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SPACE TRAJECTORIES ERROR ANALYSIS (STEAP) PROGRAMS

Volume III - Users' Manual (Update)

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Final Report

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Computer Program for Mission Analysis of Lunar and Interplanetary Missions

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FOREWORD

STEAP II is a series of three computer programs developed by the Martin-Marietta Corporation for the mathematical analysis of the navigation and guidance of lunar and interplanetary trajectories. STEAP is an acronym for Space Trajectory Error Analysis Programs. The first series of programs under this name was developed under contract NAS 1-8745 for Langley Research Center and was documented in two volumes (STEAP User's Manual, STEAP Analytical Manual) as NASA Contract Report 66818. Under contract NAS 5-11795 the STEAP series was extensively modified and expanded for Goddard Space Flight Center. This second generation series of programs is referred to as STEAP II.

STEAP II is composed of three independent yet related programs: NOMNAL, ERRAN, and SIMUL. All three programs require the integration of n-body trajectories for both interplanetary and lunar missions. The virtual mass technique is the scheme used for this purpose in all three programs.

The first program named NOMNAL is responsible for the generation of n-body nominal trajectories (either lunar or interplanetary) performing a number of deterministic guidance events. These events include initial or injection targeting, midcourse retargeting, and orbit insertion. A variety of target parameters are available for the targeting events. The actual targeting is done iteratively either by a modified Newton-Raphson algorithm or by a steepest descent-conjugate gradient scheme. Planar and nonplanar strategies are available for the orbit insertion computation. All maneuvers may be executed either by a simple impulsive model or by a pulsing sequence model.

ERRAN, the second program of STEAP II, is used to conduct linear error analysis studies along specific targeted trajectories. The targeted trajectory may however be altered during flight by retargeting events (computed either by linear or nonlinear guidance) and by an orbit insertion event. Knowledge and control covariances are propagated along the trajectory through a series of measurements and guidance events in a totally integrated fashion. The knowledge covariance is processed through measurements using an optimal Kalman-Schmidt filter with arbitrary solve-for/consider augmentation. Execution errors at guidance events may be modeled either by an impulsive approximation or by a pulsing sequence model. The resulting knowledge and control covariances may be analysed by the program at various events to determine statistical data including probabilistic midcourse correction sizing and effectiveness, probability of impact, and biased aimpoint requirements.

The third and final program in the STEAP II series is the simulation program SIMUL. SIMUL is responsible for the testing of the mathematical models used in the navigation and guidance process. An "actual" dynamic model is used to propagate an "actual" trejectory. Noisy measurements from this "actual" trajectory are then sent to the estimation algorithm. Here the actual measurement, the statistics associated with that measurement, and an "assumed" dynamical model are blended together to generate the filter estimate of the trajectory state. This process is repeated continually through the measurement schedule. At guidance events corrections are computed based on the estimate of the current state. These corrections are then corrupted by execution errors and added to the "actual" trajectory. The statistics and augmentation of the filter, the mismatches in the "actual" and "assumed" dynamics, and the execution errors and measurement biases may then be varied to determine the effects of these parameters on the navigation and guidance process.

The documentation for STEAP II consists of three volumes: the Analytic, Programmer's and User's Manuals. Each of these documents is self-contained.

The Analytic Manual consists of two major divisions. The first section provides a unified treatment of the mathematical analysis of the STEAP II programs. The general problem description, formulation, and solution are given in a tutorial manner. The second section of this report supplies the detailed analysis of those subroutines of STEAP II dealing with technical tasks.

The Programmer's Manual provides the reader with the information he needs to effectively modify the programs. Both the overall structure of the programs as well as the computational flow and analysis of the individual subroutines is described in this manual.

The User's Manual contains the information necessary to operate the programs. The input and output quantities of the programs are described in detail. Example cases are also given and discussed.

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1. INTRODUCTION

The User's Manual provides the user of the STEAP II programs with all the information necessary to input these programs and interpret the output.

Chapter 2 presents a summary of the four programs constituting STEAP II. These are the trajectory propagation package, the targeting program NOMNAL, the error analysis program ERRAN, and the simulation program SIMUL.

Chapters 3 and 4 describe the detailed input and output, respectively, for the three programs NOMNAL, ERRAN, and SIMUL. Restrictions on the input procedure for these programs are also presented.

In Chapter 5 are discussed actual sample cases which were run using the STEAP II programs. These sample cases are presented primarily to demonstrate the operation and versatility of NOMNAL, ERRAN, and SIMUL and to assist the user in the input/output procedure for these programs. Selected pages from these sample cases are found in the Appendix of the User's Manual.

2. SUMMARY OF MODES

The Space Trajectory Error Analysis Programs (STEAP) consist of four subprograms or operational modes. The first mode, used as a subroutine by each of the other three programs, is the trajectory mode VMP by which an n-body trajectory (lunar or interplanetary) is propagated by the virtual mass technique. The second mode is the nominal trajectory generator or targeter (NOMNAL) by which a lunar or interplanetary trajectory meeting specified conditions is determined. The third mode is the error analysis program ERRAN in which the navigation and guidance characteristics of a nominal trajectory are analyzed by linearly propagating knowledge and control covariances along the trajectory. Finally the simulation mode SIMUL tests the mathematical models used in the navigation and guidance processes by modeling the tracking and correction of an "actual" trajectory. In this chapter a general description of each of these modes will be provided.

2.1 The Virtual Mass Propagator VMP

The dynamic model used by STEAP is supplied by the trajectory propagation package. The only external forces acting upon the spacecraft are assumed to be the gravitational forces of the celestial bodies considered in the integration. Both the spacecraft and the gravitational bodies are assumed to be point masses so neither spacecraft attitude nor planet asphericities are considered.

The celestial bodies to be in the integration are specified by the user and may include the sun, any of the nine planets, and the earth's moon. The motion of the planets about the sun and the moon about the earth are modeled by using mean ecliptic elements of date. If the user desires, each of the planets can be set in a fixed ellipse referenced to some epoch for speedier computation.

The coordinate system used in the integration is also specified by the user. The options available are either heliocentric ecliptic or barycentric ecliptic (nominally for lunar trajectories).

The actual scheme used in the propagation of the trajectory in the virtual mass or varicentric technique (see reference 15). No actual integration is performed by the trajectory mode; the key idea of the virtual mass technique is to build up an n-body trajectory by using a sequence of conic sections around a moving effective force center called the virtual mass. At each instantaneous moment along the trajectory, the combined effects of all the gravitational bodies can be viewed as resulting from a fictitious body of unique magnitude and position which is called the virtual mass. The computational procedure then assumes that over a small time interval, the motion of the spacecraft can be represented by a two-body conic section arc relative to this virtual mass. The complete trajectory is thus generated by a series of small arcs pieced together in steps while updating the position and magnitude of the effective force center. The main advantage of the virtual-mass technique is that the tedious numerical integration of the differential equations is avoided.

Another significant feature of the virtual-mass technique is its flexibility. By varying a simple parameter called the "accuracy level" related to the true anomaly increment of each step, trajectories ranging from a sequence of relatively few conic section arcs corresponding to a very approximate solution to those requiring a large number of arcs corresponding to highly accurate solutions may be generated.

2.2 The Nominal Trajectory Targeter NOMNAL

NOMNAL is responsible for the generation of a nominal trajectory for either lunar or interplanetary missions. The method or propagation in either case is the virtual-mass n-body integrator. The trajectory may be processed through a series of deterministic maneuvers including initial or injection targeting, subsequent retargeting, miniprobe targeting, and orbit insertion. A variety of target parameters are available for the targeting events. Both coplanar and nonplanar strategies are permitted in the orbit insertion maneuver.

If an initial state for the problem is known, this may be read in to start the trajectory. Otherwise NOMNAL generates its own zero iterate. In interplanetary missions this involves solving the Lambert time-of-flight equation for the massless planet trajectory that connects the desired initial and final positions in the specified time interval. Four options are available in describing these reference points.

Initial Point	Final Point
Launch Planet	Target planet
Launch Planet	Specified Point
Specified Point	Target Planet
Specified Point	Specified Point

If the initial point is referenced to the launch planet, a launch profile is consulted to generate a realistic set of injection conditions consistent with the heliocentric trajectory.

For lunar trajectories a slightly different procedure is used. The required data for the lunar zero iterate includes specification of the desired semimajor axis with respect to the moon, radius and time of closest approach to the moon, and inclination to the lunar equator. Then the zero iterate is generated by first targeting a patched conic trajectory and then a multiconic trajectory to the desired conditions.

A targeting event may be processed immediately after obtaining a zero iterate state or at any point along the nominal trajectory. At a targeting event the current velocity is refined to yield a trajectory satisfying target parameter constraints. The possible target parameter are:

1) TPS	5) B•T	9) SMA (Lunar)	13) DCP
2) TSI	6) B•R	10) XF	14) RAP
3) TCS	7) RCA	11) YF	15) TPR
4) TCA	8) INC	12) ZF	

The targeting method to be used is specified by the user. Either a modified Newton-Raphson algorithm or a steepest descent/conjugate gradient technique may be used.

Orbit insertion events are also available in NOMNAL. At a specified time the spacecraft state relative to the target body is computed. The resulting conic trajectory relative to the target body is then compared with the desired orbit to determine the optimal time to make the insertion and the required correction. At the proper time the velocity correction is then implemented. Two strategies are permitted in the orbit insertion computation:

1) Coplanar - The desired semimajor axis, eccentricity, and periapsis shift of a coplanar orbit are specified;

2) Nonplanar - The desired plane of the postinsertion state is specified along with nominal values of the orbit elements.

The targeted correction, orbit insertion correction, or an externally supplied correction may be executed if desired. Two models are available for this implementation--a simple impulsive addition or a more complex multiple pulse model.

NOMNAL is also capable of targeting a set of three miniprobes to three specified target sites. Since achieving impacts at three specified points on the planet surface constitutes a six-degree-of-freedom constraint while only four miniprobe release controls are available, any targeting process can, at most, achieve a minimum-miss solution. NOMNAL uses as its miss-index a weighted sum of the squares of the distances between the respective actual and desired B-plane asymptote pierce points. The weighting factors, which are supplied by the user, indicate the relative importance of securing nearby impacts at the respective target sites. NOMNAL computes its weighted least-squares solution by a hybrid pseudo-inverse and steepest-descent algorithm. The initial control iterate is constructed by approximately targeting the first miniprobe to one of the target sites using a single Newton-Raphson step.

Finally the program integrates and records all segments of the nominal trajectory between guidance events from injection at the launch planet until the appropriate termination condition input by the user. For a conglomerate vehicle NOMNAL records the separate branches of the trajectory belonging to the main probe and miniprobes as well as to the bus.

2.3 The Error Analysis/Generalized Covariance Analysis Program ERRAN

The error analysis/generalized covariance analysis program ERRAN is a preflight mission analysis tool that is used to determine how selected error sources influence the orbit determination process for interplanetary or lunar missions.

In the error analysis mode, ERRAN provides three primary quantitative results: (1) knowledge covariance matrices, which provide a measure of how well the actual trajectory is known, (2) control covariance matrices, which when propagated forward to the target provide a measure of how well the nominal target conditions will be satisfied by the actual trajectory, and (3) statistical midcourse ΔVs, which provide a measure of the amount of fuel required for a successful mission.

In the generalized covariance analysis mode, ERRAN provides all of the above information plus corresponding "actual" statistical information. The three results discussed in the previous paragraph are all computed on the basis of statistical distributions assumed by the navigation filter to describe the significant error sources. In the generalized covariance analysis mode, "actual" knowledge covariances, control convariances, and statistical midcourse ΔVs are computed on the basis of statistical distributions that actually describe both error sources acknowledged by the navigation filter and the error sources ignored. The primary use of the generalized covariance analysis program is to study the sensitivity of filter performance to off-design conditions.

ERRAN allows for employing gain generators for user-specified linear recursive navigation filters. Two gain generators are currently available in ERRAN: (1) Kalman-Schmidt filter, and (2) equivalent recursive consider mode weighted-least-squares filter.

State transition matrices are required to propagate covariance matrices over an arbitrary interval of time. Three methods are available for computing the 6x6 position/velocity state transition matrix. The first two methods, which are analytical methods, are analytical patched conic and analytical virtual mass. The third method uses numerical differencing to compute the state transition matrix. To increase the accuracy of the analytical techniques over long intervals, a state transition matrix cascading option is also available. Augmented parameter state transition matrices are always computed using numerical differencing.

Up to 23 dynamic and measurement parameters may be solved-for or considered by the navigation filter. Parameters not acknowledged in design of the filter may be treated as ignore parameters when ERRAN is run in the generalized covariance analysis mode. The dynamic parameters include biases in the gravitational constants of the sun and the target planet and biases in the six orbital elements of the target planet. Measurement biases include biases in the locations of the three earth-based tracking stations, and biases in all measurements. Available measurement types are range, range-rate, star-planet angles, and apparent planet diameter measurements. Measurement noise for each measurement type is assumed to be constant.

The computational procedure in ERRAN is divided into basic cycle computations and event computations. Basic cycle computations are concerned with the propagation of covariances forward to a measurement time and processing the measurement. Events refer to a set of specialized computation, not directly concerned with measurement processing, that can be scheduled to occur at arbitrary times along the trajectory.

The four events available in ERRAN are eigenvector, prediction, guidance, and probe release. At an eigenvector event the position and velocity partitions of the knowledge covariance matrix are diagonalized to reveal geometric information about the size and orientation of the position and velocity navigation uncertainties. Associated hyperellipsoids are also computed. At a prediction event the most recent covariance matrix is propagated forward to some critical trajectory time to determine predicted navigation uncertainties in the absence of further measurements.

The guidance event is the most complex event and yields much useful information for preflight mission analysis. Several types of guidance events are available in ERRAN. At a midcourse guidance event the user can choose from three midcourse guidance policies. The midcourse guidance event can also be constrainted to satisfy planetary quarantine requirements. At an orbital insertion guidance event the user can choose from two insertion policies. Options are also available for changing target conditions in midflight and retargeting the trajectory using nonlinear techniques, or for simply applying an externally supplied or precomputed ΔV at some arbitrary trajectory time. Two thrust models are available--impulse and impulse series. Execution error statistics are generated using an error model defined by a proportionality error, a resolution error, and two pointing angle errors. At a midcourse guidance event in ERRAN we also compute a statistical ΔV and the target condition covariance matrix both before and after the midcourse correction.

Probe release events provide the capability to study missions employing multiprobe spacecraft. The multiprobe spacecraft is modeled as (1) a primary vehicle, or bus, with thrusting capability, (2) a main probe, with no thrusting capability, and (3) three miniprobes located symmetrically on booms attached to the bus, with no thrusting capability, and released simultaneously with ΔVs provided by spinning the bus. Probe release events currently operate only in the error analysis mode of ERRAN. All measurement types and solve-for or consider parameters described previously are defined for all probes. Separate measurement schedules can be defined for the bus and the main probe. An additional measurement schedule can also be defined for all three miniprobes. Knowledge and control covariances are propagated for each probe in sequential fashion.

2.4 The Simulation Program SIMUL

The simulation program SIMUL is the most complex program in the STEAP set of programs. In SIMUL the validity of the navigation and guidance process is examined by simulating an actual mission. Spacecraft state estimates are generated in SIMUL, as well as knowledge covariance matrices. The results given by the error analysis program ERRAN become meaningful only when SIMUL shows that the estimated spacecraft trajectory converges, within reasonable bounds specified by the covariance matrix, to the simulated actual trajectory.

All state transition matrix, parameter augmentation, and measurement options described in section 3.3 are also available in SIMUL. As in ERRAN, the computational procedure in SIMUL is divided into basic cycle computations. The SIMUL basic cycle is concerned with the generation of state estimates and an actual trajectory, together with all quantities generated in the ERRAN error analysis basic cycle. Eigenvector and prediction events in SIMUL involve all computations performed in the corresponding ERRAN events. In addition, the SIMUL prediction event propagates state estimates forward to the time to which we are predicting.

All options available in the ERRAN guidance event (see section 3.3) are also available in the SIMUL guidance event. The treatment of the midcourse guidance event, however, is different in several respects. First, since an estimated spacecraft state is generated in SIMUL, an actual midcourse ΔV can be computed rather than a statistical ΔV as in ERRAN. Also, all linear midcourse ΔVs computed in SIMUL can be recomputed using nonlinear techniques.

Finally, since an actual trajectory is generated in SIMUL, actual target errors after the midcourse correction are also computed.

Probe release events are also available in SIMUL. In addition to propagating knowledge and control covariance matrices for each probe, SIMUL also generates state estimates for each probe.

3. INPUT DESCRIPTION

3.1 NOMNAL Input Description

The input for NOMNAL is transmitted via the namelist TARIN and read in subroutine PRELIM. Each of the variables of TARIN will be described in full in this section. Many namelist variables will be specified by the program if they are not set by the user in the namelist input; these assumed values are the quantities enclosed in parentheses following the variable definition.

Namelist TARIN:

a) Nominal trajectory parameters

ALNGTH - Length units per AU for output (ALNGTH = 149598500 : kilometers)

TM - Time units per day for output (TM = 86400 : seconds)

ACKT - Integration accuracy level used in nominal trajectory propagation

NBOD - Number of gravitation bodies included in integration

NB(11) - Array of codes (defined below) of gravitating bodies to be included in integration

Body	Code
Sun	1
Mercury	2
Venus	3
Earth	4
Mars	5
Jupiter	6
Saturn	7
Uranus	8
Neptune	9
Pluto	10
Moon	11

NLP - Code of launch planet

NTP - Code of target body

IBARY - Flag determining inertial coordinate system (IBARY = 0)

= 0 - Inertial system is heliocentric ecliptic
= 1 - Inertial system is barycentric ecliptic

NCPR - Number of integration increments between printouts (NCPR = 100)

TMPR - Number of days between printouts (TMPR = 500.)

SSS(3) - Array of direction cosines of spacecraft spin axis (SSS = (0,0,1)).

b) Zero iterate parameters

IZERO - Flag determining type of zero iterate generation (IZERO = 0)

= 0 - Initial state read in through ZDAT (1-6)
= 1 - Launch planet at initial time to target body at final time
= 2 - Launch planet at initial time to arbitrary point (specified by ZDAT (4-6)) at final time
= 3 - Arbitrary initial point (specified by ZDAT (1-3) at initial time to target body at final time
= 4 - Arbitrary initial point (specified by ZDAT (1-3) at initial time to arbitrary final point (specified by ZDAT (4-6)) at final time
= 10 - Lunar targeting

KALI(5,10), SI(10) - Calendar date of initial time (year, month, day, hour, minute, second)
Specified to fractional second for IZERO = 0, 3, 4
Specified only to day for IZERO = 1, 2
Not required for IZERO = 10 (lunar targeting)
Example: KALI = 1974, 5, 16, 0, 0, SI = 0.)

KALT(5,10), TS(10) - Calendar date of final time (year, month, day, hour, minute, second) in zero iterate computation (t_{CA} for lunar zero iterate generation)

ZDAT(6) - Vector defining zero iterate computation for interplanetary targeting

ZDAT(1-3) = arbitrary initial position (inertial ecliptic)
ZDAT(4-6) = arbitrary final position (inertial ecliptic)

for lunar targeting

ZDAT(1-3) = desired semimajor axis, radius of closest approach, and equatorial inclination of lunar conic

RP - Parking orbit radius in launch model (RP = 6560 km)

SIGMAL - Nominal value of launch aximuth which may be varied if necessary (SIGMAL = 90°)

KOAST - Flag determining launch plane (KOAST = 1)

= 1 - long coast time orbit
= -1 - short coast time orbit

The following parameters are used to define the launch profile for interplanetary trajectories:

FI - True anomaly at injection (FI = 3.7°)

PSI1 - Angle of first burn (PSI1 = 17.°)

PSI2 - Angle of second burn (PSI2 = 8.°)

TIM1 - Duration of first burn (TIM1 = 500.)

TIM2 - Duration of second burn (TIM2 = 100.)

THELS - Longitude of launch site (THELS = 279.457°)

PHILS - Latitude of launch site (PHILS = 28.317°)

THEDOT - Rotation rate of launch planet (THEDOT = 15.041)

RPRAT - Inverse parking orbit rate (RPRAT = 14.689)

Up to 10 guidance events are permitted in any run of NOMNAL. The guidance event parameters are defined as arrays; parameters corresponding to the same event occur in the same component of all arrays. The indices of the events are not required to be consecutive nor must they be in chronological order.

c) General guidance event parameters

KTYP(10) - The types of guidance events

- = -1 - Termination event (each run must have such an event to terminate the integration of the nominal trajectory)
- = 1 - Targeting event (the current velocity will be directly refined to yield a trajectory satisfying input target conditions)
- = 2 - Retargeting event [the current position and target state will be used to compute a zero iterate velocity (see IZER below) that will then be refined to meet prescribed target conditions]
- = 3 - Orbit insertion event (using the current state, the velocity correction needed at a later time to insert into a desired orbit is computed and executed at that later time)
- = 4 - Main probe propagation event (the current state is stored so it can be returned to after the event. Then it is propagated to a stopping condition generating a printed time history. Finally the original current state is restored in preparation for the next event. This event type is used in treating branched trajectories)
- = 5 - Miniprobe release event (the current state is stored. Then the release controls are calculated to apply at the current time to target three miniprobes to three respective target sites characterized by input values of declination and

right ascension. Next each of the miniprobes is propagated from release to impact using the minimum-miss controls. Time histories of these trajectories are printed during their generation. Finally the current state is restored for the next event)
(KTYP = 1,1,1,...)

KTIM(10) - Codes defining epochs to which times of guidance events are referenced

= 0 - Event is not to be processed
= 1 - Epoch is initial time
= 2 - Epoch is time of intersection of sphere of influence of target body
= 3 - Epoch is time of closest approach to target body
= 4 - Time is read in as calendar date in KALG, SG
(KTIM = 0,0,0,...)

TIMG(10) - Time intervals (days) of guidance events past reference epochs (KTIM)
(TIMG = 0.,0.,0.,...)

KALG(5,10)
GS(10) - Dates of guidance events (year, month, day, hour, minute, seconds) used only for KTIM(i) = 4.
Example: KALG(1,i) = 1975,10,12,2,14,
GS(i) = 10.234

IZER(10) - Flag determining method of computing zero iterate velocity for retargeting event

= 3 - Current position to target body at target time
= 4 - Current position to target position (KTAR = 10,11,12) at target time
(IZER = 0,0,0,...)

KMXQ(10) - Compute/execute modes of events (KMXQ = 3,3,3,...)

= 1 - Compute velocity correction only
= 2 - Execute velocity correction only
= 3 - Compute and execute velocity correction at same time
= 4 - Compute velocity correction but execute at a later time (orbit insertion)

DELV(3,10) - The impulsive velocity increment in ecliptic coordinates for each event i such that KMXQ(i) = 2 (km/s).
Example: DELV(1,i) = .050, + .115, - .007

MDL(10) - Execution models for velocity corrections (MDL = 1,1,1,...)

= 1 - Impulsive model
= 2 - Multiple pulsing arc

The following parameters need be set only if the multiple pulsing arc execution model is used in the run.

PULMAG - Thrust magnitude (T) of pulsing engine

PULMAS - Nominal mass in of spacecraft during pulsing arc

DUR - Time duration (Δt) of single pulse

DTI - Time interval (Δt_i) between pulses (days)

The units of the first three variables must be such that the velocity increment imparted on a single pulse $\Delta v = T/m\ \Delta t$ is in km/s.

KLP(10)

KTP(10) - Flags used to change the launch and target bodies at a guidance event

= 0 - Use previous codes NLP and NTP
= K, - Replace previous code by K.

Example: KLP = 0,0,5, KTP = 0,0,6, determines that at the third event Mars becomes the launch planet and Jupiter the target planet.
(KLP = 0,0,..., KTP = 0,0,...)

KTAR(6,10) - Targeting event: Target parameter codes for each targeting event using the definitions listed below. Example: KTAR(1,i) = 7,8,3, triggers target parameters r_{CA}, i_{CA}, t_{CS}.

Code	Symbol	Definition
1	TPS	Time at impact in Julian days epoch 1900 extrapolated conically from SOI conditions.*
2	TSI	Time at SOI
3	TCS	Time at CA extrapolated from SOI conditions
4	TCA	Time at CA
5	BDT	B·T at target time
6	BDR	B·R at target time
7	RCA	Radius of closest approach computed at target time
8	INC†	Inclination (planet equatorial) at target time
9	ASI	Semimajor axis (computed from SOI conditions)
10	XRF	X-component of final position (inertial ecliptic)

---

*If 1 is among the target codes, 13 and 14 must be the remaining two. Then all the target values, like the 1 value, are extrapolated from SOI conditions.

†The inclination must be specified as follows. Let α be the magnitude of the inclination with $0° \le \alpha \le 90°$. Then (see IMPACT for further details)

δ_M = 0 posigrade motion $\qquad$ δ_A = +1 northern approach

= 1 retrograde motion $\qquad$ = -1 southern approach

$$i = \delta_M\, 180° + \delta_A \alpha$$

Code	Symbol	Definition
11	YRF	Y-component of final position (inertial ecliptic)
12	ZRF	Z-component of final position (inertial ecliptic)
13	DCP	Declination in degree of probe at impact relative to the probe coordinate system specified by IPCS
14	RAP	Right ascension in degree of probe at impact relative to the probe coordinate system specified by IPCS
15	TPR	Time at impact in Julian days epoch 1900 obtained completely by integration

Orbit insertion event: The flag determining whether the coplanar (= 1) or nonplanar (= 2) option is to be used on an orbit insertion event. Example: KTAR(1,i) = 1 triggers the coplanar option

TAR(6,10) - Targeting event: The desired target parameter values for each targeting event in the same order as the target parameter codes. Example: TAR(1,i) = 7000., 50., sets the desired values r_{CA} = 7000 km, i = 50° if KTAR(1,i) = 7,8

Coplanar orbit insertion: (KTYP(i) = 3, KTAR(1,i) = 1). The desired values of semimajor axis (km), eccentricity, and periapsis shift for each coplanar insertion. Example: TAR(1,i) = 20000., .75, 5

Nonplanar orbit insertion: (KTYP(i) = 3, KTAR(1,i) = 2). The desired values of semimajor axis (km), eccentricity, argument of periapsis (equatorial), inclination (equatorial), and longitude of ascending node (equatorial) for each nonplanar insertion. Example: TAR(1,i) = 20000., .75, 30., 15., 210

Miniprobe targeting: The contents of the arrays KTAR, TAR, TOL, and WGHTM are redefined as follows for this event type.

KTAR(1,10) - Flag specifying the spin axis orientation mode

= 11 - Ecliptic declination and right axcension of spin axis are free controls
= 12 - Spin axis is aligned with spacecraft velocity vector at release
= 13 - Spin axis is perpendicular to spacecraft sun line, parallel to ecliptic plane, and within 90° of spacecraft velocity vector at release
= 14 - Ecliptic declination and right ascension of spin axis are each fixed at values input by the user

KTAR(2,10) - Flag specifying the mode of miniprobe propagation

= 11 - Conic model alone
= 12 - Conic initial iteration followed by virtual-mass refinement

TAR(j,10) - Desired declination in degree of impact point of jth miniprobe in coordinate system opted by IPCS(i) and for planet radius specified by RPS(i)

TAR(j+3,10) - Desired right ascension in degree of impact point of jth miniprobe in the coordinate system and at the planet radius described above for TAR(j,10)

TOL(j,10) - Weighting factor applied to the B·T and B·R errors of the jth target site in the miss-minimizing algorithm. The least important site should be assigned a unity weight, while the more important ones should be given progressively larger values

TOL(4,10) - Tolerance, ε, on release control convergence. For the actual convergence criterion, consult the *STEAP Analytical Manual* under miniprobe targeting. A suggested value for ε is 1

TOL(5,10) - Declination in degrees of the spin axis for the fixed inertial-orientation spin axis mode

TOL(6,10) - Right ascension in degrees of the spin axis axis for the fixed inertial-orientation spin axis mode

WGHTM(10) - Length of maximum pseudoinverse step in the control space. Longer steps are deferred in favor of a best-step steepest-descent correction. A suggested value is 0.5 radians or decameters

RPS(10) - The radius of the probe impact sphere in km. It must be loaded for each targeting event to planet impact parameters, each main probe propagating event, and each miniprobe targeting event

IPCS(10) - The flag specifying the planetocentric coordinate system for the various types or probe events. It must be loaded for the same cases as is RPS (IPS = 0, 0, 0, ...)

0 = equatorial
1 = subsolar orbit plane

KALT(5,10), TS(10) - Desired value of target time in calendar dates for targeting event regardless of whether the target time is t_{SI} t_{CS}, or t_{CA}. Thus, if KALT(1,i) = 1975,9,18,0,0, TS(i) = 0., and KTAR(3,i) = 2, the desired time at the target planet SOI is September 18, 1975. If KTAR(3,i) = 4, that date is to be the desired time of closest approach. If IZERO = 1, 2, KALT(5,0) and TS(1) must correspond to the final time of the zero iterate computation

TOL(6,10) - Tolerances on desired values for targeting events in same order as the target parameter codes. Thus TOL(1,i) = 100., 1., .005 sets the tolerances of 100 km in r_{CA}, 1° in i, and .005 days in t_{CS} if KTAR(1,i) = 7,8,3

NPAR(10) - The number of targeting parameters to be targeted for each targeting event. If NPAR(i) = 3, all three velocity components will be refined to meet the three velocity components will be refined to meet the three target parameters. If NPAR(i) = 2, the X- and Y-components will be refined to meet the first two target parameters (NPAR = 3,3,3,...)

d. Targeting Scheme Parameters

METH(10) - The method to be used in the targeting

= 0 - Use Newton-Raphson targeting matrix method
= n - Use cycle of n-1 conjugate gradient steps and one steepest descent step repeatedly.

Example: METH = 0,1,10 specifies Newton-Raphson technique for first targeting event, steepest descent for second event, and a conjugate gradient technique rectified by steepest descent every 10 steps for third event (METH = 0,0,0,...)

WGHTM(10) - The weighting factor used for the time variable in assigning a scalar loss function for the auxiliary parameters for both the bad-step logic and gradient computations (WGHTM = 10^5, 10^5, 10^5,...)

PERV(10) - The velocity perturbations (km/s) used for each targeting event to compute either the targeting matrix or the gradient (PERV = .00005, .00005,...)

DVMAX(10) - The maximum step allowed (km/s) on any iterate (DVMAX = 0.1,0.1,0.1,...)

SPHFAC(10) - The factors by which the target planet sphere of influence is to be reduced at each targeting event. Thus if SPHFAC(i) = .5, the SOI will be reduced by half to do the targeting at the ith event (SPHFAC = 1.,1.,1.,...)

NOIT(10) - The number of total iterations allowed at the first and last level of the targeting events (NOIT = 8,8,8,...)

MAXB(10) - The number of bad steps allowed during any targeting event (MAXB = 4,4,4,...)

IBADS(10) - The bad-step flags for each targeting event

= 1 - Never use bad-step check
= 2 - Use bad-step check at final level only
= 3 - Use bad-step checks throughout
(IBADS = 3,3,3,...)

ISTART - Stage of first targeting event

= 0 - Compute targeting matrix on first iteration
= 1 - The first phase of the targeting has been started and a valid targeting matrix for the first phase will be read in as PHI
= 2 - The second phase of the targeting has been started and a valid targeting matrix for the second phase will be read in as PHI
(ISTART = 0)

PHI(3,3) - The targeting matrix to be used repeatedly, defined by the value of ISTART

MAT(10) - Targeting matrix computation code for each targeting event

= 1 - Compute targeting matrix only at first level
= 2 - Compute targeting matrix at each step
(MAT = 1,1,1,...)

AC(5,10) - The accuracy levels used for each event. The final accuracy level at each guidance event should be identical to the trajectory accuracy level ACKT. Thus if AC(1,i) - 1.E-4, 2.5E-5, 5.E-6, the ith guidance event will be targeted at those progressive levels

LVLS(10) - The number of accuracy levels used for each targeting event (LVLS = 3,3,3,...)

CONTK
~~CON~~(10) - The flag used in designating the controls to be used in calculating the sensitivity matrix in a targeting event

= 1 - Intertial x, y, and z spacecraft velocity components
= 2 - Magnitude of the spacecraft velocity relative to the launch planet, and in-plane and out-of-plane rotation angles from the current relative velocity*
(CON = 2,2,2,...)

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*See the analysis section of the subroutine KTROL for a detailed description of these controls.

3.2 ERRAN Input Description

The input of the error analysis/generalized covariance analysis program consists of:

a) A card containing the variable IRUNX (I10 field) that indicates how many different runs are to be made and is read only once;

b) A card containing the problem identification variable (I10 field) that precedes each set of input data;

c) An error analysis namelist section entitled ERRAN;

d) Three successive measurement schedules for the primary vehicle, main probe, and miniprobes in that order (see namelist variables NENT, NENT1, and NENT2);

e) A generalized covariance analysis namelist section entitled GENRAL, that must appear only if a generalized covariance analysis is to be performed.

