is due to altitude during ascent; SW(29) is set ØN if interrupt is due to any of the preceding reasons and the subprogram is transferred to step 9. If the time to the next interrupt point is larger than any of the times computed, control is transferred to step 58.

(6) Steps 56-57. LINT is stepped by one integration interval. If a simulation interval is not completed, the length of the current integration interval is computed at step 8 and the subprogram continues at step 9; otherwise, control is returned to the user subprogram.

(7) Steps 58-59. IFLAG is set to identification integer 1608 and the subprogram exits to RLLBCK for return to the previous checkpoint.

d. Expressions.

$$a = \frac{-h_{\triangle 2} + h_{\triangle 1}}{2} \quad (1)$$

$$b = \frac{h_{\triangle 1} + h_{\triangle z}}{2} \quad (2)$$

$$c^2 = b^2 - 4a\,(h'_{mI} - a) \quad (3)$$

$$t = -t_{CI1} + \frac{t_{CI1}\,(-b - \sqrt{c})}{2a} \quad (4)$$

2-248. SUBPROGRAM P21 (MATTIT). MATTIT computes the missile attitude vectors at the end of each integration interval for an entire simulation interval based on the orientation of the missile at the beginning of each integration interval, and on the turning rates that are applied to the pitch, yaw, and roll axes during the integration interval. The FORTRAN II reference statement is CALL MATTIT.

a. Inputs. The inputs are as follows:

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
FDELT	2	Length of integration interval	t_{cI1}	seconds
FSZTA	2,3,5	Missile attitude (in single precision) at the beginning of the previous simulation interval and at the end of each integration interval in the simulation interval	$\bar{\zeta}_o$	
FSETA	2,3,5		$\bar{\eta}_o$	
FSXI	2,3,5		$\bar{\xi}_o$	
FTFSP	2	Current time of flight since liftoff		seconds

b. Outputs. The outputs are missile attitude vectors at the beginning of the simulation interval and at the end of each integration interval in the simulation interval placed in registers FSZTA ($\bar{\zeta}_P$), FSETA ($\bar{\eta}_P$), and FSXI ($\bar{\xi}_P$).

c. Program Logic. FD P21

(1) Steps 1-5. The contents of index registers are saved. Turning rates for pitch, yaw, and roll are set to zero and flag 58 is interrogated. If on, values of steering

order magnitudes, steering order types, and conversion constant CONS2 are stored; otherwise, only values of steering order magnitudes are stored.

(2) Steps 6-16. Time of flight since liftoff t_f is tested to determine the proper factors used in computing pitch turning rate FWPYR. The turning rate is computed in degrees.

(3) Steps 17-26. PLACT+8 - IR1 is tested to determine the steering command type to be used. If equal to zero, the program continues at step 27; if equal to one, two, or three, IR2 is set to one, two, or three respectively. Steering command magnitude PLACM+8 - IR1 is converted from quanta to radians and IR2 is tested to determine if the steering command is in roll. If IR2 is three, the steering command is in roll and a factor of two is used to compensate for the conversion from quanta in computing the turning rate FWPYR+1 - IR2; otherwise, FWPYR+1 - IR2 is computed with no compensation for conversion factor CØNS1.

(4) Steps 27-29. If all four values of PLACT + PLACM have not been processed, the program decrements IR1 by one and continues at step 17; otherwise, the program sets IR1 to three and continues at step 30.

(5) Steps 30-41. If all commands have been processed, the program continues at step 51; otherwise, turning rate FWPYP+1 - IR1 is tested to determine if there is any roll, yaw, or pitch values. If zero, IR1 is decremented by one

and the program continues at step 30; otherwise, the program computes the sine and cosine of FWPYP+1 - IR1. IR1 is decremented by one and stored in ANTHR and IR4 is set to three. IR1 is interrogated to determine whether roll, pitch, or yaw will be processed and IR2 are initialized accordingly.

