13X,F9.0)
264	-	264.000	1045 FORMAT(38X,'- - - - -')
265	-	265.000	1070 FORMAT(4X,'SKIRTOTAL DRY WEIGHT',14X,F9.0,
266	-	266.000	1//6X,'GROSSHT UNCERTAINTY',15X,F9.0)
267	-	267.000	1080 FORMAT(6X,'DRY WEIGHT',23X,F9.0,
268	-	268.000	1//6X,'EXPENDABLE PR9P.',17X,F9.0)
269	-	269.000	1090 FORMAT(6X,'BURN 9JT WEIGHT',18X,F9.0,
270	-	270.000	1//6X,'USABLE PR9P WEIGHT',15X,F9.0)
271	-	271.000	1100 FORMAT(6X,'TOTAL GROSS WEIGHT',14X,'(,F9.0,')')
272	-	272.000	1110 FORMAT(7//6X,'LAMBDA=WR9P/WR9SS=',F6.5)
273	-	273.000	1120 FORMAT(6X,'TOTAL NB 9F SRMS ',F2.0)
274	-	274.000	C
275	-	275.000	C DETAILED ORBITER WEIGHT STATEMENT
276	-	276.000	C
277	-	277.000	30 IF (FIX9RR.GT.0.0.0.AND.L9NGP.GT.0.0.0) G9 T9 9999
278	-	278.000	IF (FIXWR9.GT.0.0.0.AND.L9NGP.GT.0.0.0) G9 T9 40
279	-	279.000	WRITE(108,2000)
280	-	280.000	WRITE(108,2010) WSG,WWT
281	-	281.000	WRITE(108,2020) WSTR,WTRBE,LEW,WTE,GPROV,GPR9V
282	-	282.000	1,WAIL,WAS,WADR,WAH,WAP,PAINGK
283	-	283.000	WRITE(108,2030) TSG,TAIL
284	-	284.000	WRITE(108,2040) T3STR,TT9RQB,TL9,WRUD,WRS,WR9R,WRH
285	-	285.000	1,WRP,PTAILK
286	-	286.000	WRITE(108,2050) G37
287	-	287.000	WRITE(108,2060)
288	-	288.000	WRITE(108,2070) G1,G11,G25,G10,G27,G12,G26,G15,G2,G3
289	-	289.000	1,G5,G16,WTR9BC,G17,G32,G34,G9,G18,G35,G19,G22,G7,G23,G33
290	-	290.000	2,G9,G24,G36
291	-	291.000	WRITE(108,2080) T9TTPS
292	-	292.000	WRITE(108,2090) TWGWT,W9WT,W9LEWT,TTWT,TWT,TLEWT,BTPSWT
293	-	293.000	1,PL9TTPS,BASENT,19TWT,PTPSCN,MCSWT,LDIWT,PR9WT,PP9C,PHYC
294	-	294.000	2,SCWT
295	-	295.000	WRITE(108,2100) LNDDK
296	-	296.000	WRITE(108,2110) N9EAR,NG1,NG2,NG3,M9EAR,MG1,MG2,M93
297	-	297.000	1,AX9EAR,AX1,AX2,AX3,LNDDCK
298	-	298.000	WRITE(108,2120) TAPR9P
299	-	299.000	WRITE(108,2130) ENGPAZ,ENG,TVC,CONTR,PR9PUL,PR9SYS,FAD
300	-	300.000	1,PR9,CHIL,PREVAL,FEEDS,DISC,MISC
301	-	301.000	WRITE(108,2140) TABPR9
302	-	302.000	WRITE(108,2150) WTAUX
303	-	303.000	WRITE(108,2160) WTACS,ACSENG,ACSSYS,WTACTION,ACSM9D,WTO9MS

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304 - 304.000	1, DMSENG, PR9PSY, WT9MTK, MODULE
305 - 305.000	WRITE (108, 2170) P9WR
306 - 306.000	WRITE (108, 2180) ELEC
307 - 307.000	WRITE (108, 2190) HYDR
308 - 308.000	WRITE (108, 2200) SJRFC
309 - 309.000	WRITE (108, 2210) AVI9V3
310 - 310.000	WRITE (108, 2220) ECLSS