Most namelist variables are preset by the program; these preset values are the quantities enclosed in parentheses in the namelist definitions. Unless otherwise indicated, input units correspond to the internal units defined by the variables ALNGTH and TM. Unspecified angular units are assumed to be radians.

3.2.1 Namelist ERRAN

1. Nominal trajectory variables

XI(6) - Initial position/velocity state of spacecraft; not specified if ICØØR = 3 (XI = 6 * 0.)

ICØØR - Code that specifies coordinate system of initial spacecraft state. (ICØØR = 2)

= 0, heliocentric ecliptic
= 1, geocentric equatorial
= 2, geocentric ecliptic
= 3, JPL conditions: RDS, PHIT, THETA, VEL, GAMMA, SIGMA
= 4, planetocentric ecliptic (target planet)

= 5, planetocentric equatorial
= 6, planetocentric orbital elements: semimajor axis, eccentricity, inclination, longitude of the ascending node, argument of periapsis, and true anomaly

The following six variables define the JPL conditions:

RDS	- Earth - centered injection radius
PHIT	- Injection declination (degrees)
THETA	- Injection right ascension (degrees)
VEL	- Injection velocity relative to the Earth
GAMMA	- Injection flightpath angle (degrees)
SIGMA	- Injection azimuth (degrees)
LMØ	- Launch month (integer)
LDAY	- Launch day (integer)
LHR	- Launch minute (integer)
SECL	- Launch second (floating)
LYR	- Launch year (integer)
IMØ	- Month of final computation (integer)
IDAY	- Day of final computation (integer)
IHR	- Hour of final computation (integer)
IMIN	- Minute of final computation (integer)
SECI	- Second of final computation (floating)
IYR	- Year of final computation (integer)
ALNGTH	- Length units per AU (ALNGTH = 149598500. Kilometers)

TM - Time units per day. (TM = 86400. seconds)

TRTM1 - Initial trajectory time. (TRTM1 = 0.)

TINJ - Injection trajectory time. (TINJ = 0.)

NTMC - Nominal trajectory module code. (NTMC = 2)

= 1 - patched conic (not supplied with this program)
= 2 - virtual mass

NBØD - Number of celestial bodies considered in the generation of the nominal trajectory (NBØD = 3)

NB(11) - Array of codes of celestial bodies considered in the generation of the nominal trajectory

= 1 - Sun
= 2 - Mercury
= 3 - Venus
= 4 - Earth
= 5 - Mars
= 6 - Jupiter
= 7 - Saturn
= 8 - Uranus
= 9 - Neptune
= 10 - Pluto
= 11 - Earth's Moon

NLP - Launch planet code

NTP - Target planet code

IEPHEM - Ephemeris code (IEPHEM = 1)

= 0 - Place each planet in an ellipse. The date at which this ellipse is calculated is determined by reading in a variable entitled as the first six letters of the name of the planet considered. This variable should contain six integers specifying the month, day, hour, minute, second, and year. Example: EARTH = 7, 24, 6 15, 38, 1973.
= 1 - Calculate orbital elements for each planet at each time interval

SSS(3) - Array of direction cosines of spacecraft spin axis (SSS = 0.0.1)

ACC - Nominal trajectory accuracy figure (ACC = 1.0×10^{-6})

ISP2 - Code of virtual mass trajectory (ISP2 = 0)

= 0 - Continue integrating to final time
≥ 1 - Stop integrating when target planet sphere of influence is encountered

IBARY - Reference coordinate system option (IBARY = 0)

= 0 - Reference coordinate system is heliocentric ecliptic
= 1 - Reference coordinate system is barycentric ecliptic

2. State transition matrix variables

ISTMC - State transition matrix code (ISTMC = 1)

= 1 - Analytical patched conic
= 2 - Analytical virtual mass
= 3 - Numerical differencing using virtual mass

DTMAX - Maximum time interval for which analytical computation of the state transition matrix is considered valid (DTMAX = 8.days)

NDACC - Accuracy code for numerical differencing (NDACC = 0)

= 0 - Same accuracy as is employed in the computation of the nominal trajectory
= 1 - Accuracy = ACCND, described next

ACCND - Accuracy to be used in the calculation of the state transition matrix by numerical differencing (ACCND = 2.5×10^{-5})

ISTM1 - Cascaded state transition matrix code (ISTM1 = 1)
(ISTM1 should be set to 3 for lunar missions since cascading option has not been defined for such missions)

= 1 - Patched conic Danby method
= 2 - Virtual-mass Danby method
= 3 - Numerical differencing (CASCAD not called)

DTSUN - Integration interval when sun is central body and ISTM1 = 1. (DTSUN = 2.0 days)

DTPLAN - Integration interval when target planet is central body and ISTM1 = 1. (DTPLAN = 0.25 days)

FACP - Position factor for numerical differencing (FACP = 1.)

FACV - Velocity factor for numerical differencing (FACV = $1. \times 10^{-4}$)

The following eight variables are used to compute the augmented state transition matrix by numerical differencing:

DELMUS - Sun gravitational constant factor; need be specified only if IAUGIN(10) is nonzero (DELMUS = $1. \times 10^{7}$)

DELMUP - Target planet gravitational constant factor; need be specified only if IAUGIN(11) is nonzero (DELMUP = 0.1)

DELAXS - Target planet semimajor axis factor; need be specified only if IAUGIN(12) is nonzero (DELAXS = 100.)

DELECC - Target planet eccentricity factor; need be specified only if IAUGIN(13) is nonzero (DELECC = 1. x 10^{-5})

DELICL - Target planet inclination factor; need be specified only if IAUGIN(14) is nonzero (DELICL = .0000484814 radians)

DELNØD - Target planet longitude of the ascending node factor; need be specified only if IAUGIN(15) is nonzero (DELNØD = .0000484814 radians)

DELW - Target planet argument of periapsis factor; need be specified only if IAUGIN(16) is nonzero (DELW = .0000484814 radians)

DELMA - Target planet mean anomaly factor; need be specified only if IAUGIN(17) is nonzero (DELMA = .0000484814 radians)

3. Parameter augmentation variables

IAUGIN(24) - Array of augmented parameter codes; unspecified elements are assumed to be zeros. Up to 12 solve-for parameters may be augmented; up to 8 dynamic-consider parameters; up to 15 measurement-consider parameters; and up to 12 ignore parameters

IAUGIN(I)
= 0 - neglected parameter
= 1 - consider parameter
= 2 - solve-for parameter
= 3 - ignore parameter (generalized covariance only)

I		
I = 1	Radius error of station 1	measurement parameters
2	Latitude error of station 1	
3	Longitude error of station 1	
4	Radius error of station 2	
5	Latitude error of station 2	
6	Longitude error of station 2	
7	Radius error of station 3	
8	Latitude error of station 3	
9	Longitude error of station 3	

I = 10	Sun gravitational constant bias	dynamic parameters
11	Target planet gravitational constant bias	
12	Target planet semimajor axis bias	
13	Target planet eccentricity bias	
14	Target planet inclination bias	
15	Target planet longitude of ascending node bias	
16	Target planet argument of periapsis bias	
17	Target planet mean anomaly bias	
18	Range bias of station 1	measurement parameters
19	Range-rate bias of station 1	
20	Star-planet angle 1 bias	
21	Star-planet angle 2 bias	
22	Star-planet angle 3 bias	
23	Apparent planet diameter bias	
24	Undefined	

4. Measurement variables

NENT - Number of entries (cards in primary vehicle measurement schedule (NENT = 0)

NENT1 - Number of entries (cards) in the main probe measurement schedule (NENT1 = 0)

NENT2 - Number of entries (cards) in the single measurement schedule for all three miniprobes (NENT2 = 0)

NST - Number of tracking stations (at most 3) on the rotating earth (NST = 3). If no tracking station information is read in, the following three stations will be assumed:

	Altitude	Latitude	Longitude
1. Goldstone	1.031 km	35.384 N	116.833 W
2. Madrid	.050 km	40.417 N	3.667 W
3. Canberra	.050 km	35.311 S	149.136 E

If different tracking stations are desired, their locations must be specified by the following three arrays.

SAL(3)	- Array of altitudes of each tracking station
SLAT(3)	- Array of latitudes of each tracking station in degrees north
SLØN(3)	- Array of longitudes of each tracking station in degrees east
UST(3) VST(3) WST(3)	- Direction cosine arrays of three reference stars. If not specified, the three stars and their direction cosines are as follows:

	Canopus	Betelgeuse	Rigel
UST	-.061351	.028986	.201963
VST	.237886	.960388	.831343
WST	-.969355	-.277141	-.517784

5. Eigenvector and prediction event variables

NEV1	- Number of eigenvector events (NEV1 = 0)
NEV2	- Number of prediction events (NEV2 = 0)
T1(20)	- Array of times at which eigenvector events occur; specified only if NEV1 is nonzero. Chronological order required
T2(20)	- Array of times at which prediction events occur; specified only if NEV2 is nonzero. Chronological order required
TPT2(20)	- Array of times to which one wishes to predict. The elements of the TPT2 array must correspond to the elements of the T2 array and must be specified only if the T2 array has been specified

IEIG - Eigenvector code (IEIG = 1)

= 0 - Only position eigenvectors will be calculated
= 1 - Both position and velocity eigenvectors will be calculated

IHYP1 - Hyperellipsoid sigma level code (IHYP1 = 2)

= 1 - Sigma level equals one
= 2 - Sigma level equals three
= 3 - Sigma levels of both one and three

FØP - A value to be used as an off-diagonal annihilation element in subroutine JACØBI for position eigenvalues and eigenvectors (FØP = $1. \times 10^{-15}$)

FØV - A value to be used as an off-diagonal annihilation element in subroutine JACØBI for velocity eigenvalues and eigenvectors (FØV = $1. \times 10^{-25}$)

6. Covariance variables (filter, or assumed, covariances)

P(6,6) - Initial P (position and velocity) covariance matrix. Referenced to inertial frame (diag P = 1.,1.,1., $1. \times 10^{-4}$, $1. \times 10^{-4}$, $1. \times 10^{-4}$)

The structure of the following eight parameter covariance matrix partitions must correspond to the structure of the solve-for, dynamic-consider, and measurement-consider parameter vectors.

PS(12,12) - Initial P_S (solve-for parameter) covariance matrix (PS = identity matrix)

UO(8,8) - Initial U_o (dynamic-consider parameter) covariance matrix (UO = identity matrix)

VO(15,15) - Initial V_o (measurement-consider parameter) covariance matrix (VO = identity matrix)

CXXS(6,12)	- Initial C_{xx_s} covariance matrix (CXXS = 0)
CXU(6,8)	- Initial C_{xu} covariance matrix (CXU = 0)
CXV(6,15)	- Initial C_{xv} covariance matrix (CXV = 0)
CXSU(12,8)	- Initial $C_{x_s u}$ covariance matrix (CXSU = 0)
CXSV(12,15)	- Initial $C_{x_s v}$ covariance matrix (CXSV = 0)
IGAIN	- Filter gain generator code (IGAIN = 1) = 1 - Kalman-Schmidt filter = 2 - Equivalent recursive weighted least-squares consider filter (available only if subroutine GAIN2 has been loaded)
IDNF	- Dynamic noise flag (IDNF = 0) = 0 - Dynamic noise is zero = 1 - Dynamic noise is not zero
DNCN(3)	- Array of constants used to calculate dynamic noise covariance matrix; must be specified if IDNF equals 1
IMNF	- Measurement noise flag (IMNF = 0) = 0 - Measurement noise is constant = 1 - Measurement noise is not constant (option is not available with this program)

MNCN(12) - Array of variances for each type of measurement. If not specified, the following values are assumed:

MNCN(1)	=	$1. \times 10^{-6}$	Range (idealized station)
(2)	=	$1. \times 10^{-12}$	Range rate (idealized station)
(3)	=	$1. \times 10^{-6}$	Range (station 1)
(4)	=	$1. \times 10^{-12}$	Range rate (station 1)
(5)	=	$1. \times 10^{-6}$	Range (station 2)
(6)	=	$1. \times 10^{-12}$	Range rate (station 2)
(7)	=	$1. \times 10^{-6}$	Range (station 3)
(8)	=	$1. \times 10^{-12}$	Range rate (station 3)
(9)	=	2.5×10^{-9}	Star-planet angle 1
(10)	=	2.5×10^{-9}	Star-planet angle 2
(11)	=	2.5×10^{-9}	Star-planet angle 3
(12)	=	2.5×10^{-9}	Apparent planet diameter

SIGRES - Variance of resolution execution error (SIGRES = $4. \times 10^{-8}$)

SIGPRØ - Variance of proportionality execution error (SIGPRØ = .0001)

SIGALP - Variance of pointing angle alpha execution error (SIGALP = .0043625 radians^2)

SIGBET - Variance of pointing angle beta execution error (SIGBET = .0043625 radians^2)

PSIGS - Variance of resolution execution error for pulsing engine (PSIGS = $4. \times 10^{-8}$)

PSIGK - Variance of proportionality execution error for pulsing engine (PSIGK = .0001)

PSIGA - Variance of pointing angle alpha execution error for pulsing engine (PSIGA = .0043625 radians^2)

PSIGB - Variance of pointing angle beta execution error for pulsing engine (PSIGB = .0043625 radians^2)

IGEN - Code that indicates if a generalized covariance analysis is to be performed (IGEN = 0)

= 0 - No generalized covariance analysis
= 1 - Generalized covariance analysis

7. Print codes

DELTP - Trajectory print interval in days (DELTP = 1. x 10^{50})

INPR - Trajectory print interval in increments (INPR = 100000)

IPRINT - Measurement print interval; measurement information printed every IPRINT measurements (IPRINT = 1)

KPRINT - Correlation matrix print code (KPRINT = 0)

= 0 - Print out P and P_S correlation matrices and standard deviations at a measurement
= 1 - Print out all correlation matrices and standard deviations at a measurement

IPRT - Array of print codes (IPRT = 1,1,1,1)

IPRT(I) = 1 - Print out information
= 0 - Do not print out information

I = 1 Ephemeris data
2 Spacecraft trajectory relative to planets
3 Virtual-mass data
4 Navigation parameters (TRAPAR called)

8. Guidance event variables

NEV3 - Number of guidance events (NEV3 = 0)

T3(10) - Array of times at which guidance events occur; specified only if NEV3 is nonzero. Chronological order required

ICDQ3(10) - Array of codes for guidance events to determine how the execution error covariance matrix is to be calculated. These codes must correspond to the elements of the T3 array and need be specified only if the T3 array has been specified (ICDQ3 = array of 1's)

= 0 - Calculated directly from velocity correction covariance matrix
= 1 - Calculated from the eigenvector corresponding to the maximum eigenvalue of the velocity correction covariance matrix

IGUID(5,10) - Array of guidance event codes. This array is defined more explicitly below for the I-th guidance event occurring at time T3(I)

IGUID(1,I)
= 1 - Fixed-time-of-arrival midcourse guidance event
2 - Two-variable B-plane midcourse guidance event
3 - Three-variable B-plane midcourse guidance event
4 - Planar orbital insertion decision event
5 - Nonplanar orbital insertion decision event
6 - Externally supplied velocity change event
7 - Retargeting event

IGUID(2,I)
= 0 - Linear guidance
1 - Nonlinear guidance

IGUID(3,I) = 0 - Planetary quarantine constraints not in effect
1 - Planetary quarantine constraints in effect; use linear guidance to achieve biased aimpoint
2 - Planetary quarantine constraints in effect; use nonlinear guidance to achieve biased aimpoint

IGUID(4,I) = 1 - Single impulse thrust model
2 - Pulsing thrust model
3 - Finite burn (not available)

IGUID(5,I) = 1 - Execute event only
2 - Compute event only
3 - Compute and execute event
4 - Compute, but execute event later

The IGUID(J,I) array cannot be chosen arbitrarily, but must conform to the following table of permissible combinations.

IGUID(1,I)	IGUID(2,I)	IGUID(3,I)	IGUID(4,I)	IGUID(5,I)
1, 2, 3	0	0, 1, 2	1, 2	2, 3
4, 5	---	0	1, 2	2, 4
6	---	0	1, 2	1
7	---	0	1, 2	2, 3

Additional restrictions on the IGUID(J,I) array are listed below:

a. ICDQ3(I) must be set to 1 if IGUID(3,I) ≠ 0.

b. Only one orbital insertion event may occur, and it must be the final guidance event.

c. An externally supplied velocity change event may not be preceded by a midcourse guidance event if the original nominal does not pierce the target planet sphere of influence. Note also that nominal target conditions TNØMB and TNØMC are not altered when an externally supplied velocity change event occurs.

No additional guidance variables are required if the guidance event is a linear impulsive midcourse guidance event subject to no planetary quarantine constraints. Other types of guidance events require that some of the following guidance variables be specified:

LKTAR(6,10)	-	Array defining target parameters, identical to KTAR in NOMNAL
XTAR(6,10)	-	Desired target value; identical to TAR in NØMNAL
XPERV(10)	-	Velocity perturbation used to compute targeting matrix; identical to PERV in NØMNAL
XDVMAX(10)	-	Maximum allowable velocity correction; identical to DVMAX in NØMNAL
LNPAR(10)	-	Number of target parameters desired; identical to NPAR in NØMNAL
LLVLS(10)	-	Number of integration accuracy levels used; identical to LVLS in NØMNAL
TGT3(10)	-	Desired target times; referenced to initial trajectory time
DELV(3,10)	-	Array of externally supplied velocity changes (DELV = array of zeros)
TNØMB(3)	-	Nominal B-plane target conditions: B·T, B·R, and t_{SI}
TNØMC(7)	-	Nominal closest approach target conditions: $\vec{R}_{CA}$, $\vec{V}_{CA}$, and t_{CA}
PRØBI	-	Allowable probability of impact (PRØBI = 1.)
IDENS	-	Code defining method of treating probability density function in subroutine BIAIM. Option not available at present (IDENS = 1)
PULMAG	-	Magnitude of pulsing engine thrust

PULMAS - Nominal mass of spacecraft

DUR - Duration of single pulse

DTI - Time interval between pulses

List of required variables for guidance events other than linear impulsive midcourse guidance events subject to no planetary quarantine constraints:

a. Retargeting: LKTAR, XTAR, XTØL, XAC, LNPAR, XPERV, XDVMAX, LLVLS, TGT3.

b. Nonlinear guidance: XTØL, XAC, XPERV, XDVMAX, LLVLS, TNØMB, TNØMC.

c. Orbital insertion: XTAR.

d. Biased aimpoint guidance (planetary quarantine): PRØBI, TNØMB, TNØMC, TINJ, IDENS.

e. Pulsing thrust model: PULMAG, PULMAS, DUR, DTI, PSIGS, PSIGK, PSIGA, PSIGB.

f. Externally supplied velocity change: DELV.

9. Probe release events

T6 - Time of main probe release event

T7 - Time of miniprobe release event

PMN(12) - Array of main probe measurement noise variances for each type of measurement. PMN(I) refers to same measurement type as MNCN(I) and is preset to the same values

IPMN - Main probe measurement noise code (IPMN = 0)

= 0 - PMN array will be set equal to MNCN array
= 1 - PMN array will be specified in the namelist

SMN(12) - Array of miniprobe measurement noise variances for each type of measurement. SMN(I) refers to same measurement type as MNCN(I) and is preset to the same values

ISMN - Miniprobe measurement noise code (ISMN = 0)

= 0 - SMN array will be set equal to MNCN array
= 1 - SMN array will be specified in the namelist

See section 4 for definitions of NENT1 and NENT2.

XEE(5) - Miniprobe release execution error variances

XEE(1) : spin rate variance
XEE(2) : boom length variance
XEE(3) : spin axis right ascension variance
XEE(4) : spin axis declination variance
XEE(5) : release angle variance

YYL - Miniprobe boom length

TIMPCT - Approximate probe impact (trajectory) time. Can be obtained from a NØMNAL run

RPS - Probe sphere radius; equals planet radius plus altitude of probe above planet surface at entry

IUTC - Miniprobe targeting code (IUTC = 0)

= 0 - Target controls computed internally
= 1 - Target controls supplied by user

The next four variables are user-supplied miniprobe target controls and must be specified only if IUTC = 1.

XPHI - Miniprobe release angle

ABW - Miniprobe spin rate magnitude

ALFA - Right ascension of spin axis relative to the ecliptic coordinate system

DELT - Declination of spin axis relative to the ecliptic coordinate system

The remaining variables are required for internal miniprobe targeting and must be specified only if IUTC = 0.

ACTPP - Accuracy level for virtual-mass propagation for miniprobe targeting (ACTPP = 2.5×10^{-5})

IPRØPI - Trajectory propagation code (IPRØPI = 1)

= 1 - Conic propagation
= 2 - Initial conic propagation with virtual-mass propagation refinement

IPCSK - Code that specifies planetocentric coordinate system relative to which miniprobe targets are defined (IPCSK = 1)

= 1 - Subsolar orbital-plane coordinate system
= 2 - Equatorial coordinate system

RATP(3) - Array of right ascensions of the three miniprobe targets relative to the coordinate system specified by IPCSK

DCTP(3) - Array of declinations of the three miniprobe targets relative to the coordinate system specified by IPCSK

ISAØ - Spin axis orientation flag (ISAØ = 1)

= 1 - Spin axis declination and right ascension are free controls
= 2 - Spin axis is aligned with spacecraft velocity vector at release

= 3 - Spin axis is perpendicular to the spacecraft-sun line, parallel to the ecliptic plane, and within 90° of the spacecraft velocity vector at release

= 4 - Spin axis declination and right ascension are fixed by user-specified values of DCSAF and RASAF

DCSAF - Fixed spin axis declination at release; specified only if ISAØ = 4

RASAF - Fixed spin axis right ascension at release; specified only if ISAØ = 4

SO - Step size upper bound in the control space (SO = 0.1)

WFLS(3) - Miniprobe target site weighting factors that indicate the relative importance of impacting each of the three target sites

3.2.2 Measurement Schedules

Three successive measurement schedules must appear immediately after the namelist ERRAN section. The first schedule appears on NENT cards and defines the measurement schedule for the primary vehicle. Immediately following these NENT cards are NENT1 cards that define the main probe measurement schedule. Following the NENT1 cards are NENT2 cards that define the single measurement schedule for all three miniprobes.

Each card defines an entry in the measurement schedule according to the following format:

From DAY1 (F10.0) to DAY2 (F10.0), every X (F10.0) days, measurement code ITRK (I10).

The measurement codes are defined as follows:

ITRK = 1 - Range rate (idealized station)

2 - Range and range rate (idealized station)

3 - Range rate (station 1)

= 4 - Range and range rate (station 1)
5 - Range rate (station 2)
6 - Range and range rate (station 2)
7 - Range rate (station 3)
8 - Range and range rate (station 3)
9 - Three star-planet angles
10 - Apparent planet diameter
11 - Star-planet angle 1
12 - Star-planet angle 2
13 - Star-planet angle 3

The total number of primary vehicle measurements must not exceed 1000, and measurement times must not coincide. The total number of main probe measurements must not exceed 100. The total number of miniprobe measurements must not exceed 100.

3.2.3 Namelist GENRAL

GP(6,6) - Actual spacecraft position/velocity covariance matrix P'_o (GP = P)

GPS(12,12) - Actual solve-for parameter covariance matrix P'_s (GPS = PS)

GU(8,8) - Actual dynamic-consider parameter covariance matrix V'_o (GU = VO)

GV(15,15) - Actual measurement-consider parameter covariance matrix V'_o (GV = VO)

GW(12,12) - Actual ignore parameter covariance matrix W'_o (GW = identity matrix)

GCXXS(6,12) - Actual state/solve-for parameter covariance matrix C'_{xx_s} (GCXXS = CXXS)

GCXU(6,8) - Actual state/dynamic-consider parameter covariance matrix C'_{xu} (GCXU = CXU)

GCXV(6,15) - Actual state/measurement-consider parameter covariance matrix C'_{xv} (GCXV = CXV)

GCXW(6,12) - Actual state/ignore parameter covariance matrix C'_{xw} (GCXW = 0)

GCXSU(12,8) - Actual solve-for parameter/dynamic-consider parameter covariance matrix $C'_{x_s u}$ (GCXSU = CXSU)

GCXSV(12,15) - Actual solve-for parameter/measurement-consider parameter covariance matrix $C'_{x_s v}$ (GCXSV = CXSV)

GCXSW(12,12) - Actual solve-for parameter/ignore parameter covariance matrix $C'_{x_s w}$ (GCXSW = 0)

GCUV(8,15) - Actual dynamic-consider parameter/measurement-consider parameter covariance matrix C'_{uv} (GCUV = 0)

GCUW(8,12) - Actual dynamic-consider parameter/ignore parameter covariance matrix C'_{uw} (GCUW = 0)

GCVW(15,12) - Actual measurement-consider parameter/ignore parameter covariance matrix C'_{vw} (GCVW = 0)

EXI(6) - Actual spacecraft position/velocity deviation mean $\bar{x}'_o$ (EXI = 0)

EXSI(12) - Actual solve-for parameter deviation mean $\bar{x}'_{s_o}$ (EXSI = 0)

EU(8) - Actual dynamic-consider parameter deviation mean $\bar{u}'_o$ (EU = 0)

EV(15) - Actual measurement-consider parameter deviation mean $\bar{v}'_o$ (EV = 0)

EW(12) - Actual ignore parameter deviation mean $\bar{w}'_o$ (EW = 0)

IGDNF	- Actual dynamic noise flag (IGDNF = IDNF) = 0 - Actual dynamic noise is zero = 1 - Actual dynamic noise is not zero
GDNCN(3)	- Array of constants used to calculate actual dynamic noise covariance matrix; must be specified if IGDNF equals 1
IGMNF	- Actual measurement noise flag (IGMNF = 0) = 0 - Actual measurement noise is constant = 1 - Actual measurement noise is not constant (option is not available with this program)
GMNCN(12)	- Actual measurement noise variance for each type of measurement. GMNCN(I) refers to same measurement type as MNCN(I) (GMNCN = MNCN)
EVK	- Actual proportionality execution error mean (EVK = 0.)
EVS	- Actual resolution execution error mean (EVS = 0.)
EVA	- Actual pointing angle alpha execution error mean (EVA = 0.)
EVB	- Actual pointing angle beta execution error mean (EVB = 0.)
VARK	- Actual proportionality execution error variance (VARK = SIGPRØ)
VARS	- Actual resolution execution error variance (VARS = SIGRES)
VARA	- Actual pointing angle alpha execution error variance (VARA = SIGALP)
VARB	- Actual pointing angle beta execution error variance (VARB = SIGBET)

3.3 SIMUL Input Description

The input of the simulation program consists of:

a. A card containing the variable IRUNX (I10 field) that indicates how many different runs are to be made and is read only once.

b. A card containing the problem identification variable IPRØB (I10 field) that precedes each set of input data.

c. A simulation namelist section entitled SIMUL.

d. Three successive measurement schedules for the primary vehicle, main probe, and miniprobes in that order.

Namelist SIMUL contains all variables appearing in namelist ERRAN except for the variables ICDQ3 and IGEN. No generalized covariance variables may appear in namelist SIMUL and no element of the IAUGIN array may be set to 3. The variable IGUID(2,I) may also take on the variable 1 for IGUID(1,I) = 1, 2, or 3. Variables appearing in namelist SIMUL, but not in namelist ERRAN, are defined below.

1. Actual trajectory variables

NBØD1	- Number of celestial bodies considered in the generation of the actual trajectory (NBØD1 = 11)
NB1(11)	- Array of codes of celestial bodies considered in the generation of the actual trajectory; NB1 codes defined identically to NB codes (NB1 = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11)
ACC1	- Actual trajectory accuracy figure (ACC1 = 1.0×10^{-6})
ADEVX(6)	- Actual initial position and velocity deviations from the most recent nominal trajectory (ADEVX = 0, 0, 0, 0, 0, 0)

2. Actual dynamic biases

DMUSB	- Actual bias in the gravitational constant of the sun (DMUSB = 0.)
DMUPB	- Actual bias in the gravitational constant of the target planet (DMUPB = 0.)
DAB	- Actual bias in the semimajor axis of the target planet (DAB = 0.)
DEB	- Actual bias in the eccentricity of the target planet (DEB = 0.)
DIB	- Actual bias in the inclination of the target planet (DIB = 0.)
DNØB	- Actual bias in the longitude of the ascending node of the target planet (DNØB = 0.)
DWB	- Actual bias in the argument of periapsis of the target planet (DWB = 0.)
DMAB	- Actual bias in the mean anomaly of the target planet (DMAB = 0.)
TTIM1	- The first time at which the values used for the actual unmodeled acceleration will be altered (TTIM1 = 1. x 10^{50})
TTIM2	- The second time at which the values used for the actual unmodeled acceleration will be altered (TTIM2 = 1. x 10^{50})
UNMAC(3,3)	- Array of actual unmodeled accelerations to be used over a given time interval. Each row defines the values used over a given time interval; columns define the X, Y, and Z components of the unmodeled acceleration (UNMAC = array of zeros)

3. Actual measurement biases and variances

BIA(12) - Array of actual biases for each type of measurement (BIA = array of zeros). The following association exists:

BIA(1) = Range bias (idealized station)
(2) = Range-rate bias (idealized station)
(3) = Range bias (station 1)
(4) = Range-rate gias (station 1)
(5) = Range bias (station 2)
(6) = Range-rate bias (station 2)
(7) = Range bias (station 3)
(8) = Range-rate bias (station 3)
(9) = Star-planet angle 1 bias
(10) = Star-planet angle 2 bias
(11) = Star-planet angle 3 bias
(12) = Apparent planet diameter bias

SLB(9) - Array of actual biases in the locations of the three tracking stations on the rotating earth (SLB = array of zeros). The following association exists:

SLB(1) = Station 1 altitude bias
(2) = Station 1 latitude bias (degrees north)
(3) = Station 1 longitude bias (degrees east)
(4) = Station 2 altitude bias
(5) = Station 2 latitude bias (degrees north)
(6) = Station 2 longitude bias (degrees east)
(7) = Station 3 altitude bias
(8) = Station 3 latitude bias (degrees north)
(9) = Station 3 longitude bias (degrees east)

IAMNF - Actual measurement noise code (IAMNF = 0)

= 0 - Actual measurement noise has same statistics assumed by the navigation process (as represented by the MNCN array and the R_k covariance matrix)

= 1 - Actual measurement noise has different statistics from those assumed by the navigation process. These statistics are defined by the AVARM array

AVARM(12) - Array of actual variances for each type of measurement; specified only if IAMNF = 1. The following association exists:

AVARM(1) = Range variance (idealized station)
(2) = Range-rate variance (idealized station)
(3) = Range variance (station 1)
(4) = Range-rate variance (station 1)
(5) = Range variance (station 2)
(6) = Range-rate variance (station 2)
(7) = Range variance (station 3)
(8) = Range-rate variance (station 3)
(9) = Star-planet angle 1 variance
(10) = Star-planet angle 2 variance
(11) = Star-planet angle 3 variance
(12) = Apparent planet diameter variance

4. Actual midcourse velocity correction errors

ARES(10)	- Array of actual resolution execution errors. The elements of this array and the following three arrays must correspond to the elements of the T3 array and need be specified only if the T3 array has been specified (ARES = array of zeros)
APRØ(10)	- Array of actual proportionality execution errors (APRØ = array of zeros)
AALP(10)	- Array of actual pointing angle alpha execution errors (AALP = array of zeros)
ABET(10)	- Array of actual pointing angle beta execution errors (ABET = array of zeros)

5. Quasi-linear filtering event variables

NEV5	- Number of quasi-linear filtering events (NEV5 = 0)
T5(20)	- Array of times at which quasi-linear filtering events occur; specified only if NEV5 is nonzero. Chronological order required

6. Probe release event variables

PAVARM(12)	- Array of actual main probe measurement noise variances for each measurement type. PAVARM(I) refers to same measurement type as AVARM(I) and is preset to the same values
SAVARM(12)	- Array of actual miniprobe measurement noise variances for each measurement type. SAVARM(I) refers to same measurement type as AVARM(I) and is preset to the same values

PBIA(12) - Array of actual main probe biases for each measurement type. PBIA(I) refers to same measurement type as BIA(I) and is preset to the same values.

SBIA(12) - Array of actual miniprobe biases for each measurement type. SBIA(I) refers to same measurement type as BIA(I) and is preset to the same values

The next five variables define the actual miniprobe release execution errors:

DW - Actual spin-rate execution error (DW = 0.)

DA - Actual spin axis right ascension execution error (DA = 0.)

DD - Actual spin axis declination execution error (DD = 0.)

DP - Actual release angle execution error (DP = 0.)