(6) Steps 42-50. Attitude vectors for pitch, yaw, and roll are computed and stored. If ANTHR is equal to one, the program continues at step 30 to process roll commands if they exist; otherwise, the program continues at step 51.

(7) Step 51. The contents of the index registers are restored and the subprogram returns to the user subprogram.

d. <u>Expressions</u>.

$$\bar{\eta}_F = \cos\omega\Delta t\left(\bar{\eta}_o - \frac{\omega_y}{\omega}\bar{\epsilon}\right) + \frac{\omega_y}{\omega}\bar{\epsilon} + \sin\omega\Delta t\,(\bar{\epsilon} \times \bar{\eta}_o) \tag{1}$$

$$\bar{\xi}_F = \cos\omega\Delta t\left|\bar{\xi}_o - \frac{\omega_r\bar{\epsilon}}{\omega\bar{\eta}_o}\right| + \frac{\omega_r}{\omega}\bar{\epsilon} + \sin\omega\Delta t\,(\bar{\epsilon} \times \bar{\xi}_o) \tag{2}$$

$$\bar{\zeta}_F = \bar{\eta}_F \times \bar{\xi}_F \tag{3}$$

where

$$\omega = \omega_p^2 + \omega_y^2 + \omega_r^2$$

$$\bar{\epsilon} = \frac{\omega_p\bar{\zeta}_o + \omega_y\bar{\eta}_o + \omega_r\bar{\xi}_o}{\omega}$$

and where ω_p, ω_y, and ω_r are the turning rates in the pitch ζ, yaw η, and roll ξ directions.

2-249. SUBPROGRAM P37 (MØNTØR). MØNTØR uses quadratic interpolation to compute the speed, altitude, axial deceleration, total deceleration, and time of flight at the maximum and the 25g deceleration points. MØNTØR is called by ØLØØP. The FORTRAN II reference statement is CALL MØNTØR.

a. Inputs. The inputs are as follows:

COMMON TAG	DIMENSION	ITEM	UNITS
FCGR	2	Conversion constant - mass in slugs to weight at sea level in pounds force	ft/sec^2
FVAUX	2,3	Unit vector of current missile velocity relative to local air mass	
FVA	2	Magnitude of current missile velocity relative to local air mass	ft/sec
FTFSP	2	Current time of flight since liftoff	seconds
FMALT	2	Current missile altitude above earth ellipsoid	feet
FDVX	2	X coordinate of current acceleration vector of missile	ft/sec^2
FDVY	2	Y coordinate of current acceleration vector of missile	ft/sec^2
FDVZ	2	Z coordinate of current acceleration vector of missile	ft/sec^2

b. Outputs. The outputs are as follows:

COMMON TAG	DIMENSION	ITEM	UNITS
GFZSM 1,	2	Time of flight 25g point	seconds
GFZSM 1,2,1	2	Altitude at 25g point	feet
GFZSM 1,3,1	2	Speed at 25g point	ft/sec
GFZSM 1,4,1	2	Magnitude of total deceleration at 25g point	ft/sec^2
GFZSM 1,5,1	2	Magnitude of peak axial deceleration	ft/sec^2
GFZSM 1,6,1	2	Time of flight to peak deceleration	seconds
GFZSM 1,7,1	2	Speed at peak deceleration	ft/sec
GFZSM 1,8,1	2	Magnitude of total peak deceleration	ft/sec^2
GFZSM 1,9,1	2	Altitude at peak deceleration	feet

c. <u>Program Logic</u>. FD P37

(1) Steps 1-25. MØNTØR computes total deceleration, axial deceleration, speed, and current altitude of the missile. If either the 25g or maximum deceleration point was reached between this entry to MØNTØR and a prior entry, expressions (1) through (4) are used to interpolate altitude, speed, total and axial deceleration, and time of flight at the desired point. If SW(56) and SW(57) are set ØN when MØNTØR is entered, control is returned to the user subprogram.