311 - 311.000	WRITE (108, 2230) P9R9V
312 - 312.000	WRITE (108, 2235) 999MIS
313 - 313.000	WRITE (108, 2240) 9JNCAT, 9D9YWT
314 - 314.000	WRITE (108, 2245)
315 - 315.000	WRITE (108, 2250) 9D9YWT, PERS9V, 9RES0, PL9ADU, 9INJW, 9RESV
316 - 316.000	1, PRIFL, ACSPR9, 99PR9P, 9TRAP, 9LBWT, PLBADD, 9LANWT, PLBADU, 9INJW
317 - 317.000	WRITE (108, 2255) R1, R2, RL
318 - 318.000	2000 FORMAT (11, 24X, 'ORBITER WEIGHT SUMMARY')
319 - 319.000	2010 FORMAT (7, 4X, 'WING GR9UP (AREA=', F5.0, ')', 23X,
320 - 320.000	1 ('', F9.0, ')')
321 - 321.000	2020 FORMAT (4X, 'BASIC STRUCTURE', 18X, F9.0,
322 - 322.000	1/, 9X, '199RJE 99X EXP9SE', 2X, F9.0,
323 - 323.000	3/, 9X, 'LEADING EDGE', 7X, F9.0,
324 - 324.000	4/, 9X, 'TRAILING EDGE', 5X, F9.0,
325 - 325.000	5/, 5X, 'SECONDARY STRUCTURE', 14X, F9.0,
326 - 326.000	6/, 9X, 'M.L.G. PR9VIS9NS', 2X, F9.0,
327 - 327.000	7/, 6X, 'CENTRAL SURFACE', 18X, F9.0,
328 - 328.000	8/, 9X, 'SHELL', 14X, F9.0,
329 - 329.000	9/, 9X, 'DRIVE RIB', 10X, F9.0,
330 - 330.000	5/, 9X, 'HINGE', 14X, F9.0,
331 - 331.000	6/, 9X, 'ATTACH', 13X, F9.0,
332 - 332.000	8/, 6X, 'WING WEIGHT CONSTANT', 13X, F9.0)
333 - 333.000	2030 FORMAT (4X, 'TAIL GR9UP (AREA=', F5.0, ')', 23X,
334 - 334.000	1 ('', F9.0, ')')
335 - 335.000	2040 FORMAT (4X, 'BASIC STRUCTURE', 18X, F9.0,
336 - 336.000	1/, 9X, '199RJE 99X', 9X, F9.0,
337 - 337.000	2/, 9X, 'LEADING EDGE', 7X, F9.0,
338 - 338.000	3/, 6X, 'CENTRAL SURFACE', 18X, F9.0,
339 - 339.000	4/, 9X, 'SHELL', 14X, F9.0,
340 - 340.000	5/, 9X, 'DRIVE RIB', 10X, F9.0,
341 - 341.000	6/, 9X, 'HINGE', 14X, F9.0,
342 - 342.000	7/, 9X, 'ATTACH', 13X, F9.0,
343 - 343.000	8/, 6X, 'TAIL WEIGHT CONSTANT', 13X, F9.0)
344 - 344.000	2050 FORMAT (4X, '99DY GR9UP', 35X, '(', F9.0, ')')
345 - 345.000	2060 FORMAT (31X, 'FWD', 9X, 'CTR', 9X, 'AFT')
346 - 346.000	2070 FORMAT (4X, 'BASIC STRUCTURE',
347 - 347.000	1/, 9X, 'SIDE WALLS', 10X, F9.0, 2X, F9.0, 1X, F9.0,
348 - 348.000	2/, 9X, 'L9NGERS9NS', 21X, F9.0, 1X, F9.0,
349 - 349.000	3/, 9X, 'FRAMES', 24X, F9.0, 1X, F9.0,
350 - 350.000	4/, 9X, 'BULKHEADS', 21X, F9.0,
351 - 351.000	5/, 9X, 'CREW CPT. PR9V', 4X, F9.0,
352 - 352.000	6/, 9X, 'WINDSHIELD PR9V', 3X, F9.0,
353 - 353.000	7/, 9X, 'IN9SE WHL WEL PR9V', 2X, F9.0,
354 - 354.000	8/, 9X, 'PAYL9AD REACT9N', 14X, F9.0,