DL - Actual boom length error (DL = 0.)

NQLE(2) - Number of probe quasi-linear filtering events. NQLE(1) = number of main probe quasi-linear filtering events. NQLE(2) = number of miniprobe quasi-linear filtering events

QLTIM(2,10) - Array of probe quasi-linear filtering event times. QLTIM(1,I) defines the sequence of event times for the main probe. QLTIM(2,I) defines the sequence of event times for the miniprobe. Event times must be arranged in chronological order

3.3 SIMUL Input Description

The input of the simulation program consists of (a) a card containing the variable IRUNX (I10 field) which indicates how many different runs are to be made and is read only once, (b) a card containing the problem identification variable IPROB (I10 field) which precedes each set of input data, (c) a namelist entitled SIMUL, and (d) a measurement schedule. The measurement schedule is treated exactly the same way as it is treated in the error analysis program. Namelist SIMUL contains all variables appearing in namelist ERRAN except for the variable ICDQ3. In addition, IGUID(2,I) can also take on the value 1 for IGUID(1,I) = 1,2, or 3.

Variables appearing in namelist SIMUL, but not in namelist ERRAN, are defined below.

a. Actual trajectory variables

NBOD1 - Number of celestial bodies considered in the generation of the actual trajectory. (NBOD1 = 11)

NB1(11) - Array of codes of celestial bodies considered in the generation of the actual trajectory; NB1 codes defined identically to NB codes. (NB1 = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11)

ACC1 - Actual trajectory accuracy figure. (ACC1 = 1.0×10^{-6})

ADEVX(6) - Actual initial position and velocity deviations from the most recent nominal trajectory. (ADEVX = 0, 0, 0, 0, 0, 0)

b. Actual dynamic biases

DMUSB - Actual bias in the gravitational constant of the Sun. (DMUSB = 0.)

DMUPB - Actual bias in the gravitational constant of the target planet. (DMUPB = 0.)

DAB - Actual bias in the semi-major axis of the target planet. (DAB = 0.)

DEB - Actual bias in the eccentricity of the target planet. (DEB = 0.)

DIB - Actual bias in the inclination of the target planet. (DIB = 0.)

DNØB - Actual bias in the longitude of the ascending node of the target planet. (DNØB = 0.)

DWB - Actual bias in the argument of periapsis of the target planet. (DWB = 0.)

DMAB - Actual bias in the mean anomaly of the target planet. (DMAB = 0.)

TTIM1 - The first time at which the values used for the actual unmodeled acceleration will be altered. (TTIM1 = 1. x 10^{50})

TTIM2 - The second time at which the values used for the actual unmodeled acceleration will be altered. (TTIM2 = 1. x 10^{50})

UNMAC(3,3) - Array of actual unmodeled accelerations to be used over a given time interval. Each row defines the values used over a given time interval; columns define the X, Y, and Z components of the unmodeled acceleration. (UNMAC = array of zeros)

c. Actual measurement biases and variances

BIA(12) - Array of actual biases for each type of measurement. (BIA = array of zeros) The following association exists:

BIA(1) = Range bias (idealized station)
(2) = Range-rate bias (idealized station)
(3) = Range bias (station 1)
(4) = Range-rate bias (station 1)
(5) = Range bias (station 2)
(6) = Range-rate bias (station 2)
(7) = Range bias (station 3)
(8) = Range-rate bias (station 3)
(9) = Star-planet angle 1 bias
(10) = Star-planet angle 2 bias
(11) = Star-planet angle 3 bias
(12) = Apparent planet diameter bias

SLB(9) - Array of actual biases in the locations of the three tracking stations on the rotating earth. (SLB = array of zeros) The following association exists:

SLB(1) = Station 1 altitude bias
(2) = Station 1 latitude bias (degrees north)
(3) = Station 1 longitude bias (degrees east)
(4) = Station 2 altitude bias
(5) = Station 2 latitude bias (degrees north)
(6) = Station 2 longitude bias (degrees east)
(7) = Station 3 altitude bias
(8) = Station 3 latitude bias (degrees north)
(9) = Station 3 longitude bias (degrees east)

IAMNF - Actual measurement noise code. (IAMNF = 0)

= 0 - Actual measurement noise has same statistics assumed by the navigation process (as represented by the MNCN array and the R_k covariance matrix).
= 1 - Actual measurement noise has different statistics from those assumed by the navigation process. These statistics are defined by the AVARM array.

AVARM(12) - Array of actual variances for each type of measurement; specified only if IAMNF = 1. The following association exists:

AVARM(1) = Range variance (idealized station)
(2) = Range-rate variance (idealized station)
(3) = Range variance (station 1)
(4) = Range-rate variance (station 1)
(5) = Range variance (station 2)
(6) = Range-rate variance (station 2)
(7) = Range variance (station 3)
(8) = Range-rate variance (station 3)
(9) = Star-planet angle 1 variance
(10) = Star-planet angle 2 variance
(11) = Star-planet angle 3 variance
(12) = Apparent planet diameter variance

d. Actual midcourse velocity correction errors

ARES(10) - Array of actual resolution errors. The elements of this array and the following three arrays must correspond to the elements of the T3 array and need be specified only if the T3 array has been specified. (ARES = array of zeros)

APRO(10) - Array of actual proportionality errors. (APRO = array of zeros)

C.2

AALP(10) - Array of actual pointing angle alpha errors. (AALP = array of zeros)

ABET(10) - Array of actual pointing angle beta errors. (ABET = array of zeros)

e. Quasi-linear filtering event variables

NEV5 - Number of quasi-linear filtering events. (NEV5 = 0)

T5(20) - Array of times at which quasi-linear filtering events occur; specified only if NEV5 is non-zero.

4. OUTPUT DESCRIPTION

4.1 NOMNAL Output Description

The output from the nominal trajectory generator NOMNAL is conveniently divided into seven sections -- initial data, interplanetary zero iterate, lunar zero iterate generation, nominal trajectory data, nonlinear guidance, orbit insertion, execution of a correction, and miniprobe targeting. Each of these sections will be discussed individually.

a. Initial Data

The namelist TARIN is first printed out as the data are input. Then much of the data with useful extensions are recorded in unified sections. More specific definitions of the input data are given in the Input Description Section. The trajectory parameters are first recorded.

ALNGTH	Length units per AU for trajectory output
TM	Time units per day for trajectory output
NBOD	Number of bodies used in integration
NB	Array of codes of gravitational bodies
IBARY	Flag indicating whether inertial system is heliocentric ecliptic (IBARY = 0) or barycentric ecliptic (IBARY = 1)
ICOORD	Flag not currently used
NCPR	Integration increments between printouts of nominal trajectory
TMPR	Days between printouts of nominal trajectory

Next the zero iterate data are printed, including the initial state itself and the parameters necessary to compute it.

IZERO	Flag designating which option of zero iterate generation was used
ZDAT(6)	Zero iterate state (inertial ecliptic) generated

RP	Parking orbit radius
FI	Injection true anomaly
A1	Angle of first burn
A2	Angle of second burn
T1	Time interval of first burn
T2	Time interval of second burn
LAT	Latitude of launch site
LON	Longitude of launch site
THD	Rotation rate of launch planet
RAT	Inverse rate in parking orbit
AZI	Launch azimuth

Then for each guidance event to be processed (KTIM $\neq 0$), the following data are recorded.

EVENT TYPE	Value of KTYP flag designating whether event is targeting, retargeting, orbit insertion, main-probe propagation, mini-probe targeting, or termination
REF TIME	Value of TIMG, giving time interval between event and reference epoch
REF CODE	Value of KTIM, designating the epoch to which event times are referenced (initial time, SOI, CA)
EVENT (TARGET) CALENDAR DATE	The calendar date of the event (target time)
EVENT (TARGET) JULIAN DATE	The Julian date (epoch 1900) of the guidance event (target time)
EVENT (TARGET) TRAJ DAY	The time of the guidance event (target time) referenced to the initial time

CONTROL	Code indicating which of the two possible sets of velocity control variables are to be used
IMP	Implementation code giving the compute-execute mode KMXQ
MOD	Model to be used in execution (MDL)
TAR KEY	Target parameter keys (KTAR)
TAR1, TAR2, TAR3	Desired values of target parameters (TAR)
TOL1, TOL2, TOL3	Allowable tolerances of target parameters (TOL)
DVX, DVY, DVZ	Velocity components (inertial ecliptic) of correction supplied externally (KMXQ = 2)
MAT, BAD, ITS, BIT	Values of targeting matrix option (MAT), bad-step option (IBADS), iterations (NOIT) and bad iterations (MAXB)

b. Interplanetary Zero Iterate

The massless planet (or point-to-point) approximation is used as a zero iterate for interplanetary trajectories. Since these data are printed in SPARC, it is convenient to record the zero iterate information in the same format as SPARC. The launch date, arrival date, and flight time are self explanatory. The heliocentric parameters are listed.

RL, RP	Heliocentric radius of initial and final points (10^6 km)
LAL, LAP	Heliocentric ecliptic latitude of initial and final points
LOL, LOP	Heliocentric ecliptic longitude of initial and final points
VL, VP	Heliocentric speeds at initial and final points (km/s)
GAL, GAP	Flightpath angles at initial and final points

AZL, AZP	Azimuth at initial and final points
HCA	Heliocentric central angle of transfer
TAL, TAP	True anomaly at initial and final points
SMA	Semimajor axis of heliocentric conic (10^6 km)
ECC	Eccentricity of heliocentric conic
INC	Heliocentric ecliptic inclination of conic
RCA	Perihelion of conic (10^6 km)
APO	Aphelion of conic (10^6 km)
V1	Heliocentric speed of launch planet (if applicable)
V2	Heliocentric speed of target planet (if applicable)

The data defining the launch planet conic are then listed:

C3	The launch energy (= VHL^2)
VHL	The hyperbolic excess velocity (km/s)
DLA	The declination of the departure asymptote
RAL	The right ascension of the departure asymptote
RAD	The injection radius with respect to the launch planet (km)
VEL	The injection velocity with respect to the launch planet (km/s)
PTH	The injection path angle
VHP	The hyperbolic excess velocity at the target planet
DPA	The declination of the approach asymptote (heliocentric ecliptic)

RAP	The right ascension of the approach asymptote (heliocentric ecliptic)
ECC	The eccentricity of the launch planet conic
LNCH AZMTH	The launch azimuth
LNCH TIME	The time of launch on the launch date
L-I TIME	The time between launch and injection (seconds)
INJ LAT	The injection latitude
INJ LONG	The injection longitude
INJ RT ASC	The right ascension at injection
INJ TIME	The time at injection on the launch date
PO CST TIM	The parking orbit coast time (sec)

c. Lunar Zero Iterate Generation

The zero iterate generation for lunar trajectories proceeds in two stages. The first stage determines iteratively a targeted patched conic; the second stage generates a targeted multi-conic trajectory. The following information is recorded for each iterate and for each perturbed trajectory in the patched conic trajectory:

ITR	Iteration counter
ALPHA, DELTA, THETA	Controls used on current trajectory (see LUNCON, LUNTAR)
SIGMA	Launch azimuth
SMA, RCA, INC	Semimajor axis, radius of closest approach, and equatorial inclination of current iterate
VSI (1, 2, 3)	Hyperbolic approach velocity of current iterate
B•T, B•R	Impact plane parameters (earth equatorial) of current iterate

Following the perturbed trajectories a summary of the targeting data for that iterate is listed

PHI MATRIX	Sensitivity matrix from numerical differencing
PHI INVERSE	Targeting matrix (inverse of sensitivity matrix)
ERRORS	The current errors in semimajor axis, B•T and B•R from the desired values
TARGETS	The desired values of semimajor axis, B•T and B•R
CORRECTION	The correction to be added to the controls for the next iterate

In the initial targeting to semimajor axis the numerical partial of semimajor axis to the alpha control is recorded as PARTA.

During the multi-conic stage of targeting slightly different information is recorded. Initially the targeting scheme is described:

TARGETS	Desired values of semimajor axis, inclination, radius of closest approach, and time of closest approach
TOLERANCES	Acceptable tolerances of semimajor axis, B•T, B•R, and t_{CA}
PERTURBATIONS	Perturbations used in constructing the first targeting matrix (later iterations use a perturbation which for each component would null the time error if the previous sensitivity matrix were still valid)
MAX STEPS	Maximum correction allowed on first iterate (later iterations use 100 times the perturbation size)
MAX ITERS	Maximum number of iterations allowed in multi-conic targeting
MULTI-CONIC STEP	Step size in hours of multi-conic propagator

For each iterate and for each perturbed trajectory the following data is recorded:

ITER	Iteration counter
JULIAN DATE	Julian date of injection (referenced to 1950)
x, y, z, vx, vy, vz	Injection state in earth ecliptic coordinates
SMA, B•T, B•R, TCA	Target parameter values achieved on current trajectory (impact plane parameters in earth ecliptic coordinates)

Following the perturbed trajectories a summary of the current trajectory data is given.

SENSITIVITY MATRIX	Sensitivity matrix computed from numerical partials
TARGETING MATRIX	Targeting matrix (inverse of sensitivity matrix)
ERRORS	Errors in target parameters (a, B•T, B•R, t_{CA})
TARGETS	Target values of (a, B•T, B•R, t_{CA})
PREDICT	Predicted corrections
CORRECT	Actual correction added to controls after applying constraints

After obtaining an acceptable trajectory, a summary is given listing the injection Julian and calendar date and the injection state in both earth-centered and barycenter ecliptic coordinates.

d. Nominal Trajectory Data

The nominal trajectory can consist of up to five branches if the spacecraft is a conglomerate vehicle made up of a bus, main probe, and three miniprobes. The first branch corresponds to the bus trajectory, the second to the main probe, and the last three to the miniprobes. The propagation and concurrent printout of the bus trajectory between guidance events is directed by the subroutine TRJTRY. The virtual-mass propagation (VMP) initiation data are provided, together with the trajectory status information at intervals of NCPR integration steps and TMPR days.

A time-history of the main-probe trajectory is initiated by scheduling a main-probe propagation event. When the trajectory time reaches that at which the propagation event is scheduled, control is transferred to MPPROP. This subroutine then calls VMP to propagate and simultaneously record the trajectory of the main probe from its current state, which is identical to that of the bus, to its final stopping condition. The resulting trajectory history is preceded for identification purposes by the title "Main-Probe Propagation Event" followed by the heading "Main-Probe Approach Trajectory." It contains the usual VMP propagation-initiation and trajectory status data at fixed intervals of 100 integration steps and 5 days.

Finally histories of the three miniprobe trajectories for the minimum-miss release controls are provided without user scheduling. At completion of the miniprobe targeting, the subroutine TPRTRG directs VMP via TPPROP to provide the usual VMP time history for each of the miniprobe trajectories in succession, starting from the release state. The trajectory corresponding to the ith miniprobe is identified by the title "Miniprobe I Minimum-Miss Approach Trajectory." The intervals between trajectory state printouts are the same as for the main-probe history.

The standard trajectory information printed during a given call to the VMP, with the print flag set, is as follows:

1) Initiation data (provided only at the start of the propagation)

    a) The output length units per AU and time units per day,

    b) The number of gravitational bodies,

    c) The initial date of integration,

    d) The final date of integration,

    e) The initial trajectory time,

    f) The integration accuracy level,

g) The true anomaly increment in radians corresponding to the accuracy level;

2) Trajectory status data (provided at intervals of NCPR integration steps and TMPR days),

   a) Block 1 - Spacecraft inertial state,

      (1) The current trajectory time,

      (2) The cumulative number of integration increments used to this point,

      (3) The current spacecraft state (position vector, radius, velocity vector, and speed) in inertial (heliocentric or barycentric) ecliptic coordinates,

   b) Block 2 - Gravitational bodies states,

      (1) The current calendar date,

      (2) The current Julian date (reference year 0),

      (3) The current state of all gravitating bodies in inertial ecliptic coordinates,

   c) Block 3 - Spacecraft relative state,

      (1) The current state of the spacecraft relative to all gravitational bodies in inertial ecliptic coordinates,

   d) Block 4 - Virtual mass data,

      (1) The current state of the virtual mass in inertial ecliptic coordinates,

      (2) The current state of the spacecraft relative to the virtual mass in inertial ecliptic coordinates,

      (3) The Kepler (angular momentum) vector in inertial ecliptic coordinates,

      (4) The eccentricity vector in inertial ecliptic coordinates,

(5) The virtual mass magnitude and magnitude rate,

e) Block 5 - Virtual mass relative positions, which are the current position vector and radius of the virtual mass relative to all gravitational bodies,

f) Block 6 - Navigation parameters,

(1) Flightpath angle,

(2) Angle between relative velocity and plane of the sky,

(3) Geocentric declination,

(4) Earth/spacecraft/target planet angle,

(5) Antenna axis/earth angle,

(6) Antenna axis/limb of sun angle,

(7) Spacecraft occultation ratio for the sun and gravitational bodies.

e. Nonlinear Guidance

At a targeting or retargeting guidance event, the following general information is first printed:

1) The trajectory time, calendar date, and Julian date (reference 1900) of the current event;

2) The event codes of the current event including its index KUR, the type KTYP, the compute/execute flag KMXQ, and the model MDL;

3) The current spacecraft state in inertial ecliptic and all-gravitational body-centered ecliptic coordinates;

4) A listing of the targeting parameter key definitions;

5) The targeting specifications, including the target parameter keys, desired values, and tolerances;

6) The targeting scheme parameters, including the accuracy levels to be used, the maximum velocity movement allowed, and the bad-step flag.

For each trajectory generated during the course of a nonlinear guidance event the following data are recorded.

ACCURACY	The integration accuracy level used on the integration
VX, VY, VZ	The velocity components (inertial ecliptic) used on the integration
TAR(i), TAR(j), TAR(k)	The target parameter codes (i,j,k) and the corresponding values achieved on the integration
AUX(ℓ), AUX(m), AUX(n)	The auxiliary parameter codes (ℓ,m,n) and the corresponding values achieved on the integration
INCR	The number of integration increments in the integration

If the method used to target the trajectory is the Newton-Raphson technique, the nominal trajectory and the three perturbed trajectories used to generate the targeting matrix are recorded in the above format. If the velocity controls used are those relative to the current spacecraft launch-planetocentric velocity rather than to the heliocentric velocity, additional printout is supplied from the subroutine KTROL as follows.

STATE	Launch-planetocentric state of spacecraft in km and km/s
IOPT	Code signaling to KTROL which of the velocity controls C_1, C_2, and C_3 are to be perturbed
CON	Velocity control components. First component has units of km/s; the last two components have units of radians
DV	Control correction to the spacecraft launch planetocentric velocity vector in km/s

The following targeting information is printed after the last perturbed trajectory data of the current iteration and before the nominal data of the next.

SENSITIVITY MATRIX	The Jacobian matrix giving the sensitivities of the auxiliary targets to the velocity controls
TARGETING MATRIX	The inverse of the Jacobian matrix giving the sensitivities of the velocity controls to the auxiliary targets
AUX ERROR	The negatives of the errors of the current auxiliary target values from the desired values
VEL COR	The predicted ecliptic cartesian velocity correction (after the DVMAX constraint) in km/s
DES AUX VAL	The desired auxiliary target values
DES TAR VAL	The desired actual target values
TAR TOL	The actual target tolerances

Then the four trajectories of the next iterate are given and so on through the targeting.

If the targeting method is the steepest descent technique, five trajectories are printed out for each iterate. The first trajectory is the nominal or iterate trajectory. The next three trajectories are the perturbed trajectories used to compute the gradient vector. If the velocity controls are those relative to the launch-planetocentric state, the same additional information is printed by the subroutine KTROL with each trajectory as was described for the Newton-Raphson targeting scheme. The following data unique to the descent targeting technique are printed out for each iterate.

WEIGHTS	The weighting factors for the auxiliary parameters for the scalar error
PER-ERRS	The errors corresponding to each of the perturbed trajectories
GRADIENT	The gradient based on those perturbed trajectories

CON-GRAD	The conjugate gradient
DIRECTION	The unit vector in the direction of the correction
EN	The error of the nominal trajectory
DD	The directional derivative of the error in the correction direction
HB	The linearly predicted step size
EB	The error corresponding to the linearly predicted step size
HS	The predicted optimal step size
HH	The step size to be actually used
DELTAV	The actual correction to be made on the next iterate
AUX ERR	The auxiliary errors of the current iterate
D-AUX	The desired auxiliary parameter values
D-TAR	The desired target parameter values

The following diagnostic messages may be printed out during the targeting.

ENTER OUTER TARGETING	(The current iterate missed the target planet SOI)
RCA	The radius of closest approach to the target planet
ARTIFICIAL SOI	The SOI set up for outer targeting (= 1.2 RCA)
TCA	The time of closest approach to the target planet
ORIG TSI	The original target time at the SOI

MODIFIED TSI	The adjusted target time to hit the artificial SOI
EXIT OUTER TARGETING	(The outer targeting has been successfully accomplished; return and target to the original values)
BAD STEP - ITERATE MISSED SOI	(Since the current iterate missed the SOI when previous iterates intersected it, reduce the correction)
BAD STEP	(The current iterate has a larger error than the previous)
REDUCTION	The fractional reduction made in the velocity correction for a bad step
PREVIOUS ERROR	The previous error
CURRENT ERROR	The current error

f. Orbit Insertion

At the start of an orbit insertion event, the following general information is given:

1) The trajectory time, calendar date, and Julian date (referenced 1900) of the current event;

2) The event codes of the current event including its index KUR, the type KTYP, the compute/execute flag KMXQ, and the model MDL:

3) The current spacecraft state in inertial ecliptic and all-gravitational body-centered ecliptic coordinates;

4) The orbit insertion option selected (coplanar or non-planar) and the desired values of the target parameters (semimajor axis, eccentricity, and periapsis shift for coplanar, equatorial conic elements for the non-planar option.

The program then records a detailed description of all important states generated during the analysis of the orbit insertion. In this section all states refer to target planet-centered equatorial coordinates. The Cartesian state (X, Y, Z, R, VX, VY, VZ, V) provides the position vector, radius, velocity vector, and speed of the spacecraft with respect to the target body at the given epoch. The conic parameters (A, E, W, TA, I, N, RP, RA, TIME) supply the semimajor axis, eccentricity, argument of periapsis, true anomaly, inclination, longitude of the ascending node, periapsis radius, apoapsis radius, and time from periapsis of the target planet-centered conic at the given epoch. The terms used in the summary of both coplanar and nonplanar insertions are defined as follows:

1) The "decision state" is the Cartesian and conic state (on the approach hyperbola) of the spacecraft at the time at which the insertion event is computed;

2) The "target orbit" is the unmodified desired orbit. Obviously only the conic parameters may be given;

3) The "preinsertion state" is the predicted Cartesian and conic state on the hyperbola at the instant before a candidate impulsive correction;

4) The "postinsertion state" is the predicted Cartesian and conic state on the ellipse immediately following the candidate impulsive correction;

5) The "insertion velocity" is the impulsive velocity (equatorial) of a candidate solution;

6) The "errors" are the weighted scalar loss functions associated with each candidate solution;

7) The "selected correction" is the impulsive velocity (equatorial) having the minimum loss function and therefore chosen for execution.

In the coplanar insertion, the target orbit automatically lies in the plane of the approach asymptote. The shape of the target ellipse is determined by the desired values of semimajor axis and eccentricity. Its orientation is fixed by the desired periapsis shift from the approach hyperbola. There are two possibilities for solutions: either the hyperbola and ellipse intersect or they do not. In the former case there are two candidate solutions and the one with minimum delta velocity is chosen for execution. In the latter case three modifications of the target orbit leading to tangential solutions are analyzed: (1) vary periapsis while holding apoapsis constant, (2) vary apoapsis holding periapsis constant, and (3) vary semimajor axis while holding eccentricity constant. The weighting factors used are identical to the indices. When a candidate modification cannot lead to a tangential solution, a message to that effect is printed out.

In the nonplanar case the two points of intersection of the approach hyperbola and the desired plane are computed and recorded. If one of the points lies in the impossible region, that information is recorded. The candidate modifications of the target orbit discussed in the coplanar case are made to determine the optimal impulsive correction. The weights are the same as above with the extension that all corrections on the departure ray are doubled. Invalid candidate modifications are recorded.

g. Execution of Correction

At an execution event, the following information is recorded regardless of the model used.

1) The title "Execution Event" is written;

2) The impulsive velocity correction and its magnitude are recorded in inertial ecliptic coordinates;

3) The conic elements (semimajor axis, eccentricity, argument of periapsis, inclination, longitude of the ascending node, and true anomaly) of the spacecraft with respect to the dominant body in ecliptic coordinates before and after an impulsive addition of the correction is recorded;

4) If the dominant body is not the sun, the same information is listed in dominant body equatorial coordinates.

If the model used is the multiple thrusting arc, the following data are also written:

1) The thrust magnitude, the nominal mass of the spacecraft during the pulsing arc, the duration of a single pulse, and the resulting magnitude of the velocity increment are recorded;

2) The ecliptic components of the total velocity increment to be imparted, the nominal impulse of the series, and the final (partial) pulse of the series are listed;

3) The time information of the pulsing arc, including the calendar and Julian dates of the initiation, midpoint, and termination of the arc, are provided;

4) The terms of the f and g series used to propagate the launch and target bodies through the pulsing arc are given;

5) The pulse-by-pulse listing of the inertial ecliptic state following each of the pulses is given (propagation between pulses is perturbed conic);

6) The state computed by adding the correction impulsively at the nominal time of the correction and then propagating by the perturbed conic to the time at the end of the arc is provided for comparison;

7) The two final states of (5) and (6) are converted to conic elements for a final comparison of the two techniques.

h. Miniprobe Targeting

When a miniprobe targeting event is begun, the following general information is given:

1) The trajectory time, calendar date, and Julian date (epoch 1900) of the current event;

2) The event codes for the current event, including its index KUR, type KTYP, compute/execute flag KMXQ, and model MDL;

3) The current spacecraft (bus) state in heliocentric-ecliptic and gravitational-body-centered coordinates for all gravitating bodies (units are km and km/s);

4) Planetocentric ecliptic state of spacecraft (bus) at impact based on an n-body propagation from the release state (units are km and km/s);

5) Equivalent conic planetocentric ecliptic state of spacecraft (bus) at release in km and km/s.

Next, information from the Gauss least-squares routine is printed. This begins with a summary of procedure parameters.

Gauss Least-Squares Parameters

N	Number of control variables (preset at 4 for miniprobe targeting)
M	Number of constraint variables (preset at 6 for miniprobe targeting)
DELTA	Perturbation size used for all control variables in approximating the Jacobian matrix by divided differences (preset at 10^{-5} for miniprobe targeting)
C1	Weighting factor applied to length change of control vector in convergence criterion (preset at 10^4 for miniprobe targeting)
C2	Weighting factor applied to change in magnitude of miss index in convergence criterion (preset at 1 for miniprobe targeting)
EPS	Upper limit on weighted sum of change in length of control vector and change in magnitude of miss index in the convergence criterion (preset at 1 for miniprobe targeting)
SO	Upper bound on length of control correction above when a steepest-descent rather than a pseudo inverse step is taken (input by user for miniprobe targeting)
ITLIM	Maximum number of iterations permitted before the least-squares procedure is terminated (preset at 20 for miniprobe targeting)

Then a series of descriptions of the individual iterations is printed.

Individual Iteration Description

XN1	Nth iterate value of first control variable -- release roll angle of the first miniprobe in radians
XN2	Nth iterate value of the second control variable -- tangential release velocity in decameters/s
XN3	Nth iterate value of the third control variable -- inertial ecliptic declination of spacecraft spin axis at release in radians
XN4	Nth iterate value of the fourth control variable -- inertial ecliptic right ascension of spacecraft spin at release in radians
GRADN	Magnitude of the gradient of the miss index at the nth iterate
YN	Value of miss index at the nth iterate in km^2
PHI(j)	Jth component of constraint (miss) vector printed at the iteration point itself as well as at those points obtained from it by successively perturbing each component by DELTA (units are km)
JACOBIAN MATRIX	Jacobian matrix of constraint vector with respect to control vector as obtained by divided differencing
PROJECTION MATRIX	Pseudoinverse of Jacobian matrix, i.e., $(J^T J)^{-1} J^T$
LAMBDA	Initial estimate of the step size in the search direction necessary to bracket the minimum of the miss index as required in the descent procedure
ALPHA	Fraction of the bracketing step at which miss index is evaluated for cubic interpolation

YP(0) Slope of miss index in the search direction at the current iterate

XK Length of a trial step in the search direction as used in bracketing the minimum of the miss index and fitting it with a cubic polynomial

Y(XK) Value of the miss index at the trial step XK

The following messages may be printed out when the iteration process is terminated. A brief explanation of each is provided.

Iteration Termination Messages

ADEQUATE CONVERGENCE OCCURRED ON PREVIOUS STEP - This is the normal termination after a successful miniprobe targeting

CONVERGENCE DID NOT OCCUR - After ITLIM iterations the current and previous iterations are still too far apart to satisfy the convergence criterion

PERFORMANCE INDEX DECREASES MONOTONICALLY IN SEARCH DIRECTION. SEARCH HAS BEEN TERMINATED - A minimum of the miss index in the direction of search could not be bracketed in 10 trial steps

To conclude the least-squares printout, an "Iteration History" is supplied. It contains the control vector, the miss index and the gradient magnitude of the miss index for each iterate in sequential order.

The "Minimum-Miss Release Controls for Conic Propagation" are next printed after being converted from the unusual dimensions required by the iteration process to the standard ones indicated in the output itself.

Then the "Conic-Model Probe Impact Data" are printed. For each miniprobe and the bus (numbered miniprobe 0) the impact declination and right ascension in the probe-sphere system, the impact speed, and the impact flightpath angle are recorded.

The information for the miniprobes is based on the conic model while that for the bus is derived from the initial n-body propagation of the bus from the release state to impact. In addition to the above data, an angle of attack is printed for each miniprobe assuming its longitudinal body axis at impact remains parallel to the spacecraft spin axis at release.

If n-body release controls are not requested by the user, the n-body time histories of the respective miniprobe trajectories for minimum-miss conic release controls are printed next as described in the nominal trajectory section.

If n-body controls are requested, the output from the application of the least-squares routine to the n-body propagation model is printed next. Its format is identical to that for the conic model. After the miss-minimizing procedure is completed, the "Minimum-Miss Release Controls for the N-Body Propagation" are printed. They too are identical in format to the conic case. Then the respective n-body miniprobe trajectory histories are printed for the minimum-miss n-body release controls as described in the nominal trajectory section.

Finally the "N-Body Model Probe Impact Data" are printed. The same quantities are presented as in the corresponding section for the conic model described above, but they are now calculated from the recently computed n-body miniprobe trajectories.

4.2 ERRAN Output Description

The printed output of the error analysis mode is described in this section according to the following groups: input data, measurement output, additional trajectory output, eigenvector event output, prediction event output, guidance event output, and summary output.

a. Input data

The initial output consists of the following input data:

(1) Namelist ERRAN.

(2) Calendar date and Julian date at launch.

(3) Final calendar date and Julian date.

(4) Initial trajectory time in days (TRTM1).

(5) Lists of solve-for, dynamic consider, and measurement consider parameters augmented to the position/velocity state vector. Definitions of names appearing in this list are given below:

RADIUS 1	Radius error of station 1
LAT 1	Latitude error of station 1
LONG 1	Longitude error of station 1
RADIUS 2	Radius error of station 2
LAT 2	Latitude error of station 2
LONG 2	Longitude error of station 2
RADIUS 3	Radius error of station 3
LAT 3	Latitude error of station 3
LONG 3	Longitude error of station 3
MU-SUN	Sun gravitational constant bias
MU-PLN	Target planet gravitational constant bias
A	Target planet semi-major axis bias
E	Target planet eccentricity bias
I	Target planet inclination bias
NODE	Target planet longitude of ascending node bias
OMEGA	Target planet argument of periapsis bias
M	Target planet mean anomaly bias
RANGE	Range bias of station 1
R-RATE	Range-rate bias of station 1
ST ANG 1	Star-planet angle 1 bias
ST ANG 2	Star-planet angle 2 bias
ST ANG 3	Star-planet angle 3 bias
APP DIAM	Apparent planet diameter bias

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(6) Definition of inertial frame.

(7) Initial spacecraft position/velocity state vector in both input coordinates (ICOOR) and inertial coordinates (IBARY).

(8) Nominal trajectory code (NTMC).

(9) List of celestial bodies assumed in the computation of the nominal trajectory (NB array).

(10) Target planet (NTP).

(11) Length units per A.U. (ALNGTH) and time units per day (TM).

(12) If the orbital elements of the assumed celestial bodies are to be computed at every time interval, a message to this effect will be printed. Otherwise, the orbital elements that will be used throughout the trajectory will be printed.

(13) If output at the initial and final steps of the virtual mass trajectory is to be suppressed, a message to this effect will be printed.