(2) Steps 26-28. If neither the 25g nor maximum deceleration point was reached, MØNTØR updates its working data tables and exits to the user subprogram. The tables are stored for later use by MØNTØR so that computations are dependent upon previous transfers to MØNTØR. When the 25g deceleration point is reached, SW(57) is set ØN; when the maximum deceleration point is reached, SW(56) is set ØN.

d. Expressions.

$$a_o = y_1 \qquad (1)$$

$$a_1 = \frac{y_1 - y_2}{\Delta t_1 - \Delta t_2} - a_2 \left(\Delta t_1 + \Delta t_2 \right) \qquad (2)$$

$$a_2 = \left[\frac{y_1 - y_2}{\Delta t_1 - \Delta t_2} - \frac{y_2 - y_3}{\Delta t_2 - \Delta t_3} \right] \frac{1}{\Delta t_1 - \Delta t_3} \qquad (3)$$

$$y = a_o + a_1 \ \Delta t + a_2 \Delta t^2 \qquad (4)$$

where y_1, y_2, and y_3 are the most recent three values of altitude, axial deceleration, total deceleration, or speed depending on which is being computed

t_1 is zero

t_2 is the difference between the time of flight at the last entry to MØNTØR and the prior entry time

t_3 is the difference between the time of flight at the present entry to MØNTØR and the time at two entries prior

When computations for the 25g deceleration point are made

$$\Delta t = \frac{- a_1 \pm \sqrt{a_1{}^2 - 4a_2 \left(a_2 \pm 25 \right)}}{2a_2} \qquad (5)$$

where 25 assumes the sign of the most recent value of the axial deceleration and the radical assumes the sign of a_1. When computations for the peak deceleration point are made

$$\Delta t = - \frac{a_1}{2a_2} \tag{6}$$

2-250. SUBPROGRAM P44 (ØLØØP). ØLØØP performs open loop flight simulation. The FORTRAN II reference statement is CALL ØLØØP.

a. Inputs. The inputs are as follows:

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
FSPPS	2,3	Current missile position vector	$\vec{r}_m$	feet
FSPVL	2,3	Current missile velocity vector	$\vec{V}_m$	ft/sec
FTFSP	2	Current time of flight since liftoff	t_f	seconds
GAIR	2	Altitude above mean sea level of upper limit of atmosphere		feet
IRFSG	2,1,10	Output fuzing parameters for all ten targets		
ISLØT	1	Current target slot		integer
FRFSG	2,6 ISLØT	25g point detection time adjustment factor		seconds
ILEVL	3	Number of output intervals per simulation interval, powered, ballistic, re-entry		integer
TWDA	2	Current target desired detonation altitude above target		feet
SW(32)		If ØN, ØLØØP on re-entry to stop at air burst time; if ØFF, stop at detonation altitude		

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
GDELT	2,3	Outputs in leng for power phase, ballistic phase, re-entry phase		
GRNGL	2	Re-entry angle		
GRSPD	2	Re-entry speed		
SW(159)	1	If ØN, ballistic simulation requested		
FMALT	2	Altitude of missile above ellipsoid		feet
TWAL	2	Target altitude above missile		feet
TWGS	2	Geoidal separation at target		feet
LLIX	3	Number of output intervals per integration interval		integer

b. Outputs. The outputs are as follows:

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
GRESM	2,9	Re-entry point summary data table		
GAPSM	2,9	Apogee data table		
GDPSM	2,9	Final detonation point summary data table		
GFZSM	2,9,1	Re-entry deceleration data table for fuzing computations		
FHDN	2	Flight interrupt specified by altitude on way down		feet
FXTIM	2	Reset normal sequencing interrupt point time from liftoff		seconds

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
LEVEL	1	Number of output intervals per simulation interval		integer
LSEQ	1	Flight stage and substage indicator for normal sequencing		integer
FQVAX	2	Maximum value of qVa product during reentry		lbs/ft-sec
FDELT	2	Length of integration (.097603)		seconds
GDCWK	2,9,3	Deceleration monitor working table		
LAG	1	Runge-Kutta step number		
IFLAG	1	Identification integer		

c. Program Logic. FD P44.