355 - 355.000	9/, 9X, 'WING CARRY THRU', 14X, F9.0,
356 - 356.000	8/, 9X, 'WING SHEAR PR9V', 14X, F9.0,
357 - 357.000	1/, 9X, 'THRUST STRUCTURE', 25X, F9.0,
358 - 358.000	2/, 9X, 'TAIL PR9V', 31X, F9.0,
359 - 359.000	3/, 6X, 'SJR TBAL', 13X, F9.0, 2X, F9.0, 2X, F9.0,
360 - 360.000	4/, 6X, 'SECONDARY STRUCTURE',
361 - 361.000	5/, 9X, 'CARG9 999R SHELL', 14X, F9.0,
362 - 362.000	6/, 9X, 'CARG9 999R MECH', 14X, F9.0,
363 - 363.000	7/, 6X, 'MISCELLANEOUS WTS', 4X, F9.0, 2X, F9.0, 2X, F9.0,
364 - 364.000	8/, 6X, 'TBAL', 17X, F9.0, 2X, F9.0, 2X, F9.0)

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365	-	365.000	2090	FORMAT(4X, 'INDUCED ENVIRON. PROT.', 23X,
366	-	366.000		1('(', F9.0, ')')
367	-	367.000	2090	FORMAT(6X, 'WING', 29X, F9.0,
368	-	368.000		1/, 9X, 'SURFACE PANELS', 5X, F9.0,
369	-	369.000		2/, 9X, 'LEADING EDGE', 7X, F9.0,
370	-	370.000		3/, 6X, 'TAIL', 29X, F9.0,
371	-	371.000		4/, 9X, 'SURFACE PANELS', 5X, F9.0,
372	-	372.000		5/, 9X, 'LEADING EDGE', 7X, F9.0,
373	-	373.000		6/, 6X, 'BODY', 29X, F9.0,
374	-	374.000		7/, 9X, 'BODY PANELS', 8X, F9.0,
375	-	375.000		8/, 9X, 'BASE', 16X, F9.0,
376	-	376.000		9/, 9X, 'INTERNAL TPS', 7X, F9.0,
377	-	377.000		5/, 9X, 'BODY CNST TPS WT.', 2X, F9.0,
378	-	378.000		1/, 6X, 'MIS CNST. SURFACE', 16X, F9.0,
379	-	379.000		2/, 6X, 'LAND + DCKING', 19X, F9.0,
380	-	380.000		3/, 6X, 'PROPULSION', 23X, F9.0,
381	-	381.000		4/, 6X, 'PRIME POWER', 22X, F9.0,
382	-	382.000		5/, 6X, 'HYDRAULICS', 23X, F9.0,
383	-	383.000		6/, 6X, 'SURFACE CONTROLS', 17X, F9.0)
384	-	384.000	2100	FORMAT(11, 3X, 'LANDING & DCKING', 28X, '((', F9.0, ')')
385	-	385.000	2110	FORMAT(6X, 'INSE GEAR', 24X, F9.0,
386	-	386.000		1/, 9X, 'ROLL GEAR', 10X, F9.0,
387	-	387.000		2/, 9X, 'STRUCTURE', 10X, F9.0,
388	-	388.000		3/, 9X, 'CONTROLS', 11X, F9.0,
389	-	389.000		4/, 6X, 'MAIN GEAR', 24X, F9.0,
390	-	390.000		5/, 9X, 'ROLL GEAR', 10X, F9.0,
391	-	391.000		6/, 9X, 'STRUCTURE', 10X, F9.0,
392	-	392.000		7/, 9X, 'CONTROLS', 11X, F9.0,
393	-	393.000		8/, 6X, 'AUXILIARY SYSTEMS', 16X, F9.0,
394	-	394.000		9/, 9X, 'DECELERATION SYS', 3X, F9.0,
395	-	395.000		1/, 9X, 'SEPARATION SYS', 5X, F9.0,
396	-	396.000		2/, 9X, 'HANDLING & MANIP', 3X, F9.0,
397	-	397.000		3/, 6X, 'MISCELLANEOUS', 20X, F9.0)
398	-	398.000	2120	FORMAT(4X, 'PROPULSION MAIN ASCENT', 23X, '((', F9.0, ')')