(14) If the virtual mass program will integrate only until the sphere of influence of the target planet is reached, a message to that effect will be printed. However, if the trajectory will continue until reaching a normal stopping condition, the appropriate message will be printed.

(15) Trajectory accuracy figure (ACC).

(16) Trajectory print intervals in days (DELTP) and increments (INPR).

(17) Measurement schedule; measurement codes defined in section dealing with input description.

(18) Schedule of eigenvector, prediction, and guidance events.

(19) Sigma level of hyperellipsoid computed at an eigenvector event (IHYP1).

(20) Initial P, C_{xx_s}, C_{xu}, C_{xv}, P_s, $C_{x_s u}$, U_o, and V_o covariance matrix partitions; defined in section dealing with input description.

(21) Definition of structure of augmented state transition, observation, and covariance matrices and their dimensions.

(22) State transition matrix code (ISTMC). If the state transition matrix is to be computed using numerical differencing, the position and velocity factors are also printed.

(23) Dynamic noise constants used to compute the dynamic noise covariance matrix if dynamic noise is non-zero.

(24) Measurement noise for range, range-rate, star-planet angle, and apparent planet diameter measurements.

(25) Tracking station locations.

b. Measurement output

Measurement information is printed every IPRINT measurements. At such a time the following information is printed:

(1) Measurement number and corresponding trajectory time.

(2) Type of measurement.

(3) Trajectory time t_{k-1} at most recent measurement or event (initial trajectory time).

(4) Trajectory time t_k at present measurement (final trajectory time).

(5) Initial and final spacecraft ecliptic position/velocity components and magnitudes relative to inertial space, the Earth, and the target planet.

(6) If IPRT(4) = 1, all navigation parameters at the present measurement time will be printed.

(7) State transition matrix partitions Φ, θ_{xx_s}, and θ_{xu} over the time interval $[t_{k-1}, t_k]$, relating deviations in spacecraft position and velocity, solve-for parameters, and dynamic consider parameters at time t_{k-1} to spacecraft position and velocity deviations at time t_k. Note that transposed matrices are printed.

(8) Diagonal of dynamic noise covariance matrix Q; represents unmodeled accelerations over the time interval $[t_{k-1}, t_k]$.

(9) Observation matrix partitions H, M, G, and L relating deviations in spacecraft position and velocity, solve-for parameters, dynamic consider parameters, and measurement consider parameters at time t_k to deviations in the observables at time t_k. Note that transposed matrices are printed.

(10) Measurement noise correlation matrix and standard deviations (covariance matrix R).

(11) Measurement residual correlation matrix and standard deviations (covariance matrix J).

(12) Kalman gain matrix partitions. The K matrix is used in the filtering equations to compute the P, C_{xx_s}, C_{xu}, and C_{xv} covariance matrix partitions. The S matrix is used in the filtering equations to compute the P_s, $C_{x_s u}$, and $C_{x_s v}$ covariance matrix partitions.

(13) Correlation matrix partitions and standard deviations at time t_k, just before the measurement. The first group of correlation matrix partitions represents the correlation between spacecraft position and velocity and the variables listed in the left hand column; they are obtained by converting P, C_{xx_s}, C_{xu}, and C_{xv} into the corresponding correlation matrices and standard deviations. The second group represents the correlation between the solve-for parameters and the variables listed in the left hand column; they are obtained by converting P_s, $C_{x_s u}$, and $C_{x_s v}$ into the corresponding correlation matrices and standard deviations.

(14) Correlation matrix partitions and standard deviations at time t_k, just after processing the measurement. See (13) above for definitions of the two groups of matrix partitions.

c. Additional trajectory output

If the spacecraft encounters the sphere of influence or closest approach during the course of the nominal trajectory, the information related to the encounter is printed. Also information normally printed during trajectory mode operation is printed during error analysis mode operation every DELTP days and INPR increments. This information includes spacecraft inertial state, planet ephemeris data, spacecraft state relative to planets, virtual mass data, and navigation parameters, depending on the value of the IPRT vector.

d. Eigenvector event output

At an eigenvector event the following information is printed:

(1) Name of event and event time t_{ev}.

(2) Spacecraft position/velocity state vector relative to inertial space at event time t_{ev}.

(3) If IPRT(4) = 1, all navigation parameters at event time t_{ev} will be printed.

(4) State transition matrix partitions $\emptyset$, Θ_{xx_s}, and Θ_{xu} over the time interval $[t_{k-1}, t_{ev}]$, where t_{k-1} is the time of the most recent measurement or event.

(5) Diagonal of dynamic noise covariance matrix Q; represents unmodeled accelerations over the time interval $[t_{k-1}, t_{ev}]$.

(6) Correlation matrix partitions and standard deviations at event time t_{ev} propagated forward from time t_{k-1}. See article (13) under measurement output for definitions of the two groups of matrix partitions.

(7) Spacecraft position and velocity eigenvalues, square roots of eigenvalues, and eigenvectors at event time as specified by IEIG code.

(8) Hyperellipsoids for both position and velocity covariance matrix partitions at event time for the sigma level specified by IHYP1 code.

e. Prediction event output

At a prediction event the following information is printed:

(1) Name of event, event time t_{ev}, and time t_p to which prediction is being made.

(2) Articles (2) through (6) under eigenvector event output.

(3) State transition matrix partitions $\emptyset$, Θ_{xx_s}, and Θ_{xu} over the time interval $[t_{ev}, t_p]$.

(4) Diagonal of dynamic noise covariance matrix Q; represents unmodeled accelerations over the time interval $[t_{ev}, t_p]$.

(5) Correlation matrix partitions and standard deviations at time t_p based on prediction from time t_{ev}. See article (13) under measurement output for definitions of the two groups of matrix partitions.

(6) Spacecraft position and velocity eigenvalues, square root of eigenvalues, and eigenvectors at time t_p as specified by IEIG code.

(7) Hyperellipsoids for both position and velocity covariance matrix partitions at time t_p for the sigma level specified by IHYP1 code.

(8) If time t_p occurs within the target planet sphere of influence, the Cartesian position/velocity correlation matrix and standard deviations are transformed to B-plane coordinates B•T, B•R, time-of-flight, S•R, S•T, and C_3. The transformation matrix relating these coordinates to Cartesian position/velocity coordinates is printed, followed by the B-plane correlation matrix and standard deviations. The semimajor axis, semiminor axis, and orientation of the B-plane 1-σ uncertainty ellipse are also printed.

f. Output preceding all types of guidance events

At a guidance event the following information is printed:

(1) Articles (1) through (8) under eigenvector event output.

(2) State transition matrix partitions over the time interval $[t_g, t_{ev}]$, where t_g is the time of the previous guidance event ($t_g = t_o$ if no guidance event has occurred previously).

(3) Diagonal of dynamic noise covariance matrix Q; represents unmodeled accelerations over the time interval $[t_g, t_{ev}]$.

(4) Control correlation matrix partitions and standard deviations at time t_{ev}, just before the guidance correction is applied. See article (13) under measurement output for

definitions of the two groups of matrix partitions. Eigenvalues, eigenvectors, and hyperellipsoids are also printed.

(5) Description of guidance event:

(a) Guidance policy

(b) Linear or nonlinear guidance

(c) Status of planetary quarantine constraints

(d) Thrust model

(e) Guidance event treatment

g. Linear midcourse guidance event output

Three midcourse guidance policies are available: fixed-time-of-arrival (FTA), two-variable B-plane (2VBP), and three-variable B-plane (3VBP).

(1) Time, position, and velocity when spacecraft encounters closest approach at target planet if FTA. Time, position, and velocity when spacecraft pierces target planet sphere of influence, together with B, B•T, and B•R, if 2VBP or 3VBP.

(2) Matrix M relating position/velocity deviations at t_{SI} to deviations in B•T and B•R.

(3) State transition matrix partitions over $[t_{ev}, t_{CA}]$ if FTA; over $[t_{ev}\ t_{SI}]$ if 2VBP.

(4) Variation matrix η (or partitions) relating position/velocity deviations at time t_{ev} to target condition deviations.

(5) Target condition correlation matrix and standard deviations (covariance matrix W^-) immediately prior to guidance correction, together with eigenvalues, eigenvectors, and hyperellipsoid.

(6) Guidance matrix Γ used to compute the velocity correction required to null out target condition deviations.

(7) Velocity correction correlation matrix and standard deviations (covariance matrix S), together with eigenvalues and eigenvectors. The hyperellipsoid is also printed if the guidance policy is not 2VBP.

(8) Expected value of the effective velocity correction.

(9) Execution error correlation matrix and standard deviations (covariance matrix $\tilde{Q}$).

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(10) Control (and knowledge) correlation matrix partitions and standard deviations just after the guidance correction at time t_{ev}, together with eigenvalues, eigenvectors, and hyperellipsoids.

(11) Target condition correlation matrix and standard deviations (covariance matrix W^{+}) just after guidance correction is applied, together with eigenvalues, eigenvectors, and hyperellipsoid.

(12) Targeted nominal trajectory just after guidance correction.

h. Orbital insertion guidance event output

(1) Orbital insertion decision output: see NOMNAL output description.

(2) Orbital insertion execution output:

(a) Orbital insertion ΔV in both ecliptic and equatorial coordinates.

(b) Execution error correlation matrix and standard deviations.

(c) Spacecraft position/velocity state relative to target planet immediately after orbital insertion in both ecliptic and equatorial coordinates.

(d) Spacecraft orbital elements relative to the planeto-centric equatorial coordinate system immediately after orbital insertion.

i. Nonlinear guidance and retargeting event output is summarized in the NOMNAL output description.

j. Pulsing thrust model output.

(1) Pulsing arc output: see NOMNAL output description.

(2) Pulsing arc covariance output:

(a) Nominal state transition matrix over the time interval separating pulses.

(b) Error model variances.

(c) Nominal pulse components and magnitude.

(d) Nominal execution error covariance matrix.

(e) Final pulse components and magnitude.

(f) Final execution error covariance matrix.

(g) Accumulated execution error covariance matrix.

k. Biased aimpoint guidance event output.

(1) Target planet capture radius.

(2) Matrix ψ used to compute the velocity correction required to achieve the biased aimpoint.

(3) Previously imparted aimpoint bias, $\overrightarrow{\delta\mu}$, if any.

(4) Velocity correction $\overrightarrow{\Delta V}_{RB}$ required to remove the previously imparted aimpoint bias.

(5) Execution error covariance matrix associated with the velocity correction required to remove bias and null out nominal target errors.

(6) Covariance matrix Λ_+, the projection of the target condition covariance matrix W^+ into the impact plane.

(7) Probability of impact if the spacecraft is targeted to the nominal aimpoint.

Articles (8) through (13) appear for each iteration which occurs within subroutine BIAIM.

(8) Equation defining the probability constraint ellipse.

(9) Biased aimpoint $\vec{\mu}$ and aimpoint bias $\overrightarrow{\delta\mu}$.

(10) Velocity correction $\overrightarrow{\Delta V}_{bias}$ required to achieve the biased aimpoint.

(11) Execution error covariance matrix associated with the velocity correction required to achieve the biased aimpoint and null out target errors.

(12) Covariance matrix Λ.

(13) Probability of impact if the spacecraft is targeted to the biased aimpoint.

ℓ. Probe release event output

The probe release event output for both main probe and miniprobe release events is essentially the same. Differences are noted in the following probe release event output description:

(1) Type of probe release event and trajectory time t_j at release.

(2) Heliocentric ecliptic probe state at t_j.

(3) If IPRT(4) = 1, all navigation parameters at t_j will be printed.

(4) State transition matrix partitions over the interval $[t_k, t_j]$, where t_k is the time of the previous measurement or event.

(5) Probe knowledge correlation matrix partitions and standard deviations at t_j.

(6) Eigenvalues, eigenvectors, and hyperellipsoids of the position and velocity partitions of the probe position/velocity knowledge covariance matrix.

(7) If a miniprobe is being treated and if miniprobe targeting has been performed internally (i.e., user-specified target controls are not available), the following information is printed,

   a) Bus state at probe sphere relative to target planet obtained by propagating bus state at t_j forward to entry. B-plane coordinates of bus at entry,

   b) Miniprobe target controls, including release roll angle of miniprobe No. 1 (radians), tangential velocity magnitude of miniprobe at release (decameters/s), declination of spin axis (radians), and right ascension of spin axis (radians),

   c) Value of KKWIT. If KKWIT = 0, miniprobe targeting was successful. If KKWIT = 1, targeting failed.

(8) If a miniprobe is being treated, the execution error covariance matrix for the ith miniprobe is printed.

(9) Probe planetocentric ecliptic state relative to target planet when probe sphere is pierced at entry trajectory time t_E. Probe B-plane coordinates at entry.

(10) Probe planetocentric ecliptic state (same as item 9)).

(11) Julian date (epoch 1900) and trajectory time at entry. Probe sphere radians (AUs).

(12) State transition matrix partitions over $[t_j, t_E]$.

(13) Probe control correlation matrix partitions at t_E.

(14) Julian date (epoch 1900) and calendar date at t_E.

(15) Probe state relative to target planet at t_E in planetocentric ecliptic coordinates.

(16) Probe state relative to target planet at t_E in subsolar orbital-plane coordinates;

(17) Probe communication angle at t_E.

(18) Transformation matrix relating Cartesian position and velocity coordinates to (LTR) entry parameters h, v, γ, and ϕ_s at entry.

(19) Entry parameters h, v, γ, ϕ_s, Ω_s, and i_s at t_E.

(20) Entry parameter control covariance matrix at t_E for entry parameters h, v, γ, and ϕ_s.

(21) Measurement output for every IPRINT probe measurement over the interval $[t_j\ t_E]$. Format is identical to the standard ERRAN measurement output format.

(22) Probe planetocentric ecliptic state relative to target planet at t_E. Probe B-plane coordinates at entry.

(23) Items 1) through 20) with the words "control correlation" replaced with "knowledge coorelation."

(24) If probe release event is a miniprobe release event and if not all miniprobes have been treated (three miniprobes), return to item 8) and continue.

m. Summary output

At a successful conclusion of an error analysis run, the following error analysis summary is printed:

(1) Method used to compute nominal trajectory.

(2) Trajectory accuracy figure (ACC) and true anomaly increment.

(3) Length units per AU; time units per day.

(4) Method used to compute orbital elements of planets.

(5) Initial and final trajectory times, calendar dates, and Julian dates.

(6) Inertial coordinates of spacecraft position and velocity at initial and final times.

(7) Spacecraft position and velocity coordinates relative to both Earth and target planet at final time.

(8) Time of closest approach and position and velocity relative to target planet at closest approach.

(9) If the spacecraft did not reach the target planet sphere of influence, a message to that effect is printed. Otherwise, the time at which the sphere of influence is pierced, together with position and velocity relative to the target planet at that time B, B·T, and B·R, are printed.

(10) Method used to compute state transition matrix, together with associated information.

(11) Number of measurements taken.

(12) Number of events having occurred and the number of each type of event.

(13) Variances used for the resolution, proportionality, and pointing angle errors in guidance events.

(14) Locations of tracking stations.

(15) Dynamic and measurement noise constants.

(16) Direction cosines of the three reference stars.

(17) Lists of solve-for, dynamic consider, and measurement consider parameters.

(18) Correlation matrix partitions and standard deviations at final time.

4.3 SIMUL Output Description

The printed output of the simulation mode is described in this section according to the following groups: input data, measurement output, additional trajectory output, eigenvector event output, prediction event output, guidance event output, quasi-linear filtering event output, and summary output.

a. Input data

The initial output consists of the following input data:

(1) Namelist SIMUL.

(2) All input data printed out in the error analysis mode.

(3) Actual trajectory information:

(a) List of celestial bodies assumed in the computation of the actual trajectory (NB1 array).

(b) Trajectory accuracy figure (ACC1).

(c) Actual measurement biases (BIA array).

(d) Dynamic biases.

(e) Description of unmodeled acceleration characteristics.

(f) Station location biases (SLB array).

(g) Actual spacecraft position and velocity deviations from the most recent nominal trajectory at the initial time (ADEVX array).

(h) Actual measurement noise variances (AVARM array).

b. Measurement output

Measurement output in the simulation mode repeats the measurement output in the error analysis mode except for the following differences:

(1) Spacecraft states are given for three trajectories: targeted nominal, most recent nominal, and actual.

(2) Navigation parameters are based on the actual trajectory.

(3) State transition, observation, and covariance matrices are based on the most recent nominal trajectory.

In addition, the following output appears:

(4) Actual dynamic noise representing effect of the actual unmodeled acceleration.

(5) Actual measurement noise correlation matrix and standard deviations (covariance matrix $\underline{R}$).

(6) Actual measurement noise ν.

(7) Estimated and actual measurements. Measurement residuals ε.

(8) Estimated and actual spacecraft position/velocity deviations from the most recent and the targeted nominal trajectories. Actual orbit estimation error.

(9) Estimated and actual solve-for parameter deviations. Actual estimation error.

c. Additional trajectory output appearing in the simulation mode is identical to that appearing in the error analysis mode.

d. Eigenvector event output.

Eigenvector event output appearing in the simulation mode is identical to that appearing in the error analysis mode with the following additions:

(1) Spacecraft position/velocity states for three trajectories: targeted nominal, most recent nominal, and actual.

(2) Actual dynamic noise representing effect of the actual unmodeled acceleration.

(3) Estimated and actual spacecraft position/velocity deviations from the most recent nominal trajectory.

(4) Estimated and actual solve-for parameter deviations.

e. Prediction event output

Prediction event output appearing in the simulation mode is identical to that appearing in the error analysis mode with the following additions:

(1) Spacecraft position/velocity states for three trajectories: targeted nominal, most recent nominal, and actual.

(2) Actual dynamic noise representing effect of the actual dynamic noise at the time of the event t_{ev}.

(3) Estimated and actual spacecraft position/velocity deviations from the most recent nominal trajectory at t_{ev}.

(4) Estimated and actual solve-for parameter deviations at t_{ev}.

(5) Most recent nominal trajectory state and the estimated deviations from this state at time t_p to which the prediction is being made.

f. Output preceding all types of guidance events.

(1) All eigenvector event output.

(2) State transition matrix partitions over the time interval $\left[t_g, t_{ev}\right]$, where t_g is the time of the previous guidance event ($t_g = t_o$ if no guidance event has previously occurred).

(3) Diagonal of dynamic noise covariance matrix Q.

(4) Control correlation matrix partitions and standard deviations at time t_{ev}, just before the guidance correction is applied.

(5) Eigenvalues, eigenvectors, and hyperellipsoids associated with the position and velocity partitions of the previous control covariance.

(6) Description of guidance event:

(a) Guidance policy
(b) Linear or nonlinear guidance
(c) Status of planetary quarantine constraints.
(d) Thrust model
(e) Guidance event treatment

g. Linear midcourse guidance event output

Three midcourse guidance policies are available: fixed-time-of-arrival (FTA), two-variable B-plane (2VBP), and three-variable B-plane (3VBP).

(1) Closest approach conditions on targeted nominal trajectory if FTA. Sphere of influence conditions on targeted nominal if 2VBP or 3VBP.

(2) Matrix M relating position/velocity deviations at sphere of influence to B·T and B·R deviations.

(3) Closest approach conditions on most recent nominal trajectory if FTA. Sphere of influence conditions on most recent nominal trajectory if 2VBP or 3VBP.

(4) State transition matrix partitions over $\left[t_{ev}, t_{CA}\right]$ if FTA; over $\left[t_{ev}, t_{SI}\right]$ if 2VBP. Based on most recent nominal trajectory.

(5) Variation matrix η (or partitions) relating position/velocity deviations at time t_{ev} to target condition deviations.

(6) Target condition correlation matrix and standard deviations (covariance matrix W^-) immediately prior to guidance correction, together with eigenvalues, eigenvectors, and hyperellipsoid.

(7) Guidance matrix Γ used to compute the velocity correction required to null out target condition deviations.

(8) Velocity correction correlation matrix and standard deviations (covariance matrix S), together with eigenvalues and eigenvectors. The hyperellipsoid is also printed if the guidance policy is not 2VBP.

(9) Estimated and actual spacecraft position/velocity deviations from targeted nominal immediately prior to the guidance correction.

(10) Commanded and perfect velocity corrections $\Delta\hat{V}$ and $\underline{\Delta V}$.

(11) Magnitude of commanded velocity correction.

(12) Error in velocity correction, ΔV_e, due to navigation uncertainty.

(13) Execution error correlation matrix and standard deviations (covariance matrix $\tilde{Q}$).

(14) Control (and knowledge) correlation matrix partitions and standard deviations just after the guidance correction at time t_{ev}, together with eigenvalues, eigenvectors, and hyperellipsoids.

(15) Actual velocity correction execution error $\delta\Delta V$.

(16) Actual velocity correction ΔV.

(17) Target condition correlation matrix and standard deviations (covariance matrix W^+) just after the guidance correction is applied, together with eigenvalues, eigenvectors, and hyperellipsoid.

(18) Actual target errors ε_{nav} and ε_{ex} due to navigation uncertainty and execution error. Total target error.

(19) Most recent and targeted nominal trajectories immediately following guidance correction.

(20) Actual and estimated spacecraft position/velocity deviations from most recent nominal trajectory immediately following guidance correction.

h. Orbital insertion guidance event output

(1) Orbital insertion decision output: see NOMNAL output description.

(2) Orbital insertion execution output:

(a) Actual orbital insertion ΔV in both ecliptic and equatorial coordinates.

(b) Execution error correlation matrix and standard deviations.

(c) Actual spacecraft position/velocity state relative to target planet immediately after orbital insertion in both ecliptic and equatorial coordinate.

(d) Actual spacecraft orbital elements relative to the planetocentric equatorial coordinate system immediately after orbital insertion.

i. Nonlinear guidance and retargeting event output is summarized in the NOMNAL output description.

j. Pulsing thrust model output is identical to that appearing in the error analysis mode except that pulsing arc information is printed for both the estimated and actual trajectories.

k. Biased aimpoint guidance event output is identical to that appearing in the error analysis mode.

ℓ. Quasi-linear filtering event output

(1) Spacecraft position/velocity states for three trajectories: targeted nominal, most recent nominal, and actual.

(2) Navigation parameters based on actual trajectory.

(3) State transition matrix partitions over the interval $[t_k, t_{ev}]$, where t_k is the time of the last event or measurement.

(4) Correlation matrix partitions and standard deviations at the time of the event, together with eigenvalues, eigenvectors, and hyperellipsoids.

(5) Actual dynamic noise representing effect of the actual unmodeled acceleration.

(6) Estimated and actual spacecraft position/velocity deviations from the most recent nominal trajectory just prior to the event.

(7) Estimated and actual solve-for parameter deivations just prior to the event.

(8) Most recent nominal trajectory just after the event.

(9) Estimated and actual spacecraft position/velocity deviations from the most recent nominal trajectory just after the event.

(10) Estimated and actual solve-for parameter deviations just after the event.

m. Probe release event output

Probe release event output in SIMUL is identical to probe release event output in ERRAN, except for the following items:

(1) Targeted nominal, most recent nominal, and actual probe states are printed at release time t_j instead of just the targeted nominal.

(2) If a miniprobe release event is being executed, the actual miniprobe execution error is printed in addition to the execution error covariance matrix.

(3) Format for probe measurement output is identical to the standard SIMUL measurement output format.

(4) Quasi-linear filtering event output for a probe is identical to standard SIMUL quasi-linear filtering event output.

n. Summary output

(1) Accuracies used in nominal and actual trajectory computation.

(2) Bodies treated in nominal and actual trajectory computation.

(3) Gravitational constant biases used in actual trajectory.

(4) Ephemeris biases used in actual trajectory.

(5) Initial trajectory time.

(6) Final trajectory time.

(7) Position and velocity of vehicle relative to sun, earth, and target planet at initial time.

(8) Position and velocity of vehicle relative to sun, earth, and target planet on targeted nominal, most recent nominal, and actual trajectory at final time.

(9) Time at closest approach plus position and velocity of vehicle relative to target planet on all three trajectories.

(10) The time at which the vehicle enters the sphere of influence of the target planet in addition to the position and velocity of the vehicle relative to the target planet and B, B·T, and B·R on all three trajectories.

(11) Method by which the state transition matrix is computed in addition to its limitations.

(12) Number of measurements taken.

(13) Number of events plus the number of each type of event.

(14) Variances of errors used in guidance events.

(15) Actual errors used in guidance events.

(16) Station location constants.

(17) Dynamic noise constants.

(18) Actual unmodeled acceleration.

(19) Assumed measurement noise constants.

(20) Actual measurement noise constants.

(21) Direction cosines for three star planet angles.

(22) Initial state vector for both nominal and actual trajectories.

(23) Final state vector for all three trajectories.

(24) Estimated and actual deviations from most recent nominal at final time.

(25) Estimated and actual deviations from targeted nominal at final time.

(26) Actual orbit determination error at final time.

(27) Initial correlation matrix partitions and standard deviations.

(28) Final correlation matrix partitions and standard deviations.

4.4 GENCØV Output Description

Although the generalized covariance program GENCØV is actually a part of the error analysis program ERRAN, for the purpose of clarity and convenience to the user, the GENCØV output will be described separately in this section according to the following groups: Input data, measurement output, and guidance event output. Output for eigenvector and prediction events will not be described because of its similarity to standard ERRAN eigenvector and prediction event output. The only difference consists in the fact that both assumed and actual statistics are printed for GENCØV eigenvector and prediction events.

a. Input data

The initial output consists of the following input data:

(1) Namelist ERRAN.

(2) Calendar date and Julian date at launch or initial time.

(3) Final calendar date and Julian date.

(4) Initial trajectory time in days (TRTM1).

(5) Lists of solve-for, dynamic-consider, measurement-consider, and ignore parameters. Definitions of parameter names can be found in subsection a of the ERRAN output description.

(6) Definition of inertial frame.

(7) Initial spacecraft position/velocity state vector in both input coordinates (ICOOR) and inertial coordinates (IBARY).

(8) Nominal trajectory code (NTMC).

(9) List of celestial bodies assumed in the computation of the nominal trajectory (NB array).

(10) Target planet (NTP).

(11) Length units per AU (ALNGTH) and time units per day (TM).

(12) If the orbital elements of the assumed celestial bodies are to be computed at every time interval, a message to this effect will be printed. Otherwise, the orbital elements that will be used throughout the trajectory will be printed.

(13) If output at the initial and final steps of the virtual mass trajectory is to be suppressed, a message to this effect will be printed.

(14) If the virtual mass program will integrate only until the sphere of influence of the target planet is reached, a message to that effect will be printed. However, if the trajectory will continue until reaching a normal stopping condition, the appropriate message will be printed.

(15) Trajectory accuracy figure (ACC).

(16) Trajectory print intervals in days (DELTP) and increments (INPR).

(17) Measurement schedule; measurement codes defined in section dealing with input description.

(18) Schedule of eigenvector, prediction, and guidance events.

(19) Sigma level of hyperellipsoid computed at an eigenvector vent (IHYP1).

(20) Initial assumed covariance matrix partitions; defined in input description section.

(21) Definition of structure of augmented state transition, observation, and assumed covariance matrices and their dimensions.

(22) State transition matrix code (ISTMC). If the state transition matrix is to be computed using numerical differencing, the position and velocity factors are also printed.

(23) Dynamic noise constants used to compute the assumed dynamic noise covariance matrix if dynamic noise is nonzero.

(24) Assumed measurement noise variances for range, rante-rate, star-planet angle, and apparent planet diameter measurements.

(25) Nominal tracking station locations.

(26) Namelist GENRAL.

(27) Initial position/velocity, solve-for, dynamic-consider, measurement-consider, and ignore parameter deviation means.

(28) Initial actual covariance matrix partitions; defined in input description section.

(29) Definition of structure of augmented actual covariance matrix and dimensions of each partition.

(30) Dynamic noise constants used to compute the actual dynamic noise covariance matrix if dynamic noise is nonzero.

(31) Actual measurement noise variances for range, range-rate, star-planet angle, and apparent planet diameter measurements.

b. Measurement output

Measurement information is printed every IPRINT measurements. At such a time the following information is printed:

(1) Measurement number and corresponding trajectory time.

(2) Measurement type.

(3) Trajectory time t_{k-1} at most recent measurement or event.

(4) Trajectory time t_k at present measurement.

(5) Initial and final spacecraft position/velocity components and magnitudes relative to inertial space, the earth, and the target planet.

(6) Elevation and azimuth of spacecraft relative to the tracking station if a range or range-rate measurement is being processed.

(7) If IPRT(4) = 1, all navigation parameters will be printed.

(8) State transition matrix partitions Φ, θ_{xx_s}, θ_{xu}, and θ_{xw} over the time interval $[t_{k-1}, t_k]$, relating spacecraft position/velocity, solve-for, dynamic-consider, and ignore parameters at t_{k-1}, respectively. Note that transposed matrices are printed.

(9) Diagonal of assumed dynamic noise covariance matrix Q.

(10) Observation matrix partitions H, M, G, L, and N, relating deviations in spacecraft position and velocity and solve-for, dynamic-consider paramters, measurement-consider and ignore parameters, at time t_k to deviations in the observables at time t_k. Note that transposed matrices are printed.

(11) Assumed measurement noise correlation matrix and standard deviations (covariance matrix R).

(12) Assumed measurement residual correlation matrix and standard deviations (covariance matrix J).

(13) Kalman gain matrix partitions.

(14) Assumed correlation matrix partitions and standard deviations at time t_k just before the measurement. The first group of correlation matrix partitions represents the correlation between spacecraft position and velocity and the variables listed in the left-hand column. The second group represents the correlation between the solve-for parameters and the variables listed in the left-hand columns.

(15) Assumed correlation matrix partitions and standard deviations at time t_k just after processing the measurement (see 14) for definitions of the two groups of matrix partitions).

(16) Diagonal of actual dynamic noise covariance matrix Q'.

(17) Actual measurement noise correlation matrix and standard deviations (covariance matrix R').

(18) Actual measurement residual mean $E[\epsilon']$.

(19) Actual measurement residual correlation matrix and standard deviations (2nd moment matrix J').

(20) Actual estimate error means at time t_k just before the measurement for both position/velocity and solve-for parameter states.

(21) Actual correlation matrix partitions and standard deviations at time t_k just before the measurement.

The first group of correlation matrix partitions represents the correlation between spacecraft position and velocity and the variables listed in the left-hand column. The second group represents the correlation between the solve-for parameters and the variables listed in the left-hand column.

(22) Actual estimation error means at time t_k just after processing the measurement, for both position/velocity and solve-for parameter states.

(23) Actual correlation matrix partitions and standard deviations at time t_k just after processing the measurement.

See 21) for definitions of the two groups of matrix partitions.

c. Guidance event output

Generalized covariance analysis information relating to the execution of the guidance event is printed immediately after the standard ERRAN guidance event information has been printed. This standard guidance event output, which is described in the ERRAN output description, comprises the assumed guidance data in contrast to the actual guidance data generated by the generalized covariance analysis. The generalized covariance analysis guidance event output for a midcourse guidance policy follows. The output for other guidance policies is a subset of this output.

(1) Actual position/velocity and solve-for parameter deviation means just before the guidance correction.

(2) Actual control correlation matrix partitions and standard deviations just before the guidance correction.

(3) Eigenvalues, eigenvectors, and hyperellipsoids of the position and velocity partitions of the actual position/velocity control covariance matrix.

(4) Actual target state deviation mean, $E[\delta\tau'^{-}]$, just before the guidance correction.

(5) Actual target condition correlation matrix and standard deviations just before the guidance correction (2nd moment matrix W'^{-}).

(6) Eigenvalues, eigenvectors, and hyperellipsoid of actual target condition covariance matrix.

(7) Actual velocity correlation 2nd moment matrix S', together with eigenvalues and eigenvectors.

(8) Actual velocity correction correlation matrix and standard deviations (2nd moment matrix S').

(9) Mean of actual commanded velocity correction, $E[\Delta V']$.

(10) Mean of magnitude of actual commanded velocity correction, $E[|\Delta V'|]$.

(11) Actual statistical, or effective, velocity correction, "$E[\Delta V']$."

(12) Actual execution error mean, $E[\delta\Delta V']$.

(13) Actual execution error correlation matrix and standard deviation (2nd moment matrix $\tilde{Q}'$).

(14) Actual position/velocity deviation means just after the guidance correction.

(15) Actual position/velocity estimation error means just after the guidance correction.

(16) Actual control (and knowledge) correlation matrix partitions and standard deviations just after the guidance correction.

(17) Eigenvalues, eigenvectors, and hyperellipsoids of the position and velocity partitions of the actual position/velocity control (and knowledge) covariance matrix.

(18) Actual target state deviation mean, $E[\delta\tau'^{+}]$, just after the guidance correction.

(19) Actual target condition correlation matrix and standard deviations just after the guidance correction (2nd moment matrix W'^{+}).