(1) Steps 1-7. IFLAG is set to identification integer 1644 and INTRØG interrogates SW(159) to determine whether ballistic simulation is requested (SW(159) = ØN). If ØN, LØCALT determines the current missile altitude and if the missile is above upper limit of atmosphere, FHDN is set to the altitude of the upper limit of atmosphere so FSIMLC will interrupt at missile re-entry. Otherwise control is transferred to step 16. A test is made to set up for apogee condition. SW(24) is set ØFF (missile not in powered flight). SW(26) is set ØFF and SW(28) is set ØN to indicate that simulation is to be interrupted on altitude during descent but not time of flight.

(2) Steps 8-11. LEVEL is set for ballistic flight, and FSIMLC performs flight simulation for one cycle of ballistic flight. A test is made to see whether apogee has been reached. If it has, missile position, velocity, time of flight, and altitude are stored in a table for apogee data.

(3) Steps 12-17. RSDØRE stores current trajectory information for range safety use. IFLAG is set to identification integer 1644, and FSIMLC and RSDØRE are repeated until the interruption is based on re-entry into the atmosphere (SW(5) = ØN). SW(5) is set ØFF and RANGLE computes missile re-entry angle and speed.

(4) Steps 18-30. Current missile data is stored in a table for re-entry point data. IFLAG is set to identification integer 1644. INTRØG interrogates SW(160) to determine whether re-entry simulation should be done (SW(160) = ØN). If ØN, SW(56) and SW(57) are set ØFF, and the first 18 registers of the re-entry deceleration table and the first 30 registers of the deceleration monitoring working table are cleared. If ØFF, the subprogram continues at step 50. SW(28) and SW(40) are set ØN and SW(34) and SW(39) are set ØFF to initialize for the re-entry phase. LEVEL is set to the number of output intervals per simulation interval in re-entry phase. FHDN is set to cause an interrupt point at the current target desired detonation altitude. The register to contain the maximum value of qVa during re-entry

is cleared and PRESET performs flight simulation initialization. If the output fuzing parameter is greater than zero, IFLAG is set to identification integer 1644. Otherwise control is transferred to step 37.

(5) Steps 31-36. INTRØG interrogates SW(32) to determine whether ØLØØP is to stop at air burst time (SW(32) = ØN). If ØFF, control is transferred to step 37. If ØN, SW(26) is set ØN to direct FSIMLC to interrupt on time of flight; SW(28) is set ØFF, and INTRØG interrogates SW(57) to determine whether MØNTØR has determined the 25g deceleration point (SW(57) = ØN). If ØN, the next normal sequencing interrupt point time is computed by expression (1). If ØFF, control is transferred to step 37.

(6) Steps 37-50. FSIMLC performs flight simulation. If the missile is above upper limit of atmosphere, control is transferred to step 51. Otherwise, IFLAG is set to identification integer 1644. INTRØG interrogates SW(5) to determine whether an interrupt has occurred (SW(5) = ØN). If ØN, control is transferred to step 45. Otherwise, INTRØG interrogates SW(7) to determine whether an interrupt has occurred on the basis of a normal sequence time criterion (SW(7) = ØN). If ØN, control is transferred to step 45. If ØFF, MØNTØR determines the 25g and maximum deceleration points and RSDØRE stores the current trajectory data. At step 45, SW(11) is set ØN so that RSDØRE is to conclude data recording of current target, SW(5) is set ØFF, and RANGLE

computes the missile re-entry angle and speed. The missile position, velocity, time of flight, re-entry angle, and speed are stored in table for final detonation point data. CUTIE is stepped by one and control is returned to the user subprogram.