399	-	399.000	2130	FORMAT(4X, 'ENGINES+ACCESSORIES', 15X, F9.0,
400	-	400.000		1/, 9X, 'ENGINES', 12X, F9.0,
401	-	401.000		2/, 9X, 'GIMBAL SYSTEM', 6X, F9.0,
402	-	402.000		3/, 9X, 'CONTROLS', 11X, F9.0,
403	-	403.000		4/, 9X, 'PROPELLANT UTILIZ', 2X, F9.0,
404	-	404.000		5/, 6X, 'PROPELLANT SYSTEM', 16X, F9.0,
405	-	405.000		6/, 9X, 'FILL & DRAIN', 7X, F9.0,
406	-	406.000		7/, 9X, 'PRESSURIZATION', 5X, F9.0,
407	-	407.000		8/, 9X, 'CHILL DUMP LINES', 3X, F9.0,
408	-	408.000		9/, 9X, 'PRE VALVES', 9X, F9.0,
409	-	409.000		5/, 9X, 'FEED SYSTEM', 8X, F9.0,
410	-	410.000		1/, 9X, 'DISCONNECTS', 8X, F9.0,
411	-	411.000		2/, 9X, 'MISCELLANEOUS', 6X, F9.0)
412	-	412.000	2140	FORMAT(4X, 'PROPULSION AIR BREATH', 24X, '((', F9.0, ')')
413	-	413.000	2150	FORMAT(4X, 'PROPULSION AUXILIARY', 25X,
414	-	414.000		1('(', F9.0, ')')
415	-	415.000	2160	FORMAT(6X, 'ACC SYSTEM', 23X, F9.0,
416	-	416.000		1/, 9X, 'THRUSTERS', 10X, F9.0,
417	-	417.000		2/, 9X, 'PROP. SYSTEM', 7X, F9.0,
418	-	418.000		3/, 9X, 'TANK', 15X, F9.0,
419	-	419.000		4/, 9X, 'MODULE', 13X, F9.0,
420	-	420.000		5/, 6X, 'GAMS SYSTEM', 22X, F9.0,
421	-	421.000		6/, 9X, 'THRUSTERS', 10X, F9.0,
422	-	422.000		7/, 9X, 'PROP. SYSTEM', 7X, F9.0,
423	-	423.000		8/, 9X, 'TANK', 15X, F9.0,
424	-	424.000		9/, 9X, 'MODULE', 13X, F9.0)
425	-	425.000	2170	FORMAT(4X, 'PRIME POWER', 34X, '((', F9.0, ')')

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426	-	426.000	2180	FORMAT(4X,'ELECTRICAL',35X,'(F9.0,)'')
427	-	427.000	2190	FORMAT(4X,'HYDRAULIC',36X,'(F9.0,)'')
428	-	428.000	2200	FORMAT(4X,'SURFACE CONTROLS',29X,'(F9.0,)'')
429	-	429.000	2210	FORMAT(4X,'AVIONICS',37X,'(F9.0,)'')
430	-	430.000	2220	FORMAT(4X,'ENVIRONMENTAL CONTROL',24X,'(F9.0,)'')
431	-	431.000	2230	FORMAT(4X,'PERSONNEL PROVISIONS',25X,'(F9.0,)'')
432	-	432.000	2235	FORMAT(4X,'MISCELLANEOUS',32X,'(F9.0,)'')
433	-	433.000	2240	FORMAT(4X,'GROWTH/UNCERTAINTY',27X,'(F9.0,)'')
434	-	434.000		1//,49X,'- - - - -',1//,4X,
435	-	435.000		2 DRY WEIGHT',34X,'(F9.0,)'')
436	-	436.000	2245	FORMAT(//,1',24X,'REBITER MISSION HISTORY')
437	-	437.000	2250	FORMAT(//,4X,'DRY WEIGHT',13X,'(F9.0,)'',
438	-	438.000		1//,5X,'PERSONNEL',13X,F9.0,
439	-	439.000		2//,5X,'RRB RESV PRSP WT.',5X,F9.0,
440	-	440.000		3//,5X,'PAYLOAD UP',12X,F9.0,