(20) Eigenvalues, eigenvectors, and hyperellipsoid of actual target condition covariance matrix.

5. SAMPLE CASES

5.1 NOMNAL Sample Cases

Three typical trajectories generated by NOMNAL will be described in this section to illustrate the operation and versatility of the nominal trajectory generator NOMNAL. The three cases to be discussed are:

Case N-1. Broken Plane Viking Mars "75 Mission
Case N-2. Planetary Explorer Venus '78 Mission
Case N-3. Lunar Viking '76 Mission

5.1.1 Broken Plane Viking Mars '75 Mission

a. Sample Data

```
NBOD=3,NB=1,4,5,NLP=4,NTP=5,ACKT=2.5E-5,NCPR=10000,TMPR=10.,
KALI=1975,8,30,0,0,SI=0.,
IZERO=2, ZDAT(4)=-4.201823E+6,1.98231564E+8,-7.118753E+6,
KTYP=1,2,3,-1,  KMXQ=3,3,4,  KTIM=1,4,2,3,  PERV=1.E-5,5.E-5,
IBADS=2,2, LVLS=2,2, AC(1,1)=5.E-4,2.5E-5, AC(1,2)=5.E-4,2.5E-5,
KALG(1,2)=1976,1,5,9,59, GS(2)=4.901, TIMG(3)=2.0,.5, IZER(2)=3,
KTAR(1,1)=10,11,12, TAR(1,1)=-4201823.,198231564.,-7118753.,
KTAR(1,2)=8,7,3, TAR(1,2)=40.92, 5000., TOL(1,2)=1., 10., .001,
KTAR(1,3)=2,TAR(1,3)=20428.,.76,77.,40.,50., TOL(1,1)=3*100.,
KALT=1976,1,5,9,59, TS=4.901,  KALT(1,2)=1976,7,19,0,0, TS(2)=0.,
```

The exact data as read in for the Broken Plane Viking case are given above. A detailed explanation of this data follows.

The first line defines the nominal trajectory propagation between guidance events. The sun, Earth, and Mars are the gravitational bodies with the Earth as the launch planet and Mars as the target planet. The integration level of 2.5E-5 is a moderate accuracy level. The trajectory will be recorded at intervals of ten days with no printouts occurring on integration increment counts.

The initial date is given on the next line. It is specified only to a calendar day; the hours, minutes, and seconds at injection will be computed in the zero iterate computation using the internally set launch profile with a Cape Kennedy launch.

The third line defines the zero iterate computation. The option specified (IZERO=2) specifies the launch planet to prescribed point option. The heliocentric ecliptic coordinates of that point are provided in ZDAT.

The next lines of input define the guidance events. The data defining each event will be discussed in the order of the indices of the events.

The first event will be a targeting event (KTYP=1) to occur at 0 days (TIMG=0.) after the initial time (KTIM=1). The correction is to be computed and executed (KMXQ=3) using the impulsive model (MDL undefined, hence set to 1). The target values are x_f, y_f, z_f (KTAR=10,11,12) with values identical to ZDAT and tolerances of 100 km (TOL=3*100). The final time is read in the KALT, TS arrays (and used incidentally in the zero iterate computation). The Newton-Raphson scheme is to be used (METH not set, hence equal to 0) with a perturbation size of 10^{-5} km/sec (PERV) at two levels (LVLS) defined by AC to be 5×10^{-4}, 2.5×10^{-5}. Bad-step checks will be made at the high level only (IBADS=2).

The second event will be a retargeting event (KTYP=2) to occur on the calendar date (KTIM=2) specified by KALG, SG which is the same time as the target time of the first event. The correction is to be computed and executed (KMXQ=3) using the impulsive model (MDL=1 since undefined). The target parameters are i, r_{CA}, t_{CS} (KTAR=8,7,3) with target values of 40,92°, 5000 km (TAR) and 7/19/1976 (KALT) respectively and tolerances of 1°, 10 km, .001 days (TOL). The scheme to be used is identical to that of the first event with the exception of the velocity perturbation which is now set to 5×10^{-5} km/sec (PERV).

The third event is an orbit insertion event (KTYP=3) occurring .5 days (TIMG) after intersection of the Martian SOI (KTIM=2). The insertion is to be the nonplanar option (KTAR=2) with target conic elements of

$$a = 20{,}428. \qquad i = 40^\circ$$
$$e = .76 \qquad \Omega = 50^\circ$$
$$\omega = 77^\circ$$

The fourth event is a termination event (KTYP= -1) occurring at 0 days (TIMG=0 since undefined) after closest approach to Mars (KTIM=3). Thus the nominal trajectory will be integrated and recorded to the Martian closest approach.

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Discussion

The Broken Plane Viking Mars '75 mission data[1] may be summarized as follows:

Launch date: 8/30/1975
Broken plane date: 1/5/1976 9^{hr}-59^{m}-4.901^{sec}
Encounter date: 7/19/1976

---

[1] The authors are indebted to R. T. Gamber of the Martin-Marietta Corporation who generated this minimum-delta V data based on massless-planets trajectories. The sum of the broken-plane velocity and orbit insertion velocity is minimized.

Launch planet: Earth
Broken plane point (heliocentric ecliptic): 1.38780(8), -5.96016(7), 1.49455(2) km
Target planet: Mars

The massless planet trajectory generated for the first leg of the mission led to the following heliocentric conic:

SMA:	198.29 M km	TAL:	348.90^{o}
ECC:	.24094	TAP:	104.08^{o}
INC:	2.2722^{o}	TOF:	128.42 days

The injection conditions computed using the massless planet heliocentric trajectory and the internally stored launch profile generated the following near-earth conic:

C3:	14.242	SMA:	-27988.6
RAD:	6567.6	ECC:	1.23438
VEL:	11.646		
INJ TIME:	18^{hr}-26^{m}-51^{sec}		

When the injection state consistent with this conic is integrated by NOMNAL to the broken plane time, the error in position is 2.18×10^5 km. Three iterations are made at both the first and second accuracy levels to obtain a trajectory that has an error of 25 km. The Δv required and the elements of the corrected near earth conic are

Δv = 13.6 m/sec
SMA = -28085.0 km
ECC = 1.23356

The corrected nominal trajectory is now integrated to the time of the broken plane point. The second guidance event occurs at this time. First, a massless-planet trajectory is determined between the current position and the location of Mars at the encounter time. The elements of this conic are

SMA:	200.21 M km	TAL:	101.83^{o}
ECC:	.24069	TAP:	191.76^{o}
INC:	2.4785	TOF:	195.58 days

The velocity thus generated at the broken plane point by the virtual mass trajectory was altered by the massless planet correction (Δv = 222 m/sec) before integrating to the target planet for the second guidance event. The target errors on the first propagation are $\Delta i = 40^{o}$, Δr_{CA} = 3906 km, Δt_{CS} = .003 day. Three iterations at the first accuracy level and two iterations at the second are required to reduce the errors to $\Delta i = .000$, Δr_{CA} = 1.1 km, Δt_{CS} = .000. The additional correction in velocity was Δv = 4.2 m/sec.

The corrected nominal trajectory is now integrated to the time of the orbit insertion decision (.71 days before CA). The elements of the approach hyperbola, the target orbit, the modified orbit, and the orbit actually achieved upon the later execution are compared below:

Orbit	a	e	ω	i	Ω
Approach hyperbola	-8149	1.6009	80.2	40.26	51.45
Target orbit	20428	.7600	77.00	40.00	50.00
Modified orbit	20471	.7563	77.00	40.00	50.00
Achieved orbit	19967	.7513	76.13	39.77	50.53

The program computed the "best" modified orbit to be the one in which r_p alone is modified. The insertion velocity required was 886 m/sec. The time interval between decision and execution was .707 days.

After computing the time of the execution event and the velocity correction to be made at that time NOMNAL returns to the propagation of the nominal trajectory. At the required time, the insertion velocity is added impulsively and the resulting conic elements relative to the target planet are computed. The resulting conic is described in the previous chart. The achieved and modified orbits would have been improved if the decision event had been entered later.

5.1.2 Planetary Explorer Venus '78 Mission

a. Sample Data

```
NBOD=3,NB=1,3,4, NCPR=200, TMPR=500., NLP=4, NTP=3, ACKT=2.5E-5,
KALI=1978,8,17,0,0, SI=0., IZERO=1,
TIMG=0.,  90.,  .5, .25,
KTIM= 1,   1,   2,   3,
KTYP= 1,   1,   3,  -1,
KMXQ= 3,   3,   4,   3,
MDL=  1,   2,   1,   1,
LVLS= 2,   1,
PERV=.00001, .00005,
DVMAX=.01,.01,    IBADS=1,
KTAR=7,8,3,         KTAR(1,2)=7,8,4,         KTAR(1,3)=1,
TAR=7000.,-50.,     TAR(1,2)=7500.,-60.,     TAR(1,3)=27000.,.75,5.,
TOL= 100.,1.,.01,    TOL(1,2)=50.,.50,.005,
KALT=1978,12,16,0,0, TS=0.,
KALT(1,2)=1978,12,16,5,0, GS(2)=0.,
PULMAG=.001, PULMAS=1., DUR=1., DTI=.1,
AC=1.E-4,2.5E-5,    AC(1,2)=2.5E-5,
NOIT=12,

IZERO=0,ZDAT=1.2244485426E+8,-8.9139153205E+7,-4.6158128562E+3,
              6.1928578,22.7126246,-3.2751748,
KALI=1978,8,17,4,49,SI=15.201,
```

The data defining the Planetary Explorer Venus '78 mission is given above. This data will now be explained in detail.

The first line defines the nominal trajectory propagation between guidance events. The sun, Earth, and Venus are the gravitational bodies used in the trajectory integration, the Earth acting as launch planet and Venus acting as target planet. A moderate accuracy level of 2.5E-5 is used. Printouts of trajectory information are given every 200 integration increments so that the frequency of output is a function of the nearness to the virtual mass.

The initial date is read in as 8/17/1978. Since IZERO=1 the zero iterate will be based on the planet-to-planet option. Thus for the zero iterate the initial position will be Earth at the initial time and the final position will be Venus at the time given by KALT(5,1), TS(1).

Four guidance events are to be processed during the trajectory. The four events are generally defined columnwise on the input for clarity. Each event will be discussed separately.

The first event is a targeting event (KTYP=1) occurring at 0 days (TIMG=0.) after the initial time (KTIM=1). The correction is to be computed and executed (KMXQ=3) using an impulsive model (MDL=1) for the execution. The target parameters are r_{CA}, t, t_{CS} (KTAR=7,8,3) with desired values 7000 km, -50°, 1978/12/16 (TAR and KALT) and tolerances 100 km, 1°, .01 days (TOL) respectively. The Newton-Raphson scheme is to be used (METH=0) with the perturbation size 10^{-5} km/sec (PERV) and a maximum allowable step of 10^{-2} km/sec (DVMAX) during the progressive accuracy levels of 10^{-4}, 2.5×10^{-5}.

After targeting and executing the first guidance event, the trajectory is to be integrated at the second targeting event (KTYP=1) occurring 90 days (TIMG=90.) after the initial time (KTIM=1). This event has target parameters of r_{CA}, i, t_{CA} (KTAR=7,8,4) with slightly different target values and tolerances. The targeting scheme parameters are identical to the first event except that now only one accuracy level is used to do the targeting. After determining the correction to be made, the execution is to be done (KMXQ=3) using the pulsing arc model (MDL=2). The pulsing arc parameters are set as thrust magnitude: .001, nominal mass: 1, thrust duration: 1, and time interval between pulses: .1 day (PULMAG, PULMAS, DUR, DTI). This determines that 1 m/sec of velocity will be imparted on each pulse.

The third guidance event is a coplanar orbit insertion event (KTYP=3, KTAR=1) to be processed a half-day (TIMG= .5) after encountering the sphere of influence of Venus (KTIM=2). The desired orbit is to have a semimajor axis of 27000 km, an eccentricity of .75, and a periapsis shift of 5° (TAR). After generating the time of execution and the correction to be executed, the trajectory is to be integrated to that time and then added impulsively (KMXQ=4, MDL=1).

The final guidance event is a termination event (KTYP = -1) to be performed at .25 days (TIMG) after closest approach to Venus (KTIM = 3). After integrating the trajectory from the insertion execution to this time, the program is ended.

It should be noted that the data as recorded above represents two successive runs. The data to the blank line is the first run. The first run while not targeting the first event in the allowable number of iterations did significantly improve the zero iterate. Therefore a second run was made in which the last three rows of data were added to the original data. This has the effect of storing the later values over the earlier values.

Therefore in the second run IZERO was set to zero to permit the direct input of the partially targeted initial position and velocity vectors in ZDAT. The initial date KALI, SI was also updated to the exact time of injection rather than the launch date. Thus the results of the first run are used to good advantage in making the second.

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Discussion

The Planetary Explorer Venus '78 mission is launched from Earth on 8/17/1978 and arrives at Venus on 12/16/1978. The massless planet trajectory generated for the zero iterate for these dates has the following properties:

SMA:	128.38M km	TAL:	185.78^{o}
ECC:	.18117	TAP:	328.54^{o}
INC:	2.8123^{o}	TOF:	121 days

The near earth conic based on the input launch profile and the departure asymptote of the above described heliocentric conic may be summarized:

C3:	8.801	RAD:	6567.3
SMA:	-45,599	VEL:	11.410
ECC:	1.1439	INJ TIME:	4^{hr}-49^{m}-15^{sec}

The injection state was computed from this conic. When integrated to the SOI of Venus the radius of closest approach is 592,130 km with a time error of 1.43 days. Counting the two runs, twelve iterations at the low level and four at the high level are required to reduce the errors to 39 km in r_{CA} (=7000), $.7^{o}$ in i_{CA} ($=-50^{o}$) and .005 days in t_{CA}. The velocity correction needed to accomplish this and the elements of the refined near earth conic are

$$\Delta v = 10.4 \text{ m/sec}$$
$$SMA = -45593.$$
$$ECC = 1.1439$$

The corrected trajectory is now integrated to the midcourse maneuver ninety days later. It is desired to increase the r_{CA} by 500 km, vary the inclination by 10^{o}, and delay the arrival by 5 hours. This targeting requires five iterations to generate the Δv of 34 m/sec which yields errors of Δr_{CA} = .26 km, Δi_{CA} = .001°, and Δt_{CA} = .000 days. The execution model to be used in the implementation of this correction is the pulsing arc. The velocity increment imparted per pulse is 1 m/sec with pulses occurring at intervals of 2.4 hours. Thus the pulsing arc requires 34 pulses and lasts 3.3 days. The current state as generated by the virtual mass trajectory is propagated backwards over half the pulsing arc interval. Then alternately single pulses are added and the resulting state propagated until the final pulse has been executed. All propagations in this process use a conic propagation corrected by the direct term effects of the launch and target bodies. A comparison of the heliocentric conics corresponding to the uncorrected trajectory, the impulsively corrected trajectory, and the pulsing arc trajectory is provided below.

	a	e	i
Uncorrected	128 383 969	.18071	2.87435
Impulsive	128 343 645	.17996	2.87120
Pulsing Arc	128 341 692	.17997	2.87122

The n-body trajectory then picks up at the end of the pulsing arc to integrate to the next guidance event.

A coplanar orbit insertion occurs .82 days before closest approach. The elements of the approach hyperbola, the target orbit, the modified orbit, and the orbit actually achieved upon the later execution are compared below:

Orbit	a	e	ω	i	Ω
Approach Hyperbola	-12625	1.68285	-102.50	63.53	-161.06
Target Orbit	27000	.75	-97.50	63.53	-161.06
Modified Orbit	27916	.69256	-97.50	63.53	-161.06
Achieved Orbit	28327	.69424	-97.51	63.59	-161.16

The approach hyperbola and original target ellipse do not intersect: hence the target orbit is modified to obtain a tangential intersection by varying r_p. The time until execution is computed along with the velocity impulse to be added at that time (Δv = 2080 m/sec). The trajectory mode is then reentered and the nominal trajectory is integrated to the time of the execution of the insertion. Upon addition of the velocity increment, the orbit achieved is given in the last row of the above table.

The integration of the nominal trajectory continues after the addition of the impulsive insertion until the termination event .25 day after closest approach.

.1.3 Lunar Viking '76 Mission

a. Sample Data

```
NBOD=2, NB=4,11, NLP=4, NTP=11, IBARY=1, ACKT=2.5E-5, NCPR=100,
IZERO=10, RP=6563.365, ZDAT=-7200.,1820.,89., LTARG=1, TMPR=20.,
KTYP=   1,   3,   -1,
KTIM=   1,   2,    3,
TIMG=  0.,  .3,   1.,
KMXQ=   3,   4,
LVLS=1, AC=2.5E-5,
SPHFAC=.25,
KTAR= 7,8,3,
TAR=1820., 89., KALT=1976,6,20,12,0, TS=0.,
TOL=25.,1.0, .005,
KTAR(1,2)=1,   TAR(1,2)=3000.,.4, +5.,
```

The data listed above for the Lunar Viking '76 mission is typical of the data required for lunar targeting.

The first line defines the nominal trajectory. The earth and the moon are the only bodies in the integration, the earth being the launch planet and the moon the target body. The inertial coordinate system is to be the earth-moon barycentric ecliptic system (IBARY=1). The accuracy level of 2.5E-5 is a reasonable figure. Printouts of the nominal trajectory data will occur every 100 integration increments.

The second line defines the zero iterate ocmputation. Lunar targeting is specified (IZERO=10) with target conditions at closest approach to the moon given as $a = -7200$, $r_{CA} = 1820$, and $i_{CA} = 89^{o}$. The input parking orbit radius is specified as $r_p = 6563.365$ km.

Three guidance events are specified. A targeting event (KTYP=1) is requested at the initial time (TIMG=0., KTIM=1). The velocity refinement is to be both computed and executed (KMXQ=3). The target parameters are to be r_{CA}, i_{CA}, and t_{CA} (KTAR) with desired values of 1820 km, 89°, and 1976/6/20/12 (TAR,KALT) and tolerances of 25 km, 1°, and .005 days respectively. For this event the SOI of the moon is to be reduced to one-fourth its usual value (SPHFAC=.25) so that the conditions at the (reduced) SOI will be nearly identical to those at closest approach. The Newton-Raphson scheme will be used with the internally stored perturbation size PERV=.00001 and maximum step DVMAX=1. Only one level of accuracy will be used.

A coplanar insertion event (KTYP=1, KTAR=1) will be processed at .3 day (TIMG=.3) after intersecting the (normal) SOI. The desired conic elements are a semimajor axis of 3000 km, eccentricity of .4, and a periapsis shift of 5°. The impulsive model will be used for its execution at the required time.

The program will be terminated upon reaching the termination event (KTYP=-1) one day after lunar closest approach.

a.3

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Description

The Lunar Viking '76 mission discussed here is a 100-hour trajectory to the moon, arriving at closest approach to the moon on 1976/6/20/12. Because of the relatively long flight time involved, this is a reasonable test of the lunar trajectory targeter.

The first guidance event involves determining the injection time, position, and velocity required to yield a trajectory with a radius of closest approach of 1820 km, an equatorial inclination of 89°, and the time of closest approach defined above. NOMNAL first generates a patched conic trajectory meeting the targeted conditions and a semi-major axis relative to the moon of -7200. Seven iterations are required to produce a patched conic trajectory having errors of $\Delta a = 3.4$ km, $\Delta r_{CA} = 7$ km, $\Delta i_{CA} = .1^{\circ}$, and $\Delta t_{CA} = 0$. The injection conditions of this targeted patched conic are then input to the multi-conic targeter. The zero iterate of this process has errors of $\Delta a = 1150$ km, $\Delta r_{CA} = 630$ km, and $\Delta t_{CA} = .1$ days. One hundred and one iterations are required in the multi-conic targeting to reduce these errors to $\Delta a = 1$ km, $\Delta r_{CA} = 10$ km, $\Delta i_{CA} = .1^{\circ}$, and $\Delta t_{CA} =$ .001. The targeted multi-conic trajectory when integrated in the virtual mass model has errors of $\Delta r_{CA} = .15$ km, $\Delta i_{CA} = .4^{\circ}$, and $\Delta t_{CA} = .002$ and hence falls within the allowable tolerances. The elements of the targeted near earth conic are

$$a = 214325 \text{ km} \qquad i = 46.46^{\circ}$$
$$e = .96941 \qquad \Omega = 2.23^{\circ}$$
$$\omega = -166.53^{\circ}$$

This trajectory is then integrated to the time of the second guidance event, an orbit insertion decision, occurring at .3 days after SOI intersection. The elements of the approach hyperbola, the target orbit, the modified orbit and the orbit actually achieved upon the later execution are compared below.

Orbit	a	e	ω	i	Ω
Approach hyperbola	-7224	1.25206	135.50	90.70	-138.53
Target Orbit	3000	.40000	140.50	90.70	-138.53
Modified Orbit	3008	.39608	140.50	90.70	-138.53
Achieved Orbit	3028	.39406	135.57	88.75	-138.39

The discrepancy between the modified orbit and the achieved is caused by the fact that the time interval over which the insertion maneuver was predicted was so large (.3 days) that the conic approximation was bad. Therefore if the orbit insertion is required more accurately, the time of the orbit insertion decision should be adjusted later.

5.2 ERRAN Sample Cases

Two error analysis cases performed by the error analysis program ERRAN will be described in this section to illustrate the operation and versatility of ERRAN. The two cases to be discussed are:

Case E-1. Planetary Explorer Venus '78 Mission
Case E-2. Lunar Viking '76 Mission

5.2.1 Planetary Explorer Venus '78 Mission

a. Sample Data

```
XI=6.55455973324E2,4.62539152599E3,-4.6158128562E3,
-1.08550236161E1,-1.25168693509,-3.27287460527,ICOOR=2,NBOD=3,
NLP=4,NTP=3,NB(1)=1,3,4,ACC=2.5E-5,TINJ=0.,
TNOMB=1.36633590427E4,6.06305868021E3,119.48805958,
TNOMC=-5.46453815909E3,4.59782347257E2,-4.82462411161E3,
2.21797795136,-9.90977032363,-3.45655168685,120.79425159,
LMO=8,LDAY=17,LHR=4,LMIN=49,SECL=15.201,LYR=1978,IMO=12,
IDAY=16,IHR=5,IMIN=53,SECI=10.465,IYR=1978,ISTMC=1,
IAUGIN(1)=1,1,1,IAUGIN(11)=2,1,0,1,0,0,1,0,2, NENT=7,NEV1=1,
T1=60.,NEV2=1,T2=100.01,TPT2=120.794,NEV3=4,T3=0.,10.,100.,
120.4,P(1,1)=2.,P(2,2)=2.,P(3,3)=2.,P(4,4)=18.E-6,P(5,5)=18.E-6,
P(6,6)=18.E-6,PS(1,1)=1.,PS(2,2)=9.E-12,UO(1,1)=100.,
UO(2,2)=1.E-14,UO(3,3)=82.81E-16,VO(1,1)=1.7E-7,VO(2,2)=2.2E-15,
VO(3,3)=2.5E-14,IDNF=0,MNCN(3)=25.E-6,9.E-12,25.E-6,9.E-12,
25.E-6,9.E-12,SIGRFS=16.E-10,SIGPRO=16.E-6,SIGALP=20.E-5,
SIGBET=20.E-5,PSIGS=4.E-10,PSIGK=4.E-6,PSIGA=10.E-5,
PSIGB=10.E-5,IPRINT=3,KPRINT=1,IPRT=0,0,0,1,PULMAG=.001,
PULMAS=1.,DUR=1.,DTI=.1,XTAR(1,4)=27000.,.75,5.,PROBI=1.E-5,
IGUID(1,1)=2,0,1,1,3,IGUID(1,2)=2,0,1,2,3,IGUID(1,3)=2,0,1,2,3,
IGUID(1,4)=4,0,0,1,4,
```

The first two lines of the above sample data define the dynamic model assumed in the error analysis. The spacecraft position/velocity injection state (XI) is referenced to geocentric ecliptic coordinates as indicated by the value of ICØØR. The motion of the spacecraft will be subject to the influence of the three (NBØD) celestial bodies indicated by the NB array, namely, the Sun, Venus, and the Earth, and will be launched from the Earth (NLP) toward Venus (NTP). A moderate trajectory accuracy (ACC) will be employed in the generation of the spacecraft trajectory. Since the initial time is the injection time, TINJ is set to 0. Nominal B-plane and closest approach target conditions are defined by the TNØMB and TNØMC arrays. These arrays, which are obtained from the NØMNAL run which generated the injection conditions, are required in this error analysis run because several biased aimpoint guidance events are to be performed. The launch and final dates are defined by the series of variables LMØ through IYR. State transition matrices will be computed analytically using the patched conic technique as indicated by the value of ISTMC.

The IAUGIN array defines the parameter augmentation for this run, and indicates that there are two solve-for parameters: target planet gravitational constant bias and range-rate bias; three dynamic consider parameters: target planet semi-major axis, inclination, and mean anomaly biases; and three measurement consider parameters: station 1 radius, latitude, and longitude biases. The number of entries in the measurement schedule, which is presented below, is specified by NENT.

The variables NEV1 and T1 indicate that an eigenvector event will occur at 60 days, while NEV2, T2, and TPT2 indicate that a prediction event will occur at 100.01 days and will predict to 120.794 days. Four guidance events are scheduled at 0., 10., 100., and 120.4 days in this run, as indicated by NEV3 and T3. The characteristics of these guidance events are specified by the IGUID arrays which appear in the last two lines of the previous sample data. IGUID(1,1) indicates that the first guidance event will be 2VBP, linear, subject to planetary quarantine constraints, impulsive, and both computed and executed. The second and third guidance events differ from the first in that they will employ a pulsing thrust model. The final guidance event is an impulsive planar orbital insertion, not subject to quarantine constraints, computed, and executed at the appropriate time. The thrust characteristics of the pulsing engine are defined by the variables PULMAG, PULMAS, DUR, and DTI. The variable PRØBI indicates that the probability of impact with the target planet Venus must not be more than $1.x10^{-5}$. The XTAR array indicates that we desire to insert the spacecraft in an orbit about Venus having a semi-major axis of 27000 km., an eccentricity of .75, and a periapsis shift of 5 degrees.

The spacecraft injection covariance matrix is assumed to be diagonal with position variances of 2 km^2 and velocity variances 18 $m.^2/sec.^2$. The parameter covariance matrices are also assumed to be diagonal. Solve-for parameter variances are defined in the PS array; dynamic consider parameter variances, in the UO array; and measurement consider parameter variances, in the VO array. The arrangement of the elements in the PS, UO, and VO arrays must correspond to the structure of the solve-for, dynamic consider, and measurement consider parameter vectors.

Dynamic noise will be absent from this run, as indicated by the value of IDNF. Noise corrupting range and range-rate measurements from all three tracking stations will be assumed to have the statistics described by the MNCN array. Execution error statistics are described by the variables SIGRES through PSIGB.

Variables not defined in the previous sample data take on internally-specified values. For example, the internally-specified values of all required numerical differencing factors (DELMUP, DELAXS, DELICL, and DELMA) were deemed satisfactory for this run, and so were not defined in the sample data.

The measurement schedule input for this error analysis run is presented below:

.2	9.2	1.	3
.6	9.6	1.	5
.9	9.9	1.	7
19.5	99.5	5.	4
100.3	120.3	2.	3
70.1	90.1	10.	9
110.4	114.4	2.	10

The first row indicates that range-rate measurements from station 1 will be taken once a day beginning at .2 days and ending at 9.2 days. The other rows are interpreted in a similar fashion.

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Discussion

Planetary quarantine constraints require that the nominal aimpoint be biased at injection since the probability of impact (POI) exceeds the allowable POI. The linear theory indicates that a bias ΔV of nearly 15 m/sec. is required to reduce the POI to $1.x10^{-5}$. The bias in B·T is computed as 8674 km., the bias in B·R, as 119,447 km. At 10 days we recompute the target conditions and find that they do not agree with the desired bias aimpoint. This indicates that nonlinear guidance should have been employed at injection to re-target the trajectory to the bias aimpoint. The linear theory, however, does provide us with valid bias ΔV's at guidance events occurring in the heliocentric phase. After the midcourse at 10. days the spacecraft is once again heading toward the nominal aimpoint since planetary quarantine constraints are no longer violated.

Shortly before encountering the sphere of influence of Venus, spacecraft position uncertainties (1σ) have values of 5.6, 6.1, and 12.6 km. in the x,y, and z directions, respectively. Velocity uncertainties have values of $3.3x10^{-6}$, $4.5x10^{-6}$, and $6.7x10^{-6}$ km./sec. At this time the uncertainty (1σ) in the station 1 range-rate bias has been reduced from $3.x10^{-6}$ to $.62x10^{-6}$ km./sec.

At the orbital insertion decision event at 120.4 days we compute an insertion ΔV of 1.96 km./sec. to be executed at 120.77 days. After execution we are close to the desired Venus orbit.

5.2.2 Lunar Viking '76 Mission

a. Sample Data

```
XI=-6.21904171E3,-1.99290848E3,-6.55435808E2,3.162899754,
-9.601153294,-4.173272404,ICOOR=2,NBOD=2,NLP=4,NTP=11,IBARY=1,
ACC=2.5E-5,NB=4,11,LMO=6,LDAY=16,LHR=11,LMIN=7,SECL=50.055,
LYR=1976,IMO=6,IDAY=20,IHR=19,IMIN=30,SECI=43.022,IYR=1976,
FACP=.01,FACV=1.E-6, IAUGIN(7)=1,1,1,0,2,2,0,0,1,1,0,2,0,1,
NENT=7,NEV2=1,T2=1.01,TPT2=2.99,NEV3=3,T3=1.,3.,3.83,
IGUID(1,1)=3,0,0,1,3,IGUID(1,2)=1,0,0,1,3,IGUID(1,3)=4,0,0,1,4,
XTAR(1,3)=3000.,.4,5.,P(4,4)=9.E-6,P(5,5)=9.E-6,P(6,6)=9.E-6,
PS(1,1)=3.6E-3,PS(2,2)=100.,PS(3,3)=9.E-6,UO(1,1)=1.E-12,
UO(2,2)=1.E-12,VO(1,1)=.169E-6,VO(2,2)=.223E-14,VO(3,3)=2.46E-14,
VO(4,4)=1.E-8,SIGPRO=25.E-6,SIGRES=9.E-10,SIGALP=5.E-5,
SIGBET=5.E-5,IPRINT=3,KPRINT=1,IPRT=0,0,0,1, ISTMC=3,
TNOMB=-2.364898487 84E2,-5.470594585 14E3,3.433385,
TNOMC=5.253575073E2,-1.111622873E3,1.359994681E3,1.053301945,
-1.498851835,-1.632004962,4.037704,NDACC=1,ACCND=1.E-4,
```

The first two lines of the above sample data define the dynamic model assumed in the error analysis. The spacecraft position/velocity injection state (XI) is referenced to geocentric ecliptic coordinates (ICØØR). Only two (NBØD) bodies the Earth and the Moon, will govern the motion of the spacecraft. The IBARY code indicates that the barycentric ecliptic coordinate system will be used as an inertial reference coordinate system. A moderate trajectory accuracy (ACC) will be used to generate the spacecraft trajectory.

The ISTMC code indicates state transition matrices will always be computed using numerical differencing. Numerical differencing factors FACP and FACV different from the preset values were selected since the preset values are more suitable for interplanetary trajectories than for lunar trajectories. The last two variables indicate that a reduced trajectory accuracy will be employed in numerical differencing.

The IAUGIN array defines the parameter augmentation for this run, and indicates that there are three solve-for parameters: gravitational constant and semi-major axis biases of the Moon, and range bias; two dynamic consider parameters: longitude of the ascending node and argument of periapsis biases of the Moon; and four measurement consider parameters: station 3 radius, latitude, and longitude biases and star-planet angle 1 bias.

A single prediction event occurs at 1.01 days as indicated by NEV2 and T2. The prediction is made to 2.99 days (TPT2). The variables NEV3 and T3 define a schedule of three guidance events occurring at 1., 3., and 3.83 days. According to the IGUID(1,1) array, the first guidance event is 3VBP, linear, not subject to planetary quarantine constraints, impulsive, and is to be both computed and executed. The second guidance event is identical to the first except that it is FTA rather than 3VBP. The third guidance event is a planar orbital insertion, applied impulsively, and not subject to quarantine constraints. It is to be computed and executed later at the appropriate time. The desired lunar orbit has a semi-major axis of 3000. km., an eccentricity of .4, and a periapsis shift of 5 degrees. This target orbit is defined by the XTAR array.

The spacecraft injection covariance matrix is assumed to be diagonal with position variances equal to the pre-set values of 1 km.^{2} and velocity variances of 9 m.^{2}/sec.^{2}, as indicated by the P array. Solve-for parameter variances are defined in the PS array; dynamic consider parameter variances, in the UO array; and measurement consider parameter variances, in the VO array. The arrangement of the elements in these latter three arrays conforms to the structure of the three parameter vectors.