(7) Steps 51-56. SW(4)-SW(7), SW(24)-SW(30), SW(36)-SW(40), SW(34) and SW(22) are set ØFF. SW(39) and SW(28) are set ØN. The number of output intervals per integration interval for re-entry stage, the Runge-Kutta step number (LAG=5), and the length of output intervals for the ballistic stage are set. The number of output intervals per integration interval is converted to floating point form. The flight stage indicator is set to indicate the ballistic phase and control is transferred to step 6.

d. Expressions.

$$t = \frac{1}{3.185} + t_{25g} + 11.22 - \delta \qquad (1)$$

mod G 1

2-251. SUBPROGRAM C72 (PØLY). PØLY integrates for position velocity, mass, and time of flight. The FORTRAN II reference statement is CALL PØLY.

a. Inputs. The duplexed inputs are as follows:

COMMON TAG	DIMENSION	ITEM	SYMBOL	UNITS
FDLT	2	Length of current integration interval	t_{CIi}	seconds
FDER1	2,2,4	History values of derivative terms	Y'_{m-1}	
FDER2	2,2,4	History values of derivative terms	Y'_{m-2}	
FINT1	2, ,4	History values of integrated terms	Y_{m-1}	
FINT2	2,	History values of integrated terms	Y_{m-2}	
FINT3	2,4,4	History values of integrated terms	Y_{m-3}	

b. Outputs. The duplexed outputs are as follows:

COMMON TAG	DIMENSION	ITEM	UNITS
FSPPS	2,3	Current missile position vector - single precision	feet
FSPVL	2,3	Current missile velocity vector - single precision	ft/sec
FMASS	2	Current missile mass - single precision	slugs
FTFSP	2	Current time of flight since liftoff - single precision	seconds
FBKPS	2,2,3	Current missile position vector - double precision	feet

COMMON TAG	DIMENSION	ITEM	UNITS
FBKVL	2,2,3	Current missile velocity vector - double precision	ft/sec
FDPMS	2,2	Current missile mass - double precision	slugs
FTMFL	2,2	Current time of flight since liftoff-double precision	seconds
FDERO	2,2,4	History values of derivative terms	

c. Program Logic. FD C72

(1) Steps 1-7. PØLY integrates for position, velocity, mass, and time of flight. ACCELR computes the current missile derivatives. The remaining derivatives and integrals used in the expressions are inputs to PØLY. The predicted value of the integral is computed by the use of expression (2). After all integrals have been computed, the subprogram continues at step 8.

(2) Steps 8-12. ACCELR obtains new values for the missile parameters to correct the predicted integral values. The corrected integrals are computed by the use of expression (3). ~~CUTIE is stepped by one and~~ Control is returned to the user subprogram.

d. Expressions.

$$\frac{4}{3}\ t_{cIi}\ (2Y'_{m-2} - Y'_{m-1} + 2Y'_{m}) \qquad (1)$$

$$\bar{Y}_{m+1} = Y_{m-3} + \frac{4}{3} t_{CI1} \left(2Y'_{m-2} - Y'_{m-1} + 2Y'_{m}\right) \tag{2}$$

$$Y_{m+1} = \frac{2Y_{m-1} + Y_{m-2}}{3} + \frac{t_{CI1}}{72} \left(9Y'_{m-2} + 43Y'_{m-1} + 91Y'_{m} + 25\bar{Y}'_{m+1}\right)$$

mod F 1

2-252. SUBPROGRAM P20 (PRESET). PRESET initializes subprogram FSIMLC. The FORTRAN II reference statement is CALL PRESET.

a. Inputs. The inputs are the following switch settings used to select the output information:

SWITCH	DESCRIPTION (switch in ØN state)
SW(36)	Booster stage in progress
SW(37)	Sustainer stage in progress
SW(38)	Vernier stage in progress
SW(39)	Ballistic state in progress
SW(40)	Re-entry stage in progress

The following registers are also inputs:

COMMON TAG	DIMENSION	ITEM	UNITS
VTCAB	2,33,1	C_A vs mach number table, entire missile	
VTCNB	2,33,1	C_N vs mach number table, entire missile	
VTCCB	2,21,1	Center of gravity vs weight table, entire missile	feet
VNRTB	2,21,1	Pitch, yaw moment of inertia table vs weight, entire missile	slug-ft^2/ radian
VTCAS	2,7	C_A vs mach number table, stage II	
VTCNS	2,25,1	C_N vs mach number table, stage II	