441	-	441.000		4//,4X,'INERT WEIGHT',11X,'(F9.0,)'',
442	-	442.000		5//,5X,'RRB RESV PRSP WT.',5X,F9.0,
443	-	443.000		6//,5X,'RRB INFLIGHT LOSSES',3X,F9.0,
444	-	444.000		7//,4X,'ACS PRSP WT.',11X,F9.0,
445	-	445.000		8//,5X,'RAMS PRSP WT.',10X,F9.0,
446	-	446.000		9//,5X,'RRB TRAPED PRSP WT.',4X,F9.0,
447	-	447.000		10//,4X,'GROSS WT(BRB-ONLY)',5X,'(F9.0,)'',
448	-	448.000		1//,5X,'(LAND WT PAY=F6.0,)'',
449	-	449.000		2//,4X,'LANDING WEIGHT',9X,'(F9.0,)'',
450	-	450.000		3//,5X,'(INJE WT PAY=F6.0,)'',
451	-	451.000		4//,4X,'INJECTED WEIGHT',8X,'(F9.0,)'')
452	-	452.000	2255	FORMAT(//,6X,'INTER STAGE REACTIONS'
453	-	453.000		1//,2X,'R1=',1X,F9.0
454	-	454.000		2//,2X,'R2=',1X,F9.0
455	-	455.000		3//,2X,'R3=',1X,F9.0)
456	-	456.000	40	IF(SIMPTK.GT.0.0.AND.L9N3P.GT.0.0) GO TO 9999
457	-	457.000	C	
458	-	458.000	C	DETAILED EXTERNAL TANK WEIGHT STATEMENT
459	-	459.000	C	
460	-	460.000		WRITE(10R,3000)
461	-	461.000		IF(3L<H0.E0.1.) GO TO 45
462	-	462.000		GO TO 50
463	-	463.000	45	IF(EXT49.GT.EXT44) GO TO 55
464	-	464.000		WRITE(10R,3010)
465	-	465.000		GO TO 60
466	-	466.000	50	IF(3L<H0.E0.3.) GO TO 65
467	-	467.000		GO TO 70
468	-	468.000	65	WRITE(10R,3050)
469	-	469.000	70	IF(EXT49.GT.EXT44) GO TO 75
470	-	470.000		WRITE(10R,3030)
471	-	471.000		GO TO 60
472	-	472.000	55	WRITE(10R,3020)
473	-	473.000		GO TO 60
474	-	474.000	75	WRITE(10R,3040)
475	-	475.000	60	WRITE(10R,3060) EXTL,EXTD
476	-	476.000		WRITE(10R,3070)B9DGRP,T9TPS,FWDTK,FAIRT,FWDBLF,ECCTPS,
477	-	477.000		SC9N6CT,TP9IN,CYL6CT,AC9DM,AFT6LF,WINT,PR9SY,AFT9C,
478	-	478.000		5FF99YS,FWDBLA,PR9SVT
479	-	479.000		WRITE(10R,3080)AFTCYL,SUMP,AFT9LA,PNPU,TWINT,N9SFAR,
480	-	480.000		8AVJ9NT,UM9PNL,WRETR9,TUNNEL,MISCT,BAFF,SUBDRY
481	-	481.000		WRITE(10R,3090)SUBDRY,GU,DRYWT,RESIDT,UNDRAN,FEECTR,
482	-	482.000		5PR9JRT,FRIAS,INERT,PR999T,GR9SSW,TL4MB
483	-	483.000	3000	FORMAT('1',18X,'EXTERNAL TANK WEIGHT SUMMARY')
484	-	484.000	3010	FORMAT(20X,'CRM49N BULKHEAD-L9X FWD')
485	-	485.000	3020	FORMAT(20X,'CRM49N BULKHEAD-L9X AFT')
486	-	486.000	3030	FORMAT(20X,'SEPARATE BULKHEAD-L9X FWD')

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487	-	487.000	3040	FORMAT(20X,'SEPARATE BULKHEAD-L9X AFT')
488	-	488.000	3050	FORMAT(10X,'ALTERNATE FWD SECTION(WITHOUT N9SE FAIRING)')