Measurement noise variances will take on internally-specified values and so do not appear in the previous sample data. Execution error variances are defined by the variables SIGPRØ through SIGBET.

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Discussion

Prior to the first guidance event at 1. days from injection, spacecraft position knowledge uncertainties (1σ) have values of $1.85\text{x}10^{-3}$, $6.36\text{x}10^{-2}$, and $4.31\text{x}10^{-2}$ km. in the x, y, and z directions, respectively. Velocity uncertainties have values of $1.55\text{x}10^{-7}$, $1.24\text{x}10^{-6}$, and $1.53\text{x}10^{-6}$ km./sec. The control covariance at this time indicates position control uncertainties (1σ) of 1075., 579., and 279. km. and velocity control uncertainties of $1.86\text{x}10^{-2}$, $5.44\text{x}10^{-3}$, and $2.87\text{x}10^{-3}$ km./sec. These control uncertainties are a measure of the dispersion of the actual trajectory from the nominal and are useful in determining the efficacy of the guidance (control) process. Propagating these control uncertainties forward to the target indicates that if no guidance correction is applied target condition dispersions will have 1σ values of 8106 km. in B·T , 1889 km. in B·R , and .057 days in t_{SI}. With the execution of the guidance correction, we can reduce target condition dispersions to 1σ values of 48 km. in B·T , 39 km. in B·R , and $3.5\text{x}10^{-4}$ days in t_{SI} . The expected value of the velocity correction at 1. days is 22.2 m./sec. and was computed using the Hoffman-Young formula.

The orbital insertion decision event at 3.83 days computes an orbital insertion ΔV of .525 km./sec. to be executed at 4.038 days. After execution of the insertion ΔV the spacecraft is in a lunar orbit close to the desired orbit.

5.3 SIMUL Sample Cases

Two simulation cases performed by the simulation program SIMUL will be described in this section to illustrate the operation and versatility of SIMUL. These cases correspond to the two ERRAN sample cases. The two cases to be discussed are:

Case S-1. Planetary Explorer Venus '78 Mission
Case S-2. Lunar Viking '76 Mission

5.3.1 Planetary Explorer Venus '78 Mission

a. Sample Data

```
XI=6.55455973324E2,4.62539152599E3,-4.6158128562E3,
-1.08560236161E1,-1.25168693E09,-3.27287460527,ICOOR=2,NBOD=3,
NLP=4,NTP=3,NB(1)=1,3,4,ACC=2.5E-5,TINJ=0.,
TNOMB=1.36633590427E4,6.06305868021E3,119.48805958,
TNOMC=-5.46453815909E3,4.59782347257E2,-4.82462411161E3,
2.21797795136,-9.90977032363,-3.45655168685,120.79425159,
LMO=8,LDAY=17,LHR=4,LMIN=49,SECL=15.201,LYR=1978,IMO=12,
IDAY=16,IHR=5,IMIN=53,SECI=10.465,IYR=1978,ISTMC=1,
IAUGIN(1)=1,1,1,IAUGIN(11)=2,1,0,1,0,0,1,0,2, NENT=7,NEV1=1,
T1=60.,NEV2=1,T2=100.01,TPT2=120.794,NEV3=4,T3=0.,10.,100.,
120.4,P(1,1)=2.,P(2,2)=2.,P(3,3)=2.,P(4,4)=18.E-6,P(5,5)=18.E-6,
P(6,6)=18.E-6,PS(1,1)=1.,PS(2,2)=9.E-12,UO(1,1)=100.,
UO(2,2)=1.E-14,UO(3,3)=82.81E-16,VO(1,1)=1.7E-7,VO(2,2)=2.2E-15,
VO(3,3)=2.5E-14,IDNF=0,MNCN(3)=25.E-6,9.E-12,25.E-6,9.E-12,
25.E-6,9.E-12,SIGPES=16.E-10,SIGPRO=16.E-6,SIGALP=20.E-5,
SIGBET=20.E-5,PSIGS=4.E-10,PSIGK=4.E-6,PSIGA=10.E-5,
PSIGB=10.E-5,IPRINT=3,KPRINT=1,IPRT=0,0,0,1,PULMAG=.001,
PULMAS=1.,DUR=1.,DTI=.1,XTAR(1,4)=27000.,.75,5.,PROBI=1.E-5,
ADEVX=1.,-.5,1.,-2.E-3,2.E-3,-1.5E-3,ACC1=2.5E-5,NBOD1=3,
NB1=1,3,4,DMUPR=.8,DAB=15.,DTB=1.5E-7,DMAB=-12.E-8,BIA(4)=6.E-6,
SLB=8.E-4,-10.E-8,3.E-7,IAMNF=1,AVARM(3)=25.E-8,9.E-14,25.E-8,
9.E-14,25.E-8,9.E-14,4*2.5E-11,ARES=.01,-2.E-5,-2.E-5,-3.E-5,
APRO=.01,2.E-3,2.E-3,4.E-3,AALP=.01,1.E-2,1.E-2,1.E-2,
ABET=.01,-1.E-2,-1.E-2,-1.E-2,NEV5=2,T5=4.,50.,NDACC=1,
ACCND=1.E-4,IGUID(1,1)=2,1,2,1,3,IGUID(1,2)=2,1,2,2,3,
IGUID(1,3)=2,1,2,2,3,IGUID(1,4)=4,1,0,1,4,XTOL(1,1)=100.,100.,
.005,XTOL(1,2)=100.,100.,.005,XTOL(1,3)=100.,100.,.005,
XAC(1,1)=2.5E-5,XAC(1,2)=2.5E-5,XAC(1,3)=2.5E-5,XPERV=3*1.E-5,
XDVMAX=3*.05,LLVLS=3*1,
```

The first half of this sample data has already been discussed in the ERRAN Sample Cases section. The data peculiar to the simulation program is concerned primarily with the definition of actual dynamics and actual error statistics, and begins with the ADEVX array above.

The ADEVX array defines the actual initial spacecraft position/velocity deviation from the nominal trajectory. Actual trajectory accuracy (ACC1) and actual celestial bodies (NBØD1 and NB1 array) are not different from the assumed values (ACC, NBØD, and NB), although normally the actual dynamic model would be more refined than the assumed model. Some differences between these two models have been defined: actual dynamic biases in the target planet gravitational constant, semi-major axis, inclination, and mean anomaly will be added to the nominal values in the generation of the actual trajectory. These dynamic biases are specified by the variables DMUBP, DAB, DIB, and DMAB.

Actual station location errors have been defined in the SLB array for station 1. Range-rate measurements from this station will be biased by $6.\mathrm{x}10^{-3}$ m./sec. as indicated by the variable BIA(4). Actual measurement noise variances are different from their assumed values as indicated by the value of IAMNF. The actual variances are defined in the AVARM array. Actual execution errors corresponding to the four guidance events are defined in the ARES, APRØ, AALP, and ABET arrays. The first value in each of these arrays is a dummy value for this particular run since the first guidance event occurs at injection. The object of a guidance event at injection is solely to change the injection velocity state; injection statistics are assumed to remain unchanged.

The characteristics of the first 3 guidance events differ from the first 3 guidance events in the corresponding ERRAN sample case in that nonlinear guidance will be used to re-compute the guidance correction. This necessitates the specification of targeting tolerances for these three events in the three XTØL arrays. In this case all three XTØL arrays are identical and indicate that the re-targeted trajectories have tolerances of 100 km. in B·T and B·R , and .005 days in t_{SI} . A single accuracy level, which is usually chosen to be identical to the trajectory accuracy ACC, is employed in nonlinear guidance as indicated by the variables LLVLS and XAC. The XPERV array indicates that a velocity perturbation of $1.\mathrm{x}10^{-5}$ km./sec. will be used to compute the targeting matrix at each nonlinear guidance event. Velocity steps of .05 km./sec. in the targeting process are permissible, as indicated by the XDVMAX array.

b. Sample Output

Selected pages of the actual output from this run are supplied in the Appendix to this volume.

c. Discussion

Nonlinear guidance is employed at each midcourse guidance event in the case under consideration. At 0. days the aimpoint is biased in order to satisfy planetary quarantine constraints and the bias velocity is re-computed using nonlinear guidance. The nonlinear bias velocity has a magnitude over twice as large as the linear bias velocity, which indicates that linear guidance is not valid during the initial phase of the trajectory.

The measurement data presented at 9.9 days shows a convergent navigation process at that point in the trajectory. All orbit estimation errors fall within their predicted (1σ) standard deviations.

At the guidance event at 10. days the nominal aimpoint satisfies the planetary quarantine constraints. The velocity required to remove the bias (DVRB) has a magnitude of about 15 m./sec. Linear guidance is valid in this region since the sum of the commanded correction (to null out target errors) and the velocity correction required to remove the aimpoint bias agrees quite well with the total velocity correction computed using non-linear guidance. The z-components of the linear and nonlinear ΔV's will always differ for 2VBP guidance since the z-component has been constrained to be zero for nonlinear 2VBP guidance.

The guidance correction at 10. days is executed using the impulse series thrust model operating over a 1.3 day arc. The re-computed target conditions at 100. days show, as one might expect, that the impulsive guidance policy will not satisfy the target conditions if an impulse series is used to execute the impulsive ΔV.

5.3.2 Lunar Viking '76 Mission

a. Sample Data

```
XI=-6.21904171E3,-1.99290848E3,-6.5543580 8E2,3.162899754,
-9.601153294,-4.173272404,ICOOR=2,NBOD=2,NLP=4,NTP=11,IBARY=1,
ACC=2.5E-5,NB=4,11,LMO=6,LDAY=16,LHR=11,LMIN=7,SECL=50.055,
LYR=1976,IMO=6,IDAY=20,IHR=19,IMIN=30,SECI=43.022,IYR=1976,
FACP=.01,FACV=1.E-6, IAUGIN(7)=1,1,1,0,2,2,0,0,1,1,0,2,0,1,
NENT=7,NEV2=1,T2=1.01,TPT2=2.99,NEV3=3,T3=1.,3.,3.83,
IGUID(1,1)=3,1,0,1,3,IGUID(1,2)=1,1,0,1,3,IGUID(1,3)=4,1,0,1,4,
XTAR(1,3)=3000.,.4,5.,P(4,4)=9.E-6,P(5,5)=9.F-6,P(6,6)=9.F-6,
PS(1,1)=3.6E-3,PS(2,2)=100.,PS(3,3)=9.E-6,UO(1,1)=1.E-12,
UO(2,2)=1.E-12,VO(1,1)=.169E-6,VO(2,2)=.223E-14,VO(3,3)=2.46E-14,
VO(4,4)=1.E-8,SIGPRO=25.E-6,SIGRES=9.E-10,SIGALP=5.E-5,
SIGBET=5.E-5,IPRINT=3,KPRINT=1,IPRT=0,0,0,1, ISTMC=3,
ADEVX=.3,-.3,.3,-1.5E-3,1.5E-3,-1.5E-3,ACC1=2.5E-5,
NBOD1=2,NB1=4,11,
DMUPB=.04,DAB=5.,DNOB=5.E-6,DWB=-6.E-6,BIA(3)=-5.E-3,
BIA(9)=6.E-5,SLB(7)=8.E-4,-7.F-8,2.5E-7,IAMNF=1,
AVARM(3)=25.E-8,9.E-14,25.E-8,9.E-14,25.E-8,9.E-14,4*2.5E-11,
ARES=-2.E-5,-2.E-5,-3.E-5,APRO=2.E-3,2.E-3,4.E-3,
AALP=1.E-2,1.E-2,1.E-2,ABFT=3*-1.E-2,NEV5=4,T5=.2,.7,1.5,2.,
TNOMB=-2.364898487 84E2,-5.4705945851 4E3,3.433385,
TNOMC=5.253575073E2,-1.111622873E3,1.359994681E3,1.053301945,
-1.498851835,-1.632004962,4.037704,NDACC=1,ACCND=1.E-4,
XTOL(1,1)=100.,100.,.005,XTOL(1,2)=100.,100.,100.,
XAC(1,1)=2.5E-5,XAC(1,2)=2.5E-5,XPERV=2*.0001,
 XDVMAX=2*.010,LLVLS=2*1,
```

The first half of this sample data has already been discussed in the ERRAN Sample Cases section. The data peculiar to the simulation program is concerned primarily with the definition of actual dynamics and actual error statistics, and begins with the ADEVX array above.

The ADEVX array defines the actual initial spacecraft position/velocity deviation from the nominal trajectory. Actual trajectory accuracy (ACC1) and actual celestial bodies (NBØD1 and NB1 array) were chosen to be identical to the assumed values (ACC, NBØD, and NB). However, some differences between the actual and assumed dynamic models were defined: actual dynamic biases in the gravitational constant, semi-major axis, longitude of the ascending node, and argument of periapsis of the Moon are to be added to the nominal values to generate the actual trajectory. These dynamic biases are specified by the variables DMUPB, DAB, DNØB, and DWB.

Actual station location errors have been defined in the SLB array for station 3. Range measurements from station 1 will be biased by -5 meters, while star-planet angle 1 measurements will be biased by $6.\times 10^{-5}$ radians. These biases are defined in the BIA array. Actual measurement noise variances are different from their assumed values as indicated by the value of IAMNF. The actual variances are defined in the AVARM array. Actual execution errors corresponding to the three guidance events are defined in the ARES, APRØ, AALP, and ABET arrays.

The characteristics of the first 2 guidance events differ from the first 2 guidance events in the corresponding ERRAN sample case in that nonlinear guidance will be used to re-compute the guidance correction. This requires the specification of several targeting variables for these two events. At the first event tolerances of 100 km. in B·T and B·R, and .005 days in t_{SI} are imposed; at the second event tolerances of 100 km. in each of the final position components are imposed. These tolerances are defined in the XTØL arrays. A single accuracy level (LLVLS) is usually selected for a nonlinear guidance event. The accuracy level itself (XAC) is usually set to the trajectory accuracy (ACC). The XPERV array defines the velocity perturbation to be used in the computation of the targeting matrix, while the XDVMAX array defines the maximum permissible velocity changes that can be used in the targeting process.

b. Sample Output

The output from this run is provided in the accompanying document, Tabulated Runs. In the final documentation selected pages from that output will be reduced to standard size and included in the User's Manual.

c. Discussion

All midcourse guidance velocity corrections have been recomputed using nonlinear techniques. Comparison of the linear and nonlinear ΔV's at the 1st guidance event indicates very good agreement. No nonlinear ΔV is computed at the guidance event at 10. days since the target tolerances of 100. km. in each position component are satisfied by the uncorrected trajectory. This is further substantiated by the target condition standard deviations just prior to the guidance event at 3 days which indicate standard deviations of 24, 31, and 43 km. in the x, y, and z target position components, respectively.

Comparing actual orbit estimation errors with predicted 1σ position and velocity uncertainties indicates that the navigation process is generally convergent. In a convergent process the actual errors should be bounded by the $\pm 3\sigma$ predicted uncertainties. Prior to encountering the sphere of influence of the Moon at 3.3 days our error in the range bias estimate has been reduced from 5 meters to .16 meters. Errors in the estimation of the gravitational constant and semi-major axis biases of the Moon, however, have not been reduced. This may be due to the strong correlation between these two parameters in the trans-lunar phase of the mission, making it difficult for the estimation process to separate the effects of biases in these two parameters.

5.4 Multiprobe Sample Cases

5.4.1 NOMNAL Multi-Probe Sample Case

The exact data as input for a representative 1977 Planetary Explorer targeting problem is given below:

```
 C VIRTUAL-MASS INTEGRATOR DATA
     ACKT=2.5E-05,
     NBOD=3,
     NB=1,3,4,
     NLP=4,
     NTP=3,
     TMPR=50.,
     NCPR=500,

 C INITIAL TRAJECTORY TIME
     KALI=1977,1,4,6,49
     SI=38.,

 C GUIDANCE EVENT SCHEDULE
     KTYP=1,4,1,5,1,-1,
     KTIM=1,1,1,1,1,3,
     TIMG=0.,122.,122.5,123.,123.5,1.,

 C TARGET SPECIFICATION
     KTAR=13,14,1,0,0,0,
          0,0,0,0,0,0,
          13,14,1,0,0,0,
          11,11,0,0,0,0,
          13,14,15,0,0,0,
     TAR=0.,68.2,0.,0.,0.,0.,
         0.,0.,0.,0.,0.,0.,
         -14.,100.,0.,0.,0.,0.,
         30.3,-14.6,-34.4,71.3,137.7,66.6,
         20.,30.,0.,0.,0.,0.,
     TOL=1.,1.,.001,0.,0.,0.,
         0.,0.,0.,0.,0.,0.,
         1.,1.,.001,0.,0.,0.,
         1.,1.,1.,1.,0.,0.,
         1.,1.,.001,0.,0.,0.,
     KALT=1977,5,17,6,49,
          0,0,0,0,0,
          1977,5,17,6,49,
          0,0,0,0,0,
          1977,5,17,5,49,
     TS=38.,0.,38.,0.,38.,
```

```
C  INITIAL INTERATE DATA
     IZERO=1,

C TARGETING SCHEME DATA
     LVLS=6*2,
     AC=1.0E-04,2.5E-05,0.0,0.0,0.0,
        0.0,0.0,0.0,0.0,0.0,
        1.0E-04,2.5E-05,0.0,0.0,0.0,
        0.0,0.0,0.0,0.0,0.0,
        1.0E-04,2.5E-05,0.0,0.0,0.0,
     PERV=6*1.0E-05,
     CONTR=6*2.,
     DVMAX=6*5.0E-01,
     NOIT=6*12,
     MAXB=6*12,
     WGHTM=1.0E+05,0.,1.0E+05,.5,1.0E+05,

C PROBE TARGETING DATA
     IPCS=6*1,
     RPS=6*6200.,
```

A brief description of the nominal mission profile is given to motivate the selection of guidance events. A detailed explanation of the data is then provided. Finally a discussion of the targeting output is given.

a. Mission Description

The trajectory is to be of the Type I category with a launch data of 1/4/77 and an arrival date of 5/17/77. The entire conglomerate vehicle consisting of the bus, the main probe, and the three miniprobes is targeted at injection to impact the main probe target site at 0° declination and 68.2° right ascension in the planetocentric subsolar frame. The injection-targeted trajectory is then flown uneventfully until 11 days prior to entry. At this time the main probe is released to impact its target site without any further velocity correction. Twelve hours after the main probe release the conglomerate spacecraft now consisting of the bus and miniprobes is retargeted to a pseudo-impact site at -14 and 100° declination and right ascension respectively. Since the bus as well as the miniprobes will subsequently be retargeted, this site will never be reached by any portion of the spacecraft. It serves the purpose instead of shifting the ballistic trajectory of the spacecraft so that at the time of miniprobe release its point of contact with the planet is centered among those of the miniprobes. Ten days before entry the miniprobes are deployed by a simultaneous release from the spinning spacecraft. A sufficient number of release controls is not available to permit exact targeting of all three miniprobes to their respective target sites. Hence controls are used which minimize a miss index of the impact site distribution; they are tabulated in the Discussion section. Finally, nine and one-half days before entry, the bus is retargeted to its desired impact site at 20° declination and 30° right ascension. The bus is accelerated at this time to impact the planet one hour before the probes thereby easing the data management burden.

b. Sample Data

Consider the sample input of Table 1. First observe the input to the virtual-mass propagator. ACKT sets the VMP accuracy level for propagation of the nominal trajectory between guidance events at the moderate accuracy level of 2.5E-5. NBOD indicates that 3 gravitational bodies are to be considered in the virtual-mass integration. The array NB identifies these as the sun, Earth, and Venus. NLP and NTP further identify the Earth as the launch planet and Venus as the target planet. TMPR triggers trajectory status printouts every 50 days while NCPR initiates them every 500 integration steps.

Examine next the scheduling of guidance event times. The array KTYP states that there are to be 6 guidance events in all. The first, third and fifth are ordinary targetings; the second is a main probe propagation; the fourth is a miniprobe targeting, and the sixth is a termination event. The array KTIM specifies that the first five event times in the array TIMG are to be referenced to the initial trajectory time at injection while the entry for the last event is referenced to closest approach of the target planet. Observing that the trajectory is 132 days long the reader should satisfy himself that the event times listed in TIMG will indeed produce the nominal trajectory described in the mission profile.

Consider next the specification of the targets. The array KTAR specifies that all of the targeting events have the time, right ascension and declination at impact as their target variables. The first and third events, however, permit extrapolation of these target values from the integrated state at the SOI, while the fifth requires virtual-mass propagation all the way to impact. For the fourth or miniprobe targeting event KTAR dictates that the spin-axis orientation is to be of mode 1 (both the ecliptic right ascension and declination of the spin axes are free release controls) and that for targeting purposes the miniprobes are to be propagated according to the conic model. The TAR array contains the right ascensions and declinations of the respective target sites. The reader can easily verify that they agree with those given in Table 1 for the intended mission. The array TOL specifies that for all the targeting events the desired right ascensions and declinations must be achieved to within 1 deg. and the desired impact times to within 0.001 day. For the miniprobe targeting event, TOL states that equal unity weighting factors should be applied to the B.T and B.R errors for all the miniprobe target sites and that the weighted sum of the change in length of the release control vector and the change in magnitude of the miss index be less than 1 for convergence in the least-squares routine. The target times are input through the variables KALT and TS in accordance with the nominal mission profile discussed above, assuming the trajectory initial time given in KALT and SI. Actually, the initial date need only be specified to a calendar day; the hours, minutes, and seconds at injection are computed in the zero iterate computation using the internally set launch profile with a Cape Kennedy launch.

Next consider the zero iterate data. IZERO specifies for an initial iterate, a Lambert massless-planet conic from the launch planet at the initial time to the target planet at the target time.

Now study the targeting scheme data. The array LVLS specifies that all of the targeting events are to have two levels. According to AC the first level should be propagated at a VMP accuracy level of 1.0E-4 and the second at 2.5E-5. The velocity perturbation size used in approximating the sensitivity matrices of the target variables to velocity controls is given by PERV to be 1.0E-5 throughout the run. The launch-planetocentric velocity controls are to be used exclusively according to CONTR. The maximum permissible velocity correction is universally fized at 0.5 km/sec by DVMAX. The maximum number of iterations and bad steps are both set wherever applicable to 12 by the variables NOIT and MAXB, respectively. The weighting factor of timing errors to distance errors for bad step calculations is assigned the value 1.0E5 by WGHTM for all targeting events. For the miniprobe targeting event the length of pseudo-inverse release control correction is bounded above by 0.5 according to WGHTM.

Consider the special probe targeting data. The array IPCS sets the plantocentric probe-sphere frame to subsolar orbit-plane coordinates while RPS sets the radius of the probe sphere to 6200 km for all probe related targeting.

c. Sample Output

Selected pages of the actual output of this run are supplied in the appendix to this volume.

d. Discussion

The interpretation of the output from the NOMNAL programs is aptly illustrated in other sample cases. Only the printout from the miniprobe targeting algorithm and the main probe propagator are unique to this case. This "new" output is thoroughly described in the Output Description.

Table 1 Sample 1977 Planetary Explorer Targeting Results

Body	Declination of Impact Site in Degrees		Right Ascension of Impact Site in Degrees		Julian Date Epoch 1900 of Impact Time	
	Desired	Achieved	Desired	Achieved	Desired	Achieved
Main Probe	0.0	0.3	68.2	71.1	28260.784	28260.78460
Bus (Prior to Miniprobe Release)	-14.0	-12.90	100.0	102.4	28260.784	28260.78450
Miniprobe 1	30.3	30.9	71.3	74.1		28260.78731
Miniprobe 2	-14.6	-11.9	137.7	139.8		28260.78422
Miniprobe 3	-34.4	-34.5	66.6	70.8		28260.79070
Bus (Final)	20.0	20.0	30.0	30.0	28260.743	28260.74292

Table 2 Comparison of Results of Conic and Virtual-Mass Miniprobe Propagation Models

Miniprobe	Declination of Impact Site in Degrees		Right Ascension of Impact Site in Degrees		Julian Date Epoch 1900 of Epoch Time	
	Conic	N-Body	Conic	N-Body	Conic	N-Body
1	-12.279	-11.932	139.718	139.798	28260.78397	28260.78422
2	-34.649	-34.451	70.944	70.785	28260.79087	28260.79070
3	31.622	30.922	73.562	74.054	28260.78746	28260.78731

The results of the targeting as summarized in Tables 1 and 2 deserve some comment. First, the disparity between the desired and achieved impact sites for the main probe and the bus prior to miniprobe release as compared to the bus after final retargeting is caused by the use of target option 1 for the former cases and 15 for the latter cases. Thus, in the first two instances, the trajectory was integrated to the SOI and then conically extrapolated to impact, while in the latter cases, it was integrated over its entirety. Second, the promixity of the various miniprobes to their respective sites is more than satisfactory. The initial control estimate was relatively accurate and the least-squares iterations proceeded entirely by pseudo-inverse steps. The symmetrical distribution of the miniprobe target sites about the bus pseudo-impact point no doubt facilitated the miss minimization. Table 2 compares the respective impact sites and times of the miniprobes propagated under both the conic and virtual-mass models. The respective impact sites will be observed to agree to within a degree and the times to within 0.025 days illustrating the accuracy of the conic miniprobe propagation model.

5.4.2 ERRAN Multiprobe Sample Case

a. Input data

The input data for this sample case consists of the namelist ERRAN and three measurement schedules. The namelist defines the mission and the filter design and consists of the following cards:

```
XI=-1,03633510620E+8, -6.16234867839E+07, -1.27614089726E+06,
    2.15882811727E+01, -2.62615614273E+01, 1.04039769246E-01,
LMØ=4, LDAY=14, LHR=5, LMIN=22, SECL=19.879, LYR=1977,
IMØ=5, IDAY=16, IHR=23, IMIN=54, SECI=40.788, IRY=1977,
ICØØR=0,
NLP=4, NTP=3, NB=1,3,4,
P(1,1)=1.E4,
P(2,2)=1.E4,
P(3,3)=1.E4,
P(4,4)=2.5E-3,
P(5,5)=2.5E-3,
P(6,6)-2.5E-3,
MNCN(4)=1.315E-14, MNCN(5)=0.5E-14, MNCN(8)=0.561E-14,
IAUGIN=9*1,
NEV1=8,
T1=21.383,23.383,25.383,27.383,28.383,29.383,30.383,30.883,
NEV2=1,
T2=19.383,
TPT2=21.383,
ACC=2.5E-5,
DTMAX=.5,
KPRINT=1,
IPRINT-10,
VO(1,1)=.1495568E-5,
VO(1,2)=-.166533E-9,
VO(2,1)=-.166533E-9,
VO(2,2)=.1854361E-13,
VO(3,3)=.3328075E-12,
VO(4,4)=.1304207E-5,
VO(4,5)=-.1741507E-9,
VO(5,4)=-.1741507E-9,
VO(5,5)=.2325433E-13,
VO(6,6)=.3817565E-12,
VO(7,7)=.1498273E-5,
VO(7,8)=.16641E-9,
VO(8,7)=.16641E-9,
VO(8,8)=.1848279E-13,
VO(9,9)=.3323088E-12,
```

```
NENT=9,
NEV3=1, T3=18.5, IGUID(1,1)=2,0,0,1,3,
SIGPRØ=2.25E-4, SIGRES=1.0E-8,
SIGALP=6.85E-4, SIGBET=6.85E-4.

T6=19.,
T7=20.,
SMN(4)=1.315E-10,
SMN(6)=0.5 E-10,
SMN(8)=0.561E-10,
ISMN=1,
IUTC=0,
WFLS=3*1.,
DCTP=2*0.,-60.,
RATP=165.,105.,135.,
SØ=0.5,
ISAØ=1,
IPCSK=2,
YYL=1.5E-3,
TIMPCT=35.0,
RPS=6200.,
XEE(1)=0.01,
XEE(2)=2.E-12,
XEE(3)=4.E-4,
XEE(4)=4.E-4,
XEE(5)=4.E-4,
NENT1=9,
NENT2=9.
```

The first section of namelist ERRAN variables, beginning with XI and ending with SIGBET, defines the bus or primary vehicle Venus approach trajectory, the bus event schedule, and the navigation filter design. The initial bus state at the beginning of the approach phase is defined by XI and ICØØR. The initial bus position/velocity covariance is defined by the P array. Doppler measurement noise variance are specified by the MNCN variables. The navigation filter solves for no dynamic or measurement parameters, but considers the nine station location biases as indicated by the IAUGIN vector. The covariance matrix for these consider parameters is given by the VO array. Eight eigenvector events and one prediction event are scheduled for the bus. The NEV3, T3, and IGUID variables indicate that a linear 2VBP midcourse guidance event will occur at 18.5 days. Since the variable IGEN does not appear in namelist ERRAN, a standard error analysis will be performed for the bus and all four probes. A generalized covariance analysis could be performed for the bus, although the four probes currently can only be treated in the standard error analysis mode.

The final section of namelist ERRAN variables, beginning the T6 and ending with NENT2, defines the main probe and miniprobe release events. The variable T6 indicates that the miniprobe will be released at 19. days, shortly after the final bus mid-course correction, while all three miniprobes will be released at T7=20. days. A different set of doppler measurement noise variances will be used for miniprobe tracking, as indicated by variable ISMN. These new variances are defined by the SMN variables. The absence of the IPMN and PMN variables indicate that the measurement noise variances used for the bus will also be used for the main probe. The miniprobe release controls have not been specified by the user in this example, as is indicated by IUTC. Thus, the miniprobes must be targeted using the ERRAN program. Variables WFLS through IPCSK are required to perform this targeting. The miniprobe release execution error variances are specified by the XEE.

The measurement schedules for the bus, the main probe, and the three miniprobes are each defined by nine cards according to variables NENT, NENT1, and NENT2. The bus measurement schedule cards are listed.

0.0167	32.7000	1.00	3
0.0958	32.7790	1.00	3
0.1750	32.7580	1.00	3
0.1760	32.7590	1.00	7
0.3500	32.7330	1.00	7
0.5450	32.7280	1.00	7
0.5710	32.7540	1.00	5
0.7870	32.7740	1.00	5
0.9880	32.7710	1.00	5

The main probe measurement schedule cards are listed next.

19.0167	32.8000	2.00	3
19.0958	32.8790	2.00	3
19.1750	32.8580	2.00	3
19.1760	32.8590	2.00	7
19.3500	32.8330	2.00	7
19.5450	32.8280	2.00	7
19.5710	32.8540	2.00	5
19.7870	32.8740	2.00	5
19.9880	32.8710	2.00	5

Finally, the measurement schedule cards used for all three miniprobes are listed.

20.0167	30.4000	1.00	3
20.0958	30.4790	1.00	3
20.1750	30.5580	1.00	3
20.1760	30.5590	1.00	7
20.3500	30.7330	1.00	7
20.5450	30.9280	1.00	7
20.5710	30.9540	1.00	5
20.7870	31.1740	1.00	5
20.9880	31.3710	1.00	5

b. Output discussion

Selected pages from the output of this sample case appear in the appendix, where it is referred to as case MP-2. Only portions of miniprobe 1 output are presented since the output formats for the main probe and the remaining miniprobes are essentially the same. Output associated with the targeting of the miniprobes occurs on page 4. Targeting was successful, as indicated by KKWIT = 0. The final target controls are given by the UCNTRL vector. Immediately following this information, the release execution error covariance matrix for miniprobe 1 is given. The control correlation matrix partitions and standard deviations at entry time 32.781 days for miniprobe 1 are obtained by adding this execution error covariance matrix to the bus covariance matrix immediately before releasing the probe and progating the result to entry. The matrix represent the 1-σ dispersions of the miniprobe deviations about the nominal target site. The probe state relative to Venus is written out in planetocentric ecliptic and subsolar orbital-plane coordinates before transforming this state and the previous control covariance matrix to entry parameter coordinates. The following page shows the output for measurement 10 of miniprobe 1. The format is identical to bus measurement output and requires no further explanation. The output for this sample case was generated on the IBM 360 computer at GSFC.

5.5 Generalized Covariance Analysis Sample Cases

Two generalized covariance analysis sample cases generated by ERRAN will be described in this section. The nominal trajectory for both cases is an approach trajectory to Venus beginning at about 30 days before encounter. The spacecraft is tracked from three earth-based stations using doppler measurements only. In each case the objective is to examine the sensitivity of the navigation filter to off-design conditions.