COMMON TAG	DIMENSION	ITEM	UNITS
VTCGS	2,21,1	Center of gravity table vs weight, stage II	feet
VNRTS	2,15,1	Pitch, yaw moment of inertia table vs weight, stage II	slug-ft^2/ radian
FGYD	2,3,3	Current gyro drift rates; pitch, yaw, roll; booster, sustainer, vernier	quanta/ RPU
VCRØS	2,3	Effective cross section area - entire missile, stage II	feet^2
VLGA	2,3	Sine of maximum gimbal angle - booster, sustainer, vernier	
VCMT	2,3	Center of motor thrust - booster, sustainer, vernier	feet
GDELT	2,3	Output interval length - powered, ballistic, re-entry	seconds
FSPVL	2,3	Current missile velocity vector - single precision	ft/sec
FNSDV	2,1	Re-entry vehicle separation velocity impulse	ft/sec
FRVMS	2,1	Re-entry vehicle	slugs
FINIT	2,2	Largest positive floating point number	
FWBSD	2,1	Booster thrust decay, total propellant consumption	slugs
FTFSP	2	Current time of flight since liftoff	seconds
FTHR	2	Magnitude of current total thrust produced	pounds
FULB	2,1	Usable booster LOX remaining	slugs

COMMON TAG	DIMENSION	ITEM	UNITS
FUFB	2,1	Usable booster fuel remaining	slugs
FBCMS	2,1	Booster shell plus non-usable propellants	slugs
FT1	2,1	$t_1 - t_o$	seconds
FT42	2,1	$t_4 - t_2$	seconds
FT74	2,1	$t_7 - t_4$	seconds
FT98	2,1	$t_9 - t_8$	seconds
FT110	2,1	$t_{11} - t_{10}$	seconds
FT121	2,1	$t_{12} - t_{11}$	seconds
LLIX	3	Number of output intervals per integration interval - powered, ballistic, re-entry	
LSEQ	1	Flight stage and sub-stage indicator for normal sequencing	
FBKVL	2,2,3	Current missile velocity vector - double precision	ft/sec

b. Outputs. The outputs are the appropriate setting of the SENSE lights and the following registers:

COMMON TAG	DIMENSION	ITEM	UNITS
FTCA	2,33,1	C_A vs mach number table	
FTCN	2,33,1	C_N vs mach number table	
FTCG	2,21,1	Center of gravity table vs weight	feet
FTNRT	2,21,1	Pitch moment of inertia vs weight	slug-ft^2/radian
FADED	2,3	Gyro drift rates	quanta/RPU

COMMON TAG	DIMENSION	ITEM	UNITS
FCRØS	2	Current missile effective aerodynamic cross section area	$feet^2$
FLGA	2	Sine of maximum gimbal angle	
FCMT	2	Current axial position of missile center of thrust	feet
FDELT	2	Length of output intervals	seconds
LSEQ	1	Sequencing device	
FBKVL	2,2,3	Missile velocity vector - double precision	ft/sec
FMASS	2	Current missile mass	slugs
FXTIM	2	Next normal sequencing interrupt time from liftoff	seconds
LAG	1	Runge-Kutta step number	
FTTWØ	2	Thrust at time t_2	pounds
LIX	1	Number of output intervals per integration interval	
FLIX	2	Floating-point form of LIX	
FDPMS	2,2	Current missile mass - double precision	slugs
FSPVL	2,3	Current missile velocity - single precision	f
SW(22)		Switch 22	

c. Program Logic. FD P20

(1) Step 1-19. PRESET initializes FSIMLC. The present phase of flight is determined by interrogating the settings of switches described in the Inputs paragraph. The gyro

drift rates, maximum allowable gimbal angle, and center of motor thrust are chosen. The state of SW(39) and SW(40) determines the phase time interval chosen.