489	-	489.000	3060	FORMAT(/,25X,'LENGTH',2X,F5.0//,25X,'DIAMETER',F5.0)
490	-	490.000	3070	FORMAT(/23X,'WEIGHT',24X,'WEIGHT'/24X,'-LB.',24X,'-LB.'//
491	-	491.000	82Y,	BODY BRPJP',9X,'(,FR.0, ')'
492	-	492.000	82X,	IND. ENVIRN. BRBT. ',FR.0, ')'
493	-	493.000	83X,	FWD TANK',10X,'(,FR.0, ')'
494	-	494.000	83Y,	N9SE FAIRING',7X,FR.0/
495	-	495.000	84Y,	FWD BULKHEAD',6X,FR.0/
496	-	496.000	85Y,	FWD CONE & CYL.',4X,FR.0/
497	-	497.000	84X,	CONICAL SECTION ',FR.0/
498	-	498.000	85X,	INTER TANK',9X,FR.0/
499	-	499.000	84X,	CYLINDRICAL SECT. ',FR.0/
500	-	500.000	85X,	IAFT CYL & CONE',5X,FR.0/
501	-	501.000	84Y,	IAFT BULKHEAD',6X,FR.0/
502	-	502.000	83Y,	INTER TANK SECT. '(,FR.0, ')'
503	-	503.000	82X,	PROPELLANT SYSTEMS '(,FR.0, ')'
504	-	504.000	83Y,	IAFT TANK',10X,'(,FR.0, ')'
505	-	505.000	83Y,	FEED SYSTEM',9X,FR.0/
506	-	506.000	84Y,	FWD BULKHEAD',6X,FR.0/
507	-	507.000	85X,	PRES. AND VENT',5X,FR.0)
508	-	508.000	3080	FORMAT(4X,'CYLINDRICAL SECT. ',FR.0,
509	-	509.000	85Y,	SUMPS & VORTEX CTL ',FR.0/
510	-	510.000	84X,	IAFT BULKHEAD',6X,FR.0/
511	-	511.000	85X,	PNEUMATIC & PU SYS ',FR.0/
512	-	512.000	83X,	BRB/BRTR/TANK ATT. '(,FR.0, ')'
513	-	513.000	83Y,	N9SE FAIRING',6X,'(,FR.0, ')'
514	-	514.000	82X,	AVIONICS',11X,'(,FR.0, ')'
515	-	515.000	83X,	CONICAL PANEL '(,FR.0, ')'
516	-	516.000	82X,	DEGRIT SYSTEM',5X,'(,FR.0, ')'
517	-	517.000	83X,	TUNNEL',12X,'(,FR.0, ')'
518	-	518.000	82Y,	MISCELLANEOUS',6X,'(,FR.0, ')'
519	-	519.000	83X,	BAFFLES-L9X',7X,'(,FR.0, ')'
520	-	520.000	81	-----/
521	-	521.000	834X,	SUBTOTAL DRY WEIGHT',F9.0/)
522	-	522.000	3090	FORMAT(12X,'SUBTOTAL DRY WEIGHT',F9.0//
523	-	523.000	819X,	DEPTH/UNCERTAINTY '(,FR.0, ')'
524	-	524.000	818X,	-----/
525	-	525.000	819X,	DRY WEIGHT',9X,F9.0//
526	-	526.000	818X,	RESIDUAL PROPELLANT',FR.0, ')'
527	-	527.000	820X,	TANK UNDRAINABLE',3X,FR.0/
528	-	528.000	820X,	FEEDLINE TRAPPED',3X,FR.0/
529	-	529.000	820X,	PRESSURANT',9X,FR.0/
530	-	530.000	820X,	PU RIAS',12X,FR.0/
531	-	531.000	818X,	-----/
532	-	532.000	817X,	INERT WEIGHT',7X,F9.0//
533	-	533.000	818X,	USABLE PROPELLANT '(,F9.0, ')'
534	-	534.000	818X,	-----/
535	-	535.000	819X,	TOTAL GROSS WEIGHT ',F9.0//
536	-	536.000	819X,	LAMBDA=WRP9P/WGRSS= ',F6.4)
537	-	537.000	3999	CONTINUE
538	-	538.000		RETURN
539	-	539.000		END