5.5.1 Spectral Mismatch Sample Case

a. Input data

The input data for this sample case consists of two namelists and a measurement schedule. The first namelist, entitled ERRAN, defines the mission and the filter design and consists of the following cards:

```
XI=-1.00905168154E8,-6.40166075581E7,-1.72408766917E6,
    22.4153491439,-25.9718887728,0.248319225059,
LMØ=4,LDAY=15,LHR=14,LMIN=42,SECL=48.82,LYR=1977,
IMØ=5,IDAY=16,IHR=23,IMIN=54,SECI=40.788,IYR=1977,
ICØØR=0,
NLP=4,NTP=3,NB=1,3,4,
P(1,1)=1.E4,
P(2,2)=1.E4,
P(3,3)=1.E4,
P(4,4)=2.5E-3,
P(5,5)=2.5E-3,
P(6,6)=2.5E-3,
MNCN94)=1.315E-14,MNCN(6)=0.5E-14,MNCN(8)=0.561E-14,
IAUGIN=9*1,
NEV1=8,
T1=21,383,23.383,25.383,27.383,28.383,29.383,30.383,30.883,
NEV2=1,
T2=19.383,
TPT2=21,383,
ACC=2.5E-5,
DTMAX=1.,
KPRINT=1,
IPRINT=10,
VO(1,1)=.1495568E-5,
VO(1,2)=-.166533E-9,
VO(2.1)=-.166533E-9,
VO(2,2)=.1854361E-13,
VO(3,3)=.3328075E-12,
```

```
VO(4,4)=.1304207E-5,
VO(4,5)=-.1741507E-9,
VO(5,4)=-.1741507E-9,
VO(5,5)=.2325433E-13,
VO(6,6)=.3817565E-12,
VO(7,7)=.1498273E-5,
VO(7,8)=.16641E-9,
VO(8,7)=.16641E-9,
VO(8,8)=.1848279E-13,
VO(9,9)=.3323088E-12,
NENT=9,
IGEN=1,
```

The spacecraft state at the beginning of the approach phase is defined by XI relative to the heliocentric ecliptic coordinate system as indicated by ICØØR. The computation of the nominal trajectory will include the gravitational effects of the sun, Venus, and the earth. The initial assumed position/velocity covariance matrix is defined by the P-array. The assumed measurement noise variances for doppler measurements for each of the three tracking stations are given by the MNCN variables. The navigation filter design involves the nine consider parameters indicated by the IAUGIN vector. These consider parameters are the station location biases for all three stations. The assumed covariance matrix for these consider parameters is specified by the VO array. The variable IGEN set to 1 indicates that a generalized covariance analysis will be performed. The measurement schedule is defined by nine measurement cards, as indicated by NENT. These measurement cards are listed.

```
.0167          30.4000    1.00  3
.0958          30.4790    1.00  3
.1750          30.5580    1.00  3
.1760          30.5590    1.00  7
.3500          30.7330    1.00  7
.5450          30.9280    1.00  7
.5710          30.9540    1.00  5
.7870          31.1700    1.00  5
.9880          31.3710    1.00  5
```

The second namelist, GENRAL, which follows the above measurement schedule cards, defines the "actual" statistics of relevant parameters. The namelist GENRAL cards for this sample case consist of the following.

```
GV(1,1)=.1346011E-4,
GV(1,2)=-.1498797E-8,
GV(2,1)=-.1498797E-8,
```

GV(2,2)=.1668925E-12,
GV(3,3)=.2995268E-11,
GV(4,4)=.1173786E-4,
GV(4,5)=-.1567356E-8,
GV(5,4)=-.1567356E-8,
GV(5,5)=.209289E-12,
GV(6,6)=.3435808E-11,
GV(7,7)=.1348446E-4,
GV(7,8)=.149769E-8,
GV(8,7)=.149769E-8,
GV(8,8)=.1663451E-12,
GV(9,9)=.2990779E-11.

For the sample case under consideration, the only difference between actual and assumed (by filter) error statistics occurs for the station location biases considered by the filter. This is indicated by the appearance of only the GV array in namelist GENRAL. Actual standard deviations for the station location biases are defined to be three times as large as the corresponding standard deviations assumed by the filter to describe these error sources. Cases involving differences in the actual and assumed statistical distributions of an error source acknowledged (i.e., solved-for or considered) by the filter can be referred to as "spectral mismatch" cases for convenience.

b. Output discussion

Selected pages from the output of this sample case appear in the appendix, where it is referred to as case G-1. The output corresponding to measurements 220 and 270 is presented. The quantities of interest are the assumed and actual position and velocity standard deviations after the measurement is processed. At measurement 220, which occurs several days before the spacecraft pierces the sphere of influence (SOI) of Venus, actual standard deviations are about two to three times as large as the assumed standard deviations. However, at measurement 270, which occurs about a day after the spacecraft has entered the SOI, the actual standard deviations range from one to two times the magnitude of the assumed standard deviations. These results indicate that the navigation filter design is less sensitive to spectral mismatch for (considered) station location biases when the spacecraft is tracked inside the SOI. The output for this sample case was generated on the CDC 6400/6500 computer at Martin Marietta's Denver Division.

5.5.2 Ignore Parameter Case

a. Input data

The mission and filter design have not changed from the previous case discussed. Consequently, the namelist ERRAN, and measurement schedule cards for both cases are essentially the same and need not be reproduced in their entirety. Namelist ERRAN contains one additional card, namely.

IAUGIN(19)=3,

which indicates that the doppler bias for station 1 will be treated as an ignore parameter in the generalized covariance analysis.

The actual variance for this single ignore parameter is defined by

GW(1,1)=1.E-10,

which is the only card appearing in namelist GENRAL for the case under discussion.

b. Output discussion

Selected pages from the output of this sample case appear in the appendix, where it is referred to as case G-2. Output for measurement 90 and an eigenvector event occurring at 30.383 days is shown. As in the previous sample case, we are primarily interested in comparing actual and assumed position and velocity uncertainties. At measurement 90, which occurs some distance from the Venusian sphere of influence (SOI), actual standard deviations are nearly an order of magnitude larger than the assumed standard deviations. Inside the SOI, however, the ratio of actual to assumed standard deviations has been much decreased, as is evident in the output for the eigenvector event occurring at 30.383 days. This behavior appears plausible. Prior to penetrating the SOI the spacecraft velocity is not changing rapidly and as a result (doppler) observability is reduced. Consequently, ignoring the doppler bias in the filter design during this phase can be detrimental. But after the SOI has been penetrated, the spacecraft velocity begins to change rapidly both in magnitude and direction so (doppler) observatibility increases. In this situation, neglecting the doppler bias in the filter design is of less consequence. The output for this sample case was generated on the CDC 6400/6500 computer at Martin Marietta's Denver Division.

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APPENDIX: SELECTED SAMPLE CASE OUTPUT

Case N-1. Broken Plane Viking Mars '75 Mission

NOT REPRODUCIBLE

INTERPLANETARY TRAJECTORY

TARGETING PROGRAM

INPUT DATA

```
TRAJECTORY PARAMETERS
     TM 86400.00  ALNGTH  149598500.00
     NBOD     3   BODIES  1  4  5
     IBARY    0   ICOORD  1
     NCPR10000    TMPR    10.000


          HELIOCENTRIC DATA


     POINT-TO-POINT CONDITIONS
 LAUNCH DATE  1975  8 30  0  0   0.                    FLIGHT TIME   128.42        ARRIVAL DATE  1976  1  5  9 59   4.901
  HELIOCENTRIC CONIC                                   DISTANCE
 RL  151.06 LAL   .06 LOL -23.98 VL  32.982 GAL   2.15 AZL  92.27 HCA 115.18 SMA 198.29 ECC .24094 INC 2.2722 V1  29.495
 RP  198.40 LAP -2.06 LOP  91.21 VP  25.856 GAP  13.94 AZP  69.03 TAL 348.90 TAP 104.08 RCA 150.51 APO 246.06 V2   0.
  PLANETOCENTRIC CONIC
 C3  14.242 VH   3.774 DLA   2.84 RAL  80.31 RAD 6567.6 VEL 11.646 PTH  2.04 VHP  0.    DPA  0.   RAP  0.   ECC 1.2344
 LNCH AZMTH  LNCH TIME  L-I TIME  INJ LAT  INJ LONG  INJ RT ASC  INJ AZMTH  INJ TIME  PO CST TIM  INJ 2 LAT  INJ 2 LONG
    90.00     17 49  8   2263.33   -19.81    41.94     -63.03      110.66    18 26 51     1663.3

ZERO ITERATE PARAMETERS
     IZERO   2    ZDAT      1.3878020121E+08    -5.9601624791E+07    1.4945546632E+02
                            2.0519717719E+01     3.1020278288E+01   -5.9936918916E+00
                          LAUNCH PROFILE PARAMETERS
     RP   6560.0  A1   17.00  T1  500.0  LAT   28.32  THD   15.04  AZI   90.00
     FI    3.700  A2    8.00  T2  100.0  LON  279.46  RAT   15.04

GENERAL TARGETING SCHEME
     LEVELS  0    ACCYS          5.00E-04
     MAX ITERS  0 MAX BAD STEPS  0
     IBAST  0     MATRIX  0     ISTART  0
```

GUIDANCE EVENT SCHEDULE

EVENT INDEX	EVENT TYPE	REF TIME	REF CODE	EVENT CALENDAR DATE	EVENT JULIAN DAY	EVENT TRAJ DAY	TARGET CALENDAR DATE	TARGET JULIAN DAY	TARGET TRAJ DAY
1	1	0.	1	1975 8 30 18 26 50.847	27635.269	0.	1976 1 5 9 59 4.901	27762.916	0.
2	2	127.65	1	1976 1 5 9 59 4.901	27762.916	0.	1976 7 19 0 0 0.	27958.500	0.
3	3	2.00	2	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	0.	0.
4	-1	.50	3	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	-693991.500	0.

IND	IMP	MOD	TAR KEY	TAR1	TAR2	TAR3	TOL1	TOL2	TOL3	DVX	DVY	DVZ	MAT	BADITS	BIT
1	3	1	10 11 12	-4201823.00	*8231564.00	-7118753.00	100.00	100.00	100.00	0.	0.	0.	1	2 8	4
2	3	1	9 7 3	40.92	5000.00	27958.50	1.00	10.00	.00	0.	0.	0.	1	2 8	4
3	4	1	2 0 0	20428.00	.75	77.00	0.	0.	0.	0.	0.	0.	1	3 8	4
4	3	1	0 0 0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1	3 8	4

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

GUIDANCE EVENT AT      0.    DAYS
CALENDAR DATE   1975    8   30   18   26  50.847     JULIAN DATE    27635.26864

EVENT CODES        KUR  1      KTYP  1      KMXQ  3     MDL  1

CURRENT SPACECRAFT STATE
REFERENCE        X-COMP           Y-COMP           Z-COMP          RADIUS         X-DOT          Y-DOT          Z-DOT        VELOCITY
INERTIAL      138780201.21     -59601624.79           149.46     151037405.71    20.51971772    31.02027829    -5.99369189   37.67281278
SUN           138780201.21     -59601624.79           149.46     151037405.71    20.51971772    31.02027829    -5.99369189   37.67281278
EARTH            2802.50           -5937.67           149.46          6567.56     9.25153441     3.75642461    -5.99369189   11.64585580
MARS          -55206644.57    -147095899.01       2914874.80     157141571.89    29.53610766     6.87260275    -6.72253939   31.06134028
     N-BODY TARGETING EVENT


     STATE ,    1.3878020121E+08   -5.9601624791E+07    1.4945546632E+02
                2.0519717719E+01    3.1020278288E+01   -5.9936918916E+00
     JULIAN DATE     2.7635268644E+04


     PARAMETER KEY DEFINITIONS
          1-TRF      4-TCA      7-RCA      10-XRF
          2-TSI      5-B.T      8-INC      11-YRF
          3-TCS      6-B.R      9-ASI      12-ZRF


     TARGETING SPECIFICATIONS
          KEY    TARGET VALUE      TOLERANCE
           10    -4201823.000        100.000
           11    *8231564.000        100.000
           12    -7118753.000        100.000


     TARGETING SCHEME
          LEVELS    5.000E-04  2.500E-05
          DVMAX    1.0000000000E-01
          IBAST      2

  IND NOF PHS  KEYTAR        DTAR(1)       DTAR(2)        DTAR(3)   KAXTAR        DAUX(1)        DAUX(2)        DAUX(3)  ISTOP  DELT
   1   1   1  10 11 12  -4201823.00 198231564.00  -7118753.00  10 11 12  -4201823.00 198231564.00  -7118753.00    1   127.647

ACCURACY      VX          VY          VZ          TAR -10-     TAR -11-     TAR -12-     AUX -10-     AUX -11-     AUX -12- INCR   CPT
5.00E-04  20.5197177  31.0202783  -5.9936919 -4417219.879198196361.843 -7128831.280 -4417219.879198196361.843 -7128831.280  191     4
5.00E-04  20.5197277  31.0202783  -5.9936919 -4416808.571198196770.049 -7128920.154 -4416808.571198196770.049 -7128920.154  191     7
5.00E-04  20.5197177  31.0202883  -5.9936919 -4417141.549198196496.731 -7128851.098 -4417141.549198196496.731 -7128851.098  191    10
5.00E-04  20.5197177  31.0202783  -5.9936819 -4417442.305198196120.125 -7128766.960 -4417442.305198196120.125 -7128766.960  191    13

   SENSITIVITY MATRIX                 TARGETING MATRIX           AUX ERROR      VEL COR      DES AUX VAL     DES TAR VAL       TAR TOL
 4.11E+07  7.83E+06 -2.22E+07     1.09E-07 -1.75E-08  3.10E-07     2.15E+05     2.59E-02    -4201823.000    -4201823.000      100.000
 4.08E+07  1.35E+07 -2.42E+07    -1.34E-07  1.87E-07  2.41E-07     3.52E+04    -1.98E-02   198231564.000   198231564.000      100.000
```

```
5.00E-04  20.5456477  31.0005138  -5.9623750 -4192973.745198241573.051 -7120824.137 -4192973.745198241573.051 -7120824.137  191    26

   SENSITIVITY MATRIX                   TARGETING MATRIX          AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
 4.25E+07  7.72E+05 -2.21E+07      1.05E-07 -1.46E-08  3.08E-07   -9.07E+03    -1.43E-04   -4201823.000   -4201823.000     100.000
 4.19E+07  1.32E+07 -2.38E+07     -1.36E-07  1.93E-07  2.55E-07   -1.02E+04    -2.10E-04  198231564.000  198231564.000     100.000
-9.22E+06 -2.00E+06  6.37E+06      1.09E-07  3.95E-08  6.83E-07    2.13E+03     6.21E-05   -7118753.000   -7118753.000     100.000

ACCURACY     VX          VY          VZ         TAR -10-     TAR -11-      TAR -12-      AUX -10-      AUX -11-      AUX -12-  INCR   CPT
5.00E-04  20.5455045  31.0003091  -5.9623229 -4201756.789198231584.308 -7118781.806 -4201756.789198231584.308 -7118781.806  191    30

ACCURACY     VX          VY          VZ         TAR -10-     TAR -11-      TAR -12-      AUX -10-      AUX -11-      AUX -12-  INCR   CPT
2.50E-05  20.5455045  31.0003091  -5.9623229 -3981218.855198329969.949 -7127949.794 -3981218.855198329969.949 -7127949.794  796    43

   SENSITIVITY MATRIX                   TARGETING MATRIX          AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
 4.25E+07  7.72E+06 -2.21E+07      1.05E-07 -1.46E-08  3.08E-07   -2.21E+05    -1.89E-02   -4201823.000   -4201823.000     100.000
 4.19E+07  1.32E+07 -2.38E+07     -1.36E-07  1.93E-07  2.55E-07   -9.84E+04     1.32E-02  198231564.000  198231564.000     100.000
-9.22E+06 -2.00E+06  6.37E+06      1.09E-07  3.95E-08  6.83E-07    9.20E+03    -2.17E-02   -7118753.000   -7118753.000     100.000

ACCURACY     VX          VY          VZ         TAR -10-     TAR -11-      TAR -12-      AUX -10-      AUX -11-      AUX -12-  INCR   CPT
2.50E-05  20.5266353  31.0135127  -5.9840461 -4178240.538198254721.934 -7124397.799 -4178240.538198254721.934 -7124397.799  797    56

   SENSITIVITY MATRIX                   TARGETING MATRIX          AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
 4.25E+07  7.72E+06 -2.21E+07      1.05E-07 -1.46E-08  3.08E-07   -2.36E+04    -3.94E-04   -4201823.000   -4201823.000     100.000
 4.19E+07  1.32E+07 -2.38E+07     -1.36E-07  1.93E-07  2.55E-07   -2.32E+04     1.53E-04  198231564.000  198231564.000     100.000
-9.22E+06 -2.00E+06  6.37E+06      1.09E-07  3.95E-08  6.83E-07    5.64E+03     3.63E-04   -7118753.000   -7118753.000     100.000

ACCURACY     VX          VY          VZ         TAR -10-     TAR -11-      TAR -12-      AUX -10-      AUX -11-      AUX -12-  INCR   CPT
2.50E-05  20.5262410  31.0136652  -5.9836823 -4201351.548198231933.023 -7118839.497 -4201351.548198231933.023 -7118839.497  797    70

   SENSITIVITY MATRIX                   TARGETING MATRIX          AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
 4.25E+07  7.72E+06 -2.21E+07      1.05E-07 -1.46E-08  3.08E-07   -4.71E+02    -1.74E-05   -4201823.000   -4201823.000     100.000
 4.19E+07  1.32E+07 -2.38E+07     -1.36E-07  1.93E-07  2.55E-07   -3.69E+02     1.45E-05  198231564.000  198231564.000     100.000
-9.22E+06 -2.00E+06  6.37E+06      1.09E-07  3.95E-08  6.83E-07    8.65E+01    -7.03E-06   -7118753.000   -7118753.000     100.000

ACCURACY     VX          VY          VZ         TAR -10-     TAR -11-      TAR -12-      AUX -10-      AUX -11-      AUX -12-  INCR   CPT
2.50E-05  20.5262236  31.0136807  -5.9836898 -4201814.223198231567.947 -7118755.630 -4201814.223198231567.947 -7118755.630  797    83


    EXECUTION EVENT

    DELTA V =       .00650591      -.00659756       .01000209       .01363439

    DOMINANT BODY ELEMENTS        SMA               ECC            OMEGA         INC        NODE          TA
    PLANET ECLIPTIC
       BEFORE IMPULSE     -2.798859949E+04   1.2343811E+00    173.77382     31.08471   117.43128     3.70000
       AFTER IMPULSE      -2.808503330E+04   1.2335644E+00    173.68850     31.03562   117.43548     3.78172
    PLANET EQUATORIAL
       BEFORE IMPULSE     -2.798859949E+04   1.2343811E+00   -138.11351     28.31700    75.03138     3.70000
       AFTER IMPULSE      -2.808503330E+04   1.2335644E+00   -138.13001     28.28264    74.95731     3.78172
```

TRAJECTORY TIME = 0.   TOTAL TIME INCREMENTS = 0

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
SPACECRAFT INERTIAL TRAJECTORY				
POSITION.	1.38780201207E+08	-5.96016247908E+07	1.49455466318E+02	1.51037405714E+08
VELOCITY.	2.05262236309E+01	3.10136807255E+01	-5.98368979867E+00	3.76693349064E+01

****

CALENDAR DATE = AUGUST 30, 18 HR, 26 MIN, 50.847 SEC, 1975
JULIAN DATE = 2442655.26864406

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
EPHEMERIS DATA				
POSITION OF SUN	0.	0.	0.	0.
VELOCITY OF SUN	0.	0.	0.	0.
POSITION OF EARTH	1.38777398605E+08	-5.95956871174E+07	0.	1.51032487520E+08
VELOCITY OF EARTH	1.12681833098E+01	2.72638536742E+01	0.	2.95006724037E+01
POSITION OF MARS	1.33986845880E+08	8.74942742201E+07	-2.91472534875E+06	2.12825374473E+08
VELOCITY OF MARS	-9.01638934106E+00	2.41476755358E+01	7.28847495917E-01	2.57863673290E+01

****

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
SPACECRAFT RELATIVE TRAJECTORIES				
POSITION REL. TO SUN . . .	1.38780201207E+08	-5.96016247908E+07	1.49455466318E+02	1.51037405714E+08
VELOCITY REL. TO SUN . . .	2.05262236309E+01	3.10136807255E+01	-5.98368979867E+00	3.76693349064E+01
POSITION REL. TO EARTH . . .	2.80260169919E+03	-5.93767343466E+03	1.49455466318E+02	6.56756264054E+03
VELOCITY REL. TO EARTH . . .	9.25804032110E+00	3.74982705129E+00	-5.98368979867E+00	1.16437561426E+01
POSITION REL. TO MARS . . .	-5.52066446734E+07	-1.47095899011E+08	2.91487480422E+06	1.57141571893E+08
VELOCITY REL. TO MARS . . .	2.95426135720E+01	6.86600518961E+00	-6.71253729458E+00	3.10639051128E+01

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
VIRTUAL MASS DATA				
VIRTUAL MASS POSITION	1.38777394806E+08	-5.95956854860E+07	-2.28637692234E-08	1.51032483386E+08
VIRTUAL MASS VELOCITY	1.12674470968E+01	2.72641689503E+01	-4.43373966911E-12	2.95006825790E+01
SPACECRAFT POS. REL. TO V.M.	2.80640059842E+03	-5.93930481102E+03	1.49455466341E+02	6.57065924345E+03
SPACECRAFT VEL. REL. TO V.M.	9.25877653407E+00	3.74951177517E+00	-5.98368979866E+00	1.16442399952E+01
KEPLER (ANG. MOM.) VECTOR	3.49735725780E+04	1.81764053964E+04	6.55133281027E+04	7.64583442916E+04
ECCENTRICITY VECTOR	4.60756941819E-01	-1.14004391742E+00	7.02953187662E-02	1.23164058268E+00

V.M. MAGN. = 3.99164070116E+05
V.M. MAGN. RATE = 8.42166065755E-01

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
V.M. RELATIVE POSITIONS				
POSITION REL. TO SUN . . .	1.38777394806E+08	-5.95956854860E+07	-2.28637692234E-08	1.51032483386E+08
POSITION REL. TO EARTH . . .	-3.79889965057E+00	1.63137626648E+00	-2.28637692234E-08	4.13437142477E+00
POSITION REL. TO MARS . . .	-5.52094510740E+07	-1.47089959706E+08	2.91472534875E+06	1.57136995511E+08

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	1.01247710061E+01
INCLINATION TO PLANE OF SKY	2.08865729429E+00
GEOCENTRIC DECLINATION.	-1.98056964733E+01
TARGET PLANET ANGLE (ZAE)	4.58293765313E+01
ANTENNA AXIS - EARTH ANGLE.	1.30397033273E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. .	4.12257826971E+01

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GUIDANCE EVENT AT   127.647 DAYS
CALENDAR DATE   1976    1    5    9   59   4.901     JULIAN DATE    27762.91603

EVENT CODES        KUR  2     KTYP  2     KMXQ  3     MDL  1

CURRENT SPACECRAFT STATE
REFERENCE        X-COMP           Y-COMP          Z-COMP          RADIUS        X-DOT          Y-DOT          Z-DOT       VELOCITY
INERTIAL      -4201760.96      198231599.18     -7118758.00    198403877.04  -25.22336477    5.71737917     .19541682  25.86396611
SUN           -4201760.96      198231599.18     -7118758.00    198403877.04  -25.22336477    5.71737917     .19541682  25.86396611
EARTH         31872984.12       55625312.74     -7118758.00     64503792.52    4.14210024   13.13092876     .19541682  13.77012971
MARS           9229605.48      -37519618.68    -12405765.41     40580912.00   -1.96911581    5.04702555    -.38868719   5.43147878


          HELIOCENTRIC DATA


     POINT-TO-POINT CONDITIONS
  LAUNCH DATE  1976  1  5  9 59   4.901                FLIGHT TIME   195.58        ARRIVAL DATE  1976  7 19  0  0   0.
   HELIOCENTRIC CONIC                                  DISTANCE
 RL  198.40 LAL -2.05 LOL  91.21 VL  25.980 GAL  13.92 AZL  88.62 HCA  89.93 SMA 200.21 ECC .24069 INC 2.4785 V1   0.
 RP  246.76 LAP  1.38 LOP-178.90 VP  20.317 GAP   3.67 AZP  87.94 TAL 101.83 TAP 191.76 RCA 152.03 APO 248.40 V2  22.213
     N-BODY TARGETING EVENT


     STATE     -4.2017609634E+06    1.9823159918E+08   -7.1187579972E+06
               -2.5337008362E+01    5.7310319107E+00    3.8451481743E-01
     JULIAN DATE     2.7762916029E+04


     PARAMETER KEY DEFINITIONS
          1-TRF      4-TCA      7-RCA      10-XRF
          2-TSI      5-B.T      8-INC      11-YRF
          3-TCS      6-B.R      9-ASI      12-ZRF


     TARGETING SPECIFICATIONS
          KEY   TARGET VALUE     TOLERANCE
            8         40.920         1.000
            7       5000.000        10.000
            3      27958.500          .001


     TARGETING SCHEME
          LEVELS   5.000E-04  2.500E-05
          DVMAX   1.00000000E-01
          IBAST      2

 IND NOF PHS  KEYTAR        DTAR(1)      DTAR(2)      DTAR(3)   KAXTAR       DAUX(1)      DAUX(2)      DAUX(3)  ISTOP  DELT
   2  1   1    8  7  3        40.92      5000.00     27958.50   6  5  3        40.92      5000.00     27958.50    2   215.142

ACCURACY      VX           VY          VZ          TAR - 8-      TAR - 7-     TAR - 3-     AUX - 6-     AUX - 5-      AUX - 3- INCR    CPT
5.00E-04 -25.3370084   5.7310319    .3845148      137.653      8906.422    27958.230     537.298   -14967.954     27958.230    93    102
5.00E-04 -25.3369584   5.7310319    .3845148      137.893      7826.960    27958.228     409.275   -13730.472     27958.228    93    104
5.00E-04 -25.3370084   5.7310819    .3845148      136.441      9679.287    27958.228    1043.956   -15817.154     27958.228    93    106
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5.00E-04 -25.3370084  5.7310319   .3845648     138.767     8888.266   27958.229    114.366  -14956.497   27958.229   93   107

   SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
-2.56E+06  1.01E+07 -8.45E+06    2.29E-08  3.32E-08 -7.23E-03     -5.33E+02    -1.12E-03          4.203         40.920       1.000
 2.47E+07 -1.70E+07  2.23E+05    3.23E-08 -1.08E-08 -1.07E-02      2.53E+04    -3.17E-03      10315.239       5000.000      10.000
-3.28E+01 -4.59E+01 -2.58E+01   -8.65E-08 -2.30E-08 -1.06E-02      2.70E-01    -3.40E-03      27958.500      27958.500        .001

ACCURACY     VX          VY          VZ          TAR - 8-     TAR - 7-    TAR - 3-     AUX - 6-     AUX - 5-     AUX - 3- INCR   CPT
5.00E-04 -25.3381328  5.7278588   .3811170        40.935     5090.128   27958.542     15.245    10432.599   27958.542   96    109
5.00E-04 -25.3380828  5.7278588   .3811170        41.362     6090.433   27958.546   -110.761    11675.201   27958.546   96    111
5.00E-04 -25.3381328  5.7279088   .3811170        38.946     4438.285   27958.535    520.750     9577.873   27958.535   96    112
5.00E-04 -25.3381328  5.7278588   .3811670        42.526     5105.523   27958.540   -407.515    10444.196   27958.540   96    114

   SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
-2.52E+06  1.01E+07 -8.45E+06    2.26E-08  6.62E-08 -7.32E-03      3.76E+00     2.96E-04         19.009         40.920       1.000
 2.49E+07 -1.71E+07  2.32E+05    3.16E-08  3.81E-08 -1.08E-02     -1.15E+02     4.43E-04      10318.004       5000.000      10.000
 8.05E+01 -1.24E+02 -2.40E+01   -8.72E-08  2.53E-08 -1.07E-02     -4.15E-02     4.42E-04      27958.500      27958.500        .001

ACCURACY     VX          VY          VZ          TAR - 8-     TAR - 7-    TAR - 3-     AUX - 6-     AUX - 5-     AUX - 3- INCR   CPT
5.00E-04 -25.3378365  5.7283023   .3815585        40.921     5000.035   27958.500     18.127    10317.924   27958.500   95    116

ACCURACY     VX          VY          VZ          TAR - 8-     TAR - 7-    TAR - 3-     AUX - 6-     AUX - 5-     AUX - 3- INCR   CPT
2.50E-05 -25.3378365  5.7283023   .3815585        41.400    14676.274   27958.529   -290.172    21322.445   27958.529  313    121

   SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
-2.52E+06  1.01E+07 -8.45E+06    2.26E-08  6.62E-08 -7.32E-03      2.77E+02    -5.07E-04        -13.509         40.920       1.000
 2.49E+07 -1.71E+07  2.32E+05    3.16E-08  3.81E-03 -1.08E-02     -1.10E+04    -9.29E-05      10321.766       5000.000      10.000
 8.05E+01 -1.24E+02 -2.40E+01   -8.72E-08  2.59E-08 -1.07E-02     -2.95E-02     7.17E-06      27958.500      27958.500        .001

ACCURACY     VX          VY          VZ          TAR - 8-     TAR - 7-    TAR - 3-     AUX - 6-     AUX - 5-     AUX - 3- INCR   CPT
2.50E-05 -25.3383431  5.7282094   .3815657        40.759     5004.438   27958.503     25.366    10326.723   27958.503  313    126

   SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
-2.52E+06  1.01E+07 -8.46E+06    2.26E-08  6.62E-08 -7.32E-03     -4.31E+01     2.41E-05        -17.704         40.920       1.000
 2.49E+07 -1.71E+07  2.32E+05    3.16E-08  3.81E-08 -1.08E-02     -5.64E+00     3.60E-05      10321.084       5000.000      10.000
 8.05E+01 -1.24E+02 -2.40E+01   -8.72E-08  2.59E-08 -1.07E-02     -3.48E-03     4.09E-05      27958.500      27958.500        .001

ACCURACY     VX          VY          VZ          TAR - 8-     TAR - 7-    TAR - 3-     AUX - 6-     AUX - 5-     AUX - 3- INCR   CPT
2.50E-05 -25.3383190  5.7282454   .3816066        40.921     5001.114   27958.500    -17.878    10322.486   27958.500  313    132

    EXECUTION EVENT

    DELTA V =     -.00131062     -.00278654     -.00290823     .00423561

    DOMINANT BODY ELEMENTS      SMA              ECC            OMEGA        INC         NODE          TA
    PLANET ECLIPTIC
       BEFORE IMPULSE     2.002140384E+08   2.4068580E-01  -157.89640    2.47850   147.25780   101.82803
       AFTER IMPULSE      2.002237818E+08   2.4057977E-01  -158.01039    2.47465   147.39041   101.80954
```

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SPACECRAFT PIERCED SPHERE OF INFLUENCE OF MARS    AT DATE. . . . 2442975.78932916

        POSITION. . . . .  -6.95082474569E+04  -4.77171026624E+05  -2.94903795681E+05   5.65236086800E+05
        VELOCITY. . . . .   3.27400897279E-01   1.95600059388E+00   1.21323953765E+00   2.32488275974E+00

        B . . . .    1.03661840560E+04     B.T . . . .    1.03661674091E+04     B.R . . . .   -1.85777005725E+01
        INCLINATION =   40.92


INTERPOLATED INFORMATION AT SPHERE OF INFLUENCE

SPACECRAFT PIERCED SPHERE OF INFLUENCE OFMARS     AT DATE. . . . 2442975.78810307

        POSITION. . . . .  -6.95429302491E+04  -4.77378233027E+05  -2.95032318648E+05   5.65482330018E+05
        VELOCITY. . . . .   3.27400897279E-01   1.95600059388E+00   1.21323953765E+00   2.32488275974E+00

        B . . . .    1.03661189492E+04     B.T . . . .    1.03661023010E+04     B.R . . . .   -1.85782988716E+01
        INCLINATION =   40.92
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    GUIDANCE EVENT AT   322.521 DAYS
    CALENDAR DATE   1976    7   18    6   56  38.039     JULIAN DATE    27957.78933

    EVENT CODES        KUR  3     KTYP  3     KMXQ  4     MOL  1

    CURRENT SPACECRAFT STATE
    REFERENCE       X-COMP           Y-COMP           Z-COMP           RADIUS         X-DOT         Y-DOT          Z-DOT        VELOCITY
INERTIAL      -246736543.23     -3507608.19       5894116.42      246831857.12    1.58836302 -20.14071398     .75935741  20.21751420
SUN           -246736543.23     -3507608.19       5894116.42      246831857.12    1.58836302 -20.14071398     .75935741  20.21751420
EARTH         -312841458.85     133399537.68      5894116.42      340146961.82  -24.75107655 -32.98521033     .75935741  41.24580603
MARS              -12470.41       -135202.91        -83014.78         159143.93     .33553763   2.02570216    1.25618173   2.40708273


    INSERTION DECISION EVENT
    NON-PLANAR OPTION
    TARGET PARAMETERS     A=     20428.000    E=     .760000    W=    77.000    I=    40.000    N=    50.000