(2) Steps 20-30. The motor sequencing device LSEQ is stepped by one. If the present value of LSEQ is greater than 10, the missile is in ballistic flight and the normal return procedure is initialized. Also SENSE lights 1, 3, and 4 are set. If LSEQ equals 10, the time of re-entry vehicle separation and the current missile position and mass are computed. For any value of LSEQ less than 10, the program derives the next interrupt time and sets the appropriate SENSE light in accordance with the following:

	At t	LSEQ	Set FXTIM (sequence interrupt time)	SENSE Light Set
Liftoff	t_o	1	t_1	4
Stage II gas generator start	t_1	2	∞	3
Booster burnout begins	t_2	3	t_4	3,4
Stage II rockets fire	t_3	3	t_4	3,4
Booster jettison	t_4	4	t_7	2
Sustainer engine ignition	t_5	4	t_7	2
Staging rocket burnout	t_6	4	t_7	2
Sustainer full thrust	t_7	5	∞	2,4
Sustainer cutoff command	t_8	6	t_9	2,3

	At t	LSEQ	Set FXTIM (sequence interrupt time)	SENSE Light Set
Sustainer thrust decay	t_9	7	∞	2,3,4
Vernier cutoff command	t_{10}	8	t_{11}	1
Vernier thrust decay	t_{11}	9	t_{12}	1,4
Re-entry vehicle separation	t_{12}	10	∞	1,3

mod 61

2-253. SUBPROGRAM C71 (RK). RK integrates for position, velocity, mass, and time of flight. The FORTRAN II reference statement is CALL RK.

a. Inputs. The inputs are as follows:

COMMON TAG	DIMENSION	ITEM	UNITS
FBKPS	2,2,3	Current missile position vector - double precision	feet
FBKVL	2,2,3,	Current missile velocity vector - double precision	ft/sec
FDPMS	2,2	Current missile mass - double precision	slugs
FTMFL	2,2	Current time of flight since liftoff - double precision	seconds
FDLT	2	Length of current integration interval	seconds
LIX	1	Number of output intervals per integration interval	
FLIX	2	Floating point form of LIX	
SW(24)		If ØN, powered phase of guided flight simulation is in progress	
SW(22)		If ØN, initialize FSIMLS for starting new flight simulation	
LINT	1	Output interval local counter	
LEVEL	1	Number of output intervals per simulation interval	

b. Outputs. The outputs are as follows:

COMMON TAG	DIMENSION	ITEM	UNITS
FDERO	2,2,4	History values of derivative terms	
FBKPS	2,	Current missile position vector - double precision	feet
FBKVL	2,2,3,	Current missile velocity vector - double precision	ft/sec
FDPMS	2,2	Current missile mass - double precision	slugs
FTMFL	2,2	Current time of flight - double precision	seconds
FSPPS	2,3	Current missile position vector - single precision	feet
FSPVL	2,3	Current missile velocity vector - single precision	ft/sec
FMASS	2	Current missile mass - single precision	slugs
FTFSP	2	Current time of flight - single precision	seconds
SW(22)		If ØN, FSIMLC for starting new flight simulation	

c. Program Logic. FD C71

(1) Steps 1-19. RK computes four values of the integrals of veloci acceleration, the derivative of mass, and the derivative of the time of flight for each output interval or integration interval. Each estimate for the change in position during an interval is weighted, and the sum of these estimates is added to the position at the beginning of that interval. The result is an estimate of the current missile position at the end of the specified interval. The same

procedure is repeated for each of velocity, mass, and time of flight. The general equation is expression (1).

(2) Steps 20-30. If the missile is not in powered f the subprogram continues at step 31. If it is in powered flight, RØUND converts the output parameters to single-precision values. If a new simulation is not to be initialized, the subprogram continues at step 31. If a new simulation is to be initialized, and there are not four output intervals per integration interval, SW(22) is set ØFF. SW(22) is set ØFF if there are four output intervals and this is the second loop through RK. ~~RØLL maintains the output history values of missile parameters~~.

(3) Steps 31-33. If all output intervals for the current simulation or integration interval have been processed, ABCHEK determines values of the position and velocity vector magnitudes. ~~whether the duplexed values of position and velocity vector magnitudes agree within~~ a ~~specified tolerance depending on the stage of flight~~. CUTIE is stepped by one and control is returned to the user subprogram. If all the output intervals have not been processed, the subprogram continues at step 1.

d. <u>Expressions</u>.

$$Y_1 = Y_o + \frac{1}{6}(Q_1 + 2Q_2 + 2Q_3 + Q_4) \qquad (1)$$

where

Y_1 = Integral at the end of the output interval

Y_o = Integral at the beginning of the output interval

$Q = \frac{AX}{I}$ = estimate of change in parameter during one output interval

$Q = AX$ = estimate of change in parameter during one integration interval

A = Length of current integration interval

I = Number of output intervals per integration interval

X = Derivative of the parameter

(2-785 through 2-786 deleted)

2-255. SUBPROGRAM D07 (RSADD). RSADD sets up the additional outputs for the RSD tape. The FORTRAN II reference statement is CALL RSADD (IDRES, GRA(J), IKSTB).

a. Inputs. The inputs are IDRES, the address of additional outputs, GRA(J), the block where the additional outputs are to start, and IKSTB, the number of additional outputs.

b. Outputs. The outputs are the additional outputs stored in the proper printout block.

c. Program Logic. The contents of the index registers are saved. The additional outputs are set up in the proper block for printout through address modification. The contents of the index registers are restored, and the subprogram exits to the user subprogram.

2-256. SUBPROGRAM P36 (RSDØRE). RSDØRE produces a tape which is used to compute range safety data. The data can be printed and used to check the correctness of the subprogram that computed the data. The FORTRAN II reference statement is CALL RSDØRE.

a. Inputs. The inputs are switch settings which determine the quantities to be placed on the output tape. They are as follows:

COMMON TAG	ITEM (switch in ØN state)
SW(5)	Interrupt occurred based on altitude
SW(6)	Interrupt occurred based on special interrupt time
SW(7)	Normal interrupt occurred
SW(9)	Data recording to be performed
SW(10)	Target identification to be printed and SW(10) set ØFF
SW(11)	Offset to be printed and SW(11) set ØFF
SW(70)	Error occurred
SW(123)	Redundance occurred
SW(86)	Closed loop simulation in progress
SW(87)	Ballistic phase simulation in progress
SW(88)	Re-entry phase simulation in progress
SW(90)	Series simulation in progress
SW(135)	Open loop simulation in progress

b. Outputs. The outputs are in duplexed, floating point form and must be converted to the desired output format by

RSDØRE. Only the first channel of the duplexed number is placed on the tape. The outputs are as follows:

(1) Group A_1 (during a simulation interval)

COMMON TAG		ITEM	UNITS
Line 1	FSPPS(1)	Position X_m	feet
	FSPPS(3)	Position Y_m	feet
	FSPPS(5)	Position Z_m	feet
	FSPVL(1)	Velocity $\dot{X}_m$	ft/sec
	FSPVL(3)	Velocity $\dot{Y}_m$	ft/sec
	FSPVL(5)	Velocity $\dot{Z}_m$	ft/sec
	FXTIM(1)	Time	seconds
Line 2	LSEQ	Stage of flight (xx)	integer

LSEQ has the following meaning:

Entire	if xx is 0, 1, 2, 3
Stage II	if xx is 4, 5, 6, 7, 8, 9

Re-entry vehicle if xx is over 10

FGRAV(1)	Gravity g_x	ft/sec^2
FGRAV(3)	Gravity g_y	ft/sec^2
FGRAV(5)	Gravity g_z	ft/sec^2
FMALT(1)	Altitude	feet
FTFSP(1)	Time of flight	seconds
FTRST(1)	Thrust FT_x	pounds
FTRST(3)	Thrust FT_y	pounds
FTRST(5)	Thrust FT_z	pounds
FMASS(1)	Mass	slugs