NON-PLANAR INSERTION EVENT

EVENT              X/VX        Y/VY        Z/VZ         R/V          A/E        W/TA       I/N       RP/RA       TIME

DECISION         137303.9    35639.1    -72138.2    159142.8      -8149.3      80.25     40.26     4970.13    -61240.43
APPROACH RAY     -2.07108    -.40658     1.15727     2.40706      1.60989    -124.79     51.45
TIME= -61240.43
HYPERBOLA INTERSECTS DESIRED ORBIT AT TA= 353.45       R=    4.99022E+03
                                          173.45            -2.16415E+04
DESIRED ORBIT IS ALIGNED WITH INTERSECTION AT TA= 357.81      TA= 537.81
THE TRUE ANOMALY OF 173.45 LIES IN THE UNREALIZABLE REGION BETWEEN 128.40 AND 231.60

TARGET ORBIT                                                  20428.0      77.00     40.00     4902.72
                                                               .76000      0.        50.00    35953.28

PRE-INSERTION     -1985.6     3372.9      3095.6      4990.2      -8149.3      80.25     40.26     4970.13      -120.13
APPROACH RAY     -3.48353   -3.14072      .64973     4.73511      1.60989     353.45     51.45

MODIFY RA INVALID

POST-INSERTION    -1985.6     3372.9      3095.6      4990.2      20471.0      77.00     40.00     4988.65       -49.10
MODIFY RP        -2.97952   -2.41219      .61415     3.88244       .75631     357.81     50.00    35953.28
INSERTION VEL      .50402     .72853     -.03558      .88660

POST-INSERTION    -1985.6     3372.9      3095.6      4990.2      20786.0      77.00     40.00     4988.64       -49.05
MODIFY A         -2.98258   -2.41484      .61469     3.88652       .76000     357.81     50.00    36583.39
INSERTION VEL      .50096     .72588     -.03505      .88266

ERRORS=    1.00000E+25   1.71857E+02   2.14810E+03   1.00000E+25   1.00000E+25   1.00000E+25

SELECTED CORREC    .50402     .72853     -.03558      .88660
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GUIDANCE EVENT AT 323.228 DAYS
CALENDAR DATE 1976 7 18 23 55 18.345 JULIAN DATE 27958.49674

EVENT CODES KUR 3 KTYP 3 KMXQ 2 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	-246638977.17	-4725570.31	5948040.46	246755942.70	-.88490262	-18.53110862	1.53547007	18.61565760
SUN	-246638977.17	-4725570.31	5948040.46	246755942.70	-.88490262	-18.53110862	1.53547007	18.61565760
EARTH	-314349133.86	131386842.32	5948040.46	340753957.39	-27.06987548	-31.69075935	1.53547007	41.70659486
MARS	4453.94	1711.97	1374.94	4965.77	-2.27086434	3.63312112	2.03551190	4.74338515

EXECUTION EVENT

DELTA V = .58904944 -.55380964 -.36383122 .88659885

DOMINANT BODY ELEMENTS	SMA	ECC	OMEGA	INC	NODE	TA
PLANET ECLIPTIC						
BEFORE IMPULSE	-8.158692272E+03	1.6075797E+00	36.36081	31.46490	-7.06510	-4.32468
AFTER IMPULSE	1.996820420E+04	7.5132095E-01	32.29000	30.70251	-8.00357	.54988
PLANET EQUATORIAL						
BEFORE IMPULSE	-8.158963023E+03	1.6075556E+00	79.95153	39.98745	51.89792	-4.32561
AFTER IMPULSE	1.996673399E+04	7.5130403E-01	76.12704	39.77122	50.53004	.54860

```
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MARS     AT DATE. . . . . 2442978.49698485

        POSITION. . . . .    4.41802684500E+03   1.77699549901E+03   1.41018682471E+03   4.96641732914E+03
        VELOCITY. . . . .  -1.71462090457E+00   3.06641029286E+00   1.66138206612E+00   3.88625620619E+00
        INCLINATION =    39.77


INTERPOLATED INFORMATION AT CLOSEST APPROACH
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MARS     AT DATE. . . . 2442978.49659796

        POSITION. . . .    4.47447748148E+03   1.67414871733E+03   1.35437698487E+03   4.96568823801E+03
        VELOCITY. . . .  -1.66263633350E+00   3.08658523674E+00   1.67754336091E+00   3.88658201108E+00
        INCLINATION =    39.77
                 TACA=  1.99686832E+04
```

Case N-2. Planetary Explorer Venus '78 Mission

I N T E R P L A N E T A R Y   T R A J E C T O R Y

T A R G E T I N G   P R O G R A M

INPUT DATA

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TRAJECTORY PARAMETERS
     TM 86400.00  ALNGTH  149598500.00
     NBOD     3   BODIES  1  3  4
     IBARY    0   ICOORD  1
     NCPR   200   TMPR    500.000

ZERO ITERATE PARAMETERS
     IZERO    0   ZDAT      1.2244485426E+08   -8.9139153205E+07   -4.6158128562E+03
                            6.1928578000E+00    2.2712624600E+01   -3.2751748000E+00
                          LAUNCH PROFILE PARAMETERS
     RP   6550.0  A1   17.00  T1  500.0  LAT   28.32  THD   15.04  AZI   90.00
     FI    3.700  A2    8.00  T2  100.0  LON  279.46  RAT   15.04

GENERAL TARGETING SCHEME
     LEVELS  0    ACCYS        1.00E-04
     MAX ITERS  0 MAX BAD STEPS  0
     IBAST  0     MATRIX  0     ISTART  0
```

GUIDANCE EVENT SCHEDULE

EVENT INDEX	EVENT TYPE	REF TIME	REF CODE	EVENT CALENDAR DATE	EVENT JULIAN DAY	EVENT TRAJ DAY	TARGET CALENDAR DATE	TARGET JULIAN DAY	TARGET TRAJ DAY
1	1	0.	1	1978 8 17 4 49 15.201	28717.701	0.	1978 12 16 0 0 0.	28838.500	0.
2	1	90.00	1	1978 11 15 4 49 15.201	28807.701	0.	1978 12 16 5 0 0.	28838.708	0.
3	3	.50	2	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	0.	0.
4	-1	.25	3	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	-693991.500	0.

IND	IMP	MOD	TAR KEY	TAR1	TAR2	TAR3	TOL1	TOL2	TOL3	DVX	DVY	DVZ	MAT	BADITS	BIT
1	3	1	7 8 3	7000.00	-50.00	28838.50	100.00	1.00	.01	0.	0.	0.	1	1 12	4
2	3	2	7 8 4	7500.00	-60.00	28838.71	50.00	.50	.01	0.	0.	0.	1	3 8	4
3	4	1	1 0 0	27000.00	.75	5.00	0.	0.	0.	0.	0.	0.	1	3 8	4
4	3	1	0 0 0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1	3 8	4

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GUIDANCE EVENT AT      0.     DAYS
CALENDAR DATE   1973    8    17    4    49  15.201      JULIAN DATE     28717.70087

EVENT CODES          KUR  1      KTYP  1      KMXQ  3      MDL  1

CURRENT SPACECRAFT STATE
REFERENCE        X-COMP          Y-COMP           Z-COMP          RADIUS        X-DOT          Y-DOT          Z-DOT        VELOCITY
INERTIAL      122444854.26    -89139153.20         -4615.81      151454715.97    6.19285780   22.71262460   -3.27517480   23.76849961
SUN           122444854.26    -89139153.20         -4615.81      151454715.97    6.19285780   22.71262460   -3.27517480   23.76849961
VENUS         115206234.80     19333117.86       1917002.09      116842819.44  -28.51462264   20.50761175   -1.30410684   35.14749690
EARTH               655.46         4625.39         -4615.81           6567.31  -10.85412167   -1.26164101   -3.27517480   11.40747410
     N-BODY TARGETING EVENT

     STATE      1.2244485426E+08   -8.9139153205E+07   -4.6158128562E+03
                6.1928578000E+00    2.2712624600E+01   -3.2751748000E+00
     JULIAN DATE      2.8717700870E+04

     PARAMETER KEY DEFINITIONS
          1-TRF     4-TCA     7-RCA     10-XRF
          2-TSI     5-B.T     8-INC     11-YRF
          3-TCS     6-B.R     9-ASI     12-ZRF

     TARGETING SPECIFICATIONS
          KEY   TARGET VALUE     TOLERANCE
           7       7000.000        100.000
           8        -50.000          1.000
           3      28838.500           .010

     TARGETING SCHEME
          LEVELS   1.000E-04  2.500E-05
          DVMAX    1.00000000E-02
          IBAST      1

IND NOF PHS  KEYTAR       DTAR(1)      DTAR(2)      DTAR(3)   KAXTAR       DAUX(1)      DAUX(2)      DAUX(3)  ISTOP  DELT
  1   1   1   7  8  3     7000.00       -50.00     28838.50    5  6  3     7000.00       -50.00     28838.50    2   132.879

ACCURACY      VX          VY           VZ           TAR - 7-     TAR - 8-     TAR - 3-     AUX - 5-     AUX - 6-     AUX - 3-  INCR   CPT
1.00E-04   6.1928578  22.7126246  -3.2751748      7040.578       51.853    28838.502    13124.108     7231.367    28838.502   538     9
1.00E-04   6.1928678  22.7126246  -3.2751748      7047.456       53.527    28838.504    12716.234     7944.730    28838.504   538    18
1.00E-04   6.1928578  22.7126346  -3.2751748      7053.326       51.931    28838.502    13119.600     7273.831    28838.502   538    27
1.00E-04   6.1928578  22.7126246  -3.2751648      7032.011       52.396    28838.503    12981.374     7462.665    28838.503   538    36

  SENSITIVITY MATRIX                     TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL     DES TAR VAL     TAR TOL
-4.08E+07 -4.51E+05 -1.43E+07     -8.53E-09  7.74E-07 -2.86E-01      3.94E+02    -1.41E-04     13518.232        7000.000     100.000
 7.13E+07  4.25E+06  2.31E+07      4.74E-07 -8.70E-07  4.26E-01     -8.90E+02     1.39E-04      6341.464         -50.000       1.000
 1.91E+02  1.15E+01  6.31E+01     -6.06E-08 -2.19E-06  8.03E-01     -1.93E-03     3.72E-04     28838.500       28838.500        .010

ACCURACY      VX          VY           VZ           TAR - 7-     TAR - 8-     TAR - 3-     AUX - 5-     AUX - 6-     AUX - 3-  INCR   CPT
1.00E-04   6.1927165  22.7127538  -3.2748030      6925.033       51.876    28838.502    12987.024     7168.344    28838.502   538    45
1.00E-04   6.1927265  22.7127638  -3.2748030      6930.772       53.473    28838.504    12601.143     7842.102    28838.504   538    54
1.00E-04   6.1927165  22.7127738  -3.2748030      6937.540       51.948    28838.503    12983.877     7207.784    28838.503   538    63
```

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1.00E-04    6.1927165  22.7127638  -3.2747930     6915.112      52.419   28838.503   12844.099    7395.880   28838.503  538    72

     SENSITIVITY MATRIX                      TARGETING MATRIX              AUX ERROR    VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-3.86E+07 -3.15E+05 -1.43E+07      -7.62E-09  8.38E-07 -3.09E-01      5.31E+02     4.81E-05      13518.430       7000.000     100.000
 6.74E+07  3.94E+06  2.28E+07       4.76E-07 -1.16E-06  5.34E-01     -8.27E+02    -7.76E-05       6340.892        -50.000       1.000
 1.80E+02  1.07E+01  6.20E+01      -5.99E-08 -2.24E-06  8.23E-01     -2.41E-03    -1.65E-04      28838.500      28838.500        .010

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
1.00E-04    6.1927645  22.7126862  -3.2749682     7012.861      49.493   28838.499   13648.644    6094.369   28838.499  538    81

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
2.50E-05    6.1927645  22.7126862  -3.2749682    27046.054     113.821   28838.596  -17983.081   32909.346   28838.596 1011    98

     SENSITIVITY MATRIX                      TARGETING MATRIX              AUX ERROR    VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-3.86E+07 -3.15E+05 -1.43E+07      -7.62E-09  8.38E-07 -3.09E-01      3.15E+04     1.77E-03      13560.615       7000.000     100.000
 6.74E+07  3.94E+06  2.28E+07       4.76E-07 -1.16E-06  5.34E-01     -2.66E+04    -1.34E-03       6308.160        -50.000       1.000
 1.80E+02  1.07E+01  6.20E+01      -5.99E-08 -2.24E-06  8.23E-01     -9.58E-02    -5.30E-03      28838.500      28838.500        .010

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
2.50E-05    6.1945352  22.7113443  -3.2802711    12016.811     107.276   28838.535   -6921.716   19895.052   28838.535 1010   114

     SENSITIVITY MATRIX                      TARGETING MATRIX              AUX ERROR    VEL COR     DES AJX VAL    DES TAR VAL      TAR TOL
-3.86E+07 -3.15E+05 -1.43E+07      -7.62E-09  8.38E-07 -3.09E-01      2.05E+04    -7.05E-04      13537.753       7000.000     100.000
 6.74E+07  3.94E+06  2.28E+07       4.76E-07 -1.16E-06  5.34E-01     -1.36E+04     6.74E-03       6331.510        -50.000       1.000
 1.80E+02  1.07E+01  6.20E+01      -5.99E-08 -2.24E-06  8.23E-01     -3.50E-02     3.25E-04      28838.500      28838.500        .010

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
2.50E-05    6.1938298  22.7180828  -3.2799462     7456.526      63.639   28838.497   10269.906   11647.397   28838.497 1009   131

     SENSITIVITY MATRIX                      TARGETING MATRIX              AUX ERROR    VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-3.86E+07 -3.15E+05 -1.43E+07      -7.62E-09  8.38E-07 -3.09E-01      3.25E+03    -2.63E-03      13524.472       7000.000     100.000
 6.74E+07  3.94E+06  2.28E+07       4.76E-07 -1.15E-06  5.34E-01     -5.30E+03     4.52E-03       6346.302        -50.000       1.000
 1.80E+02  1.07E+01  6.20E+01      -5.99E-08 -2.24E-06  8.23E-01      2.56E-03     6.88E-03      28838.500      28838.500        .010

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
2.50E-05    6.1912020  22.7226016  -3.2730648    10974.695      78.669   28838.533    6763.701   18656.313   28838.533 1010   148

     SENSITIVITY MATRIX                      TARGETING MATRIX              AUX ERROR    VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-3.86E+07 -3.15E+05 -1.43E+07      -7.62E-09  8.38E-07 -3.09E-01      6.78E+03    -2.51E-04      13539.248       7000.000     100.000
 6.74E+07  3.94E+06  2.28E+07       4.76E-07 -1.16E-06  5.34E-01     -1.23E+04    -1.38E-05       6329.236        -50.000       1.000
 1.80E+02  1.07E+01  6.20E+01      -5.99E-08 -2.24E-06  8.23E-01     -3.28E-02     2.05E-04      28838.500      28838.500        .010

ACCURACY       VX          VY          VZ          TAR - 7-    TAR - 8-    TAR - 3-    AUX - 5-    AUX - 6-    AUX - 3-  INCR   CPT
2.50E-05    6.1909507  22.7225878  -3.2728602     7038.535      49.339   28838.495   13719.060    6027.572   28838.495 1009   165


    EXECUTION EVENT

    DELTA V =      -.00190711      .00996323      .00231463      .01040484

    DOMINANT BODY ELEMENTS       SMA               ECC            OMEGA          INC         NODE          TA
    PLANET ECLIPTIC
       BEFORE IMPULSE     -4.559908781E+04   1.1439099E+00   -113.90007     48.74751   -158.12911     3.10739
       AFTER IMPULSE      -4.559279446E+04   1.1439262E+00   -113.91186     48.73145   -158.18543     3.15632
    PLANET EQUATORIAL
       BEFORE IMPULSE     -4.559908781E+04   1.1439099E+00   -132.27175     28.05035   -143.44721     3.10739
       AFTER IMPULSE      -4.559279446E+04   1.1439262E+00   -132.25472     28.02177   -143.52194     3.15632
```

TRAJECTORY TIME = 0.   TOTAL TIME INCREMENTS = 0

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
SPACECRAFT INERTIAL TRAJECTORY				
POSITION.	1.22444854260E+08	-8.91391532050E+07	-4.61581285620E+03	1.51454715972E+08
VELOCITY.	6.19095068768E+00	2.27225878325E+01	-3.27286016578E+00	2.37772050899E+01

****

CALENDAR DATE = AUGUST 17, 4 HR, 49 MIN, 15.201 SEC, 1978
JULIAN DATE = 2443737.70087038

EPHEMERIS DATA				
POSITION OF SUN	0.	0.	0.	0.
VELOCITY OF SUN	0.	0.	0.	0.
POSITION OF VENUS	7.23861945766E+06	-1.08532271069E+08	-1.92161790346E+06	1.08790367636E+08
VELOCITY OF VENUS	3.47074804399E+01	2.20501285155E+00	-1.97106795620E+00	3.48332655525E+01
POSITION OF EARTH	1.22444198804E+08	-8.91437785965E+07	0.	1.51456908338E+08
VELOCITY OF EARTH	1.70469794598E+01	2.39742656129E+01	0.	2.94170855239E+01

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SPACECRAFT RELATIVE TRAJECTORIES				
POSITION REL. TO SUN . . .	1.22444854260E+08	-8.91391532050E+07	-4.61581285620E+03	1.51454715972E+08
VELOCITY REL. TO SUN . . .	6.19095068768E+00	2.27225878325E+01	-3.27286016578E+00	2.37772050899E+01
POSITION REL. TO VENUS . . .	1.15206234802E+08	1.93931178641E+07	1.91700209060E+06	1.16842819441E+08
VELOCITY REL. TO VENUS . . .	-2.85165297522E+01	2.05175749809E+01	-1.30179220958E+00	3.51547722957E+01
POSITION REL. TO EARTH . . .	6.55455973324E+02	4.62539152599E+03	-4.61581285620E+03	6.56731281614E+03
VELOCITY REL. TO EARTH . . .	-1.08560287821E+01	-1.25167778042E+00	-3.27286016578E+00	1.14075269822E+01

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
VIRTUAL MASS DATA				
VIRTUAL MASS POSITION	1.22444195480E+08	-8.91437761767E+07	-2.78073434538E-07	1.51456904226E+08
VIRTUAL MASS VELOCITY	1.70464694170E+01	2.39746359596E+01	-4.30486708162E-11	2.94170917832E+01
SPACECRAFT POS. REL. TO V.M.	6.58773774571E+02	4.62297169411E+03	-4.61581285592E+03	6.56594139456E+03
SPACECRAFT VEL. REL. TO V.M.	-1.08555187293E+01	-1.25204812717E+00	-3.27286016573E+00	1.14070822325E+01
KEPLER (ANG. MOM.) VECTOR	-2.09095597466E+04	5.22631369907E+04	4.93599318276E+04	7.48668688202E+04
ECCENTRICITY VECTOR	1.73920521160E-01	8.12826745428E-01	-7.86959636681E-01	1.14465764992E+00
V.M. MAGN. = 3.98350323753E+05				
V.M. MAGN. RATE = -9.28922994087E-01				
V.M. RELATIVE POSITIONS				
POSITION REL. TO SUN . . .	1.22444195480E+08	-8.91437761767E+07	-2.78073434538E-07	1.51456904226E+08
POSITION REL. TO VENUS . . .	1.15205576023E+08	1.93884948924E+07	1.92161790346E+06	1.16841478492E+08
POSITION REL. TO EARTH . . .	-3.32380104065E+00	2.41983175278E+00	-2.78073434538E-07	4.11135489463E+00

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-2.06062132742E+01
INCLINATION TO PLANE OF SKY	1.68413230154E+00
GEOCENTRIC DECLINATION.	-2.13829902458E+01
TARGET PLANET ANGLE (ZAE)	7.82422426963E+01
ANTENNA AXIS - EARTH ANGLE.	-4.46558279065E+01
ANTENNA AXIS - LIMB OF SUN ANGLE. .	1.17724767665E+02
OCCULTATION RATIO FOR SUN IS	2.04537766147E+02

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GUIDANCE EVENT AT    90.000 DAYS
CALENDAR DATE   1978   11   15    4   49  15.201     JULIAN DATE    28807.70087

EVENT CODES        KUR  2     KTYP  1     KMXQ  3     MDL  2

CURRENT SPACECRAFT STATE
REFERENCE       X-COMP          Y-COMP          Z-COMP           RADIUS        X-DOT        Y-DOT         Z-DOT        VELOCITY
INERTIAL      63379142.86    102083522.26     6010901.56     120308321.43  -31.72685391  12.87333748   -.43494527   34.24186406
SUN           63379142.86    102083522.26     6010901.56     120308321.43  -31.72685391  12.87333748   -.43494527   34.24186406
VENUS          4327365.03     11673409.99     8163732.18      14887616.06   -2.29414993  -6.12403883  -2.39563003    6.96462625
EARTH        -26755752.98    -15265735.86     6010901.56      31385409.77   -7.61632742  -5.16395544   -.43494527    9.21216894
     N-BODY TARGETING EVENT


     STATE      6.3379142859E+07    1.0208352226E+08    6.0109015557E+06
              -3.1726853912E+01    1.2873337485E+01   -4.3494527019E-01
     JULIAN DATE     2.8807700870E+04


     PARAMETER KEY DEFINITIONS
          1-TRF      4-TCA      7-RCA      10-XRF
          2-TSI      5-B.T      8-INC      11-YRF
          3-TCS      6-B.R      9-ASI      12-ZRF


     TARGETING SPECIFICATIONS
          KEY   TARGET VALUE      TOLERANCE
           7       7500.000          50.000
           8        -60.000            .500
           4      28838.708            .005


     TARGETING SCHEME
          LEVELS   2.500E-05
          DVMAX    1.00000000E-02
          IBAST       3

IND NOF PHS  KEYTAR          DTAR(1)       DTAR(2)       DTAR(3)   KAXTAR        DAUX(1)       DAUX(2)       DAUX(3)  ISTOP  DELT
 2  2   1    7  8  3         7500.00        -60.00      28838.71   5  6  3       7500.00        -60.00      28838.71    2     34.108

ACCURACY      VX           VY            VZ          TAR - 7-      TAR - 8-     TAR - 3-     AUX - 5-      AUX - 6-      AUX - 3- INCR   CPT
2.50E-05 -31.7268539  12.8733375   -.4349453      7038.729        49.339    28838.495   13719.219      6027.774     28838.495  225    183
2.50E-05 -31.7268039  12.8733375   -.4349453      6974.295        49.478    28838.495   13611.018      6065.242     28838.495  225    187
2.50E-05 -31.7268539  12.8733875   -.4349453      7113.592        49.453    28838.495   13782.120      6126.094     28838.495  225    191
2.50E-05 -31.7268539  12.8733375   -.4348953      7012.093        49.197    28838.495   13719.910      5939.723     28838.495  225    195

   SENSITIVITY MATRIX                  TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL     DES TAR VAL      TAR TOL
-2.16E+06  1.26E+06  1.38E+04    -4.33E-07  8.29E-08  5.32E-02    -2.32E+03    3.19E-03     11403.102       7500.000       50.000
 7.49E+05  1.97E+05 -1.75E+06     5.20E-08  1.47E-07  9.01E-02     4.59E+03    4.95E-03     10615.810        -60.000         .500
 2.80E-02  7.17E+00  2.85E+00    -1.26E-07 -3.69E-07  1.23E-01     2.14E-01    6.24E-03     28838.708      28838.708         .005

ACCURACY      VX           VY            VZ          TAR - 7-      TAR - 8-     TAR - 3-     AUX - 5-      AUX - 6-      AUX - 3- INCR   CPT
2.50E-05 -31.7236663  12.8782920   -.4287079      7022.088        51.778    28838.548   13149.088      7187.510     28838.548  226    198
2.50E-05 -31.7236163  12.8782920   -.4287079      6963.115        51.947    28838.548   13040.759      7225.078     28838.548  226    202
2.50E-05 -31.7236663  12.8783420   -.4287079      7101.098        51.889    28838.548   13212.239      7286.098     28838.548  226    206
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2.50E-05 -31.7236663  12.8782920   -.4286579      6990.207       51.625    28838.548   13149.784    7099.388    28838.548  226   210

   SENSITIVITY MATRIX                 TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-2.17E+06  1.26E+05  1.39E+04      -4.30E-07  7.84E-08  5.31E-02   -1.72E+03     4.76E-03     11424.694       7500.000       50.000
 7.51E+05  1.97E+06 -1.76E+06       5.58E-08  1.39E-07  8.97E-02    3.44E+03     7.37E-03     10625.564        -60.000         .500
 1.86E-01  7.32E+00  2.72E+00      -1.21E-07 -3.79E-07  1.23E-01    1.60E-01     9.30E-03     28838.708      28838.708         .005

ACCURACY      VX          VY           VZ          TAR - 7-     TAR - 8-    TAR - 3-    AUX - 5-     AUX - 6-     AUX - 3- INCR   CPT
2.50E-05 -31.7189099  12.8856658   -.4194059      7167.787       55.826    28838.629   12306.171    8934.562    28838.629  227   214
2.50E-05 -31.7188599  12.8856658   -.4194059      7117.391       56.033    28838.629   12197.644    8972.286    28838.629  227   218
2.50E-05 -31.7189099  12.8857158   -.4194059      7252.363       55.919    28838.629   12369.695    9033.559    28838.629  227   221
2.50E-05 -31.7189099  12.8856658   -.4193559      7128.361       55.669    28838.629   12306.877    8846.335    28838.629  227   225

   SENSITIVITY MATRIX                 TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-2.17E+06  1.27E+06  1.41E+04      -4.25E-07  7.22E-08  5.29E-02   -8.49E+02     4.70E-03     11457.121       7500.000       50.000
 7.54E+05  1.98E+06 -1.75E+06       6.28E-08  1.28E-07  8.90E-02    1.71E+03     7.27E-03     10640.161        -60.000         .500
 4.49E-01  7.50E+00  2.52E+00      -1.11E-07 -3.93E-07  1.22E-01    7.98E-02     9.20E-03     28838.708      28838.708         .005

ACCURACY      VX          VY           VZ          TAR - 7-     TAR - 8-    TAR - 3-    AUX - 5-     AUX - 6-     AUX - 3- INCR   CPT
2.50E-05 -31.7142053  12.8929327   -.4102070      7499.455       60.040    28838.709   11476.907   10667.025    28838.709  219   229

   IND NOF PHS  KEYTAR        DTAR(1)       DTAR(2)      DTAR(3)    KAXTAR        DAUX(1)       DAUX(2)       DAUX(3)   ISTOP  DELT
    2   2   2    7  8  4      7500.00       -60.00      28838.71    5  6  4       7500.00       -60.00      28838.71     3    34.108

ACCURACY      VX          VY           VZ          TAR - 7-     TAR - 8-    TAR - 4-    AUX - 5-     AUX - 6-     AUX - 4- INCR   CPT
2.50E-05 -31.7142053  12.8929327   -.4102070      7830.483       60.131    28838.709   11766.880   10977.494    28838.709  700   240
2.50E-05 -31.7142003  12.8929327   -.4102070      7826.263       60.154    28838.709   11756.007   10981.283    28838.709  700   252
2.50E-05 -31.7142053  12.8929377   -.4102070      7839.493       60.138    28838.709   11773.285   10987.432    28838.709  700   264
2.50E-05 -31.7142053  12.8929327   -.4102020      7825.776       60.117    28838.709   11766.942   10968.664    28838.709  700   275

ACCURACY      VX          VY           VZ          TAR - 7-     TAR - 8-    TAR - 4-    AUX - 5-     AUX - 6-     AUX - 4- INCR   CPT
2.50E-05 -31.7142053  12.8929327   -.4102070      7830.483       60.131    28838.709   11766.880   10977.494    28838.709  700   287

   SENSITIVITY MATRIX                 TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-2.17E+06  1.28E+06  1.23E+04      -4.19E-07  6.76E-08  5.28E-02   -2.70E+02     4.33E-05     11497.247       7500.000       50.000
 7.58E+05  1.99E+06 -1.77E+06       7.11E-08  1.19E-07  8.84E-02   -3.30E+02    -1.37E-04     10647.535        -60.000         .500
 7.32E-01  7.62E+00  2.35E+00      -9.96E-08 -4.04E-07  1.22E-01   -8.95E-04     5.08E-05     28838.708      28838.708         .005

ACCURACY      VX          VY           VZ          TAR - 7-     TAR - 8-    TAR - 4-    AUX - 5-     AUX - 6-     AUX - 4- INCR   CPT
2.50E-05 -31.7141620  12.8927953   -.4101562      7500.257       59.999    28838.708   11497.290   10647.545    28838.708  703   299


   EXECUTION EVENT

   DELTA V =        .01269195      .01945780      .02478908      .03397338

   DOMINANT BODY ELEMENTS        SMA               ECC            OMEGA          INC         NODE          TA
   PLANET ECLIPTIC
      BEFORE IMPULSE     1.283839695E+08   1.8071017E-01   174.61141     2.87435   -36.74059   -79.71127
      AFTER IMPULSE      1.283436452E+08   1.7996488E-01   173.78454     2.87120   -35.94368   -79.68032


   PULSING ARC DATA

   THRUST  1.0000E-03    MASS  1.0000E+00    DJR  1.0000E+00    DV  1.0000E-03

   DELTA V           X-COMP        Y-COMP        Z-COMP        MAG
   IMPULSIVE         .012692       .019458       .024789       .033973
   NOM PULSE         .000374       .000573       .000730       .001000
   END PULSE         .000364       .000557       .000710       .000973

   PULSE ARC      JULIAN DATE        CALENDAR DATE
```

MIDPOINT	28807.70087	1978 11 15 4 4915.201
INITIATION	28805.05087	1978 11 13 13 1315.200
TERMINATION	28809.35087	1978 11 16 20 2515.200

F AND G SERIES	F2	F3	F4	F5	F6	G3	G4	G5	G6
LAUNCH BODY	-2.0482E-14	-5.2887E-23	7.2029E-29	5.5868E-37	3.6651E-42	-6.8272E-15	-2.6444E-23	1.5251E-29	1.9192E-37
TARGET BODY	-5.2665E-14	-1.1160E-22	4.6454E-28	2.9541E-36	6.3805E-41	-1.7555E-14	-5.5798E-23	9.3822E-29	9.8987E-37

PULSING ARC EXECUTION

PULSE	TIME	X-COMP	Y-COMP	Z-COMP	X-DOT	Y-DOT	Z-DOT
0	0.	67852225.396	100170251.747	6068260.250	-31.02124380	13.96110273	-.36987349
1	0.	67852225.396	100170251.747	6068260.250	-31.02087022	13.96167547	-.36914383
2	.10000	67584016.179	100290601.242	6065053.905	-31.06418506	13.89757728	-.37233479
3	.20000	67315433.235	100410396.243	6061819.978	-31.10738118	13.83332046	-.37552859
4	.30000	67046477.591	100529635.381	6058558.445	-31.15045806	13.76890510	-.37872524
5	.40000	66777150.280	100648317.284	6055269.280	-31.19341509	13.70433127	-.38192472
6	.50000	66507452.341	100766440.585	6051952.459	-31.23625166	13.63959903	-.38512703
7	.60000	66237384.817	100884003.916	6048607.958	-31.27896716	13.57470847	-.38833214
8	.70000	65966948.756	101001005.907	6045235.753	-31.32156096	13.50965965	-.39154003
9	.80000	65696145.213	101117445.194	6041835.820	-31.36403247	13.44445266	-.39475070
10	.90000	65424975.247	101233320.408	6038408.135	-31.40638105	13.37908758	-.39796411
11	1.00000	65153439.923	101348630.186	6034952.674	-31.44860609	13.31356449	-.40118026
12	1.10000	64881540.310	101463373.161	6031469.414	-31.49070696	13.24788347	-.40439913
13	1.20000	64609277.485	101577547.970	6027958.331	-31.53268306	13.18204462	-.40762069
14	1.30000	64336652.528	101691153.250	6024419.402	-31.57453375	13.11604803	-.41084494
15	1.40000	64063666.525	101804187.638	6020852.604	-31.61625841	13.04989379	-.41407185
16	1.50000	63790320.568	101916649.772	6017257.914	-31.65785642	12.98358199	-.41730141
17	1.60000	63516615.754	102028538.292	6013635.309	-31.69932714	12.91711274	-.42053359
18	1.70000	63242553.185	102139851.837	6009984.768	-31.74066997	12.85048612	-.42376839
19	1.80000	62968133.970	102250589.049	6006306.266	-31.78188425	12.78370226	-.42700577
20	1.90000	62693359.220	102360748.569	6002599.782	-31.82296937	12.71676125	-.43024573
21	2.00000	62418230.056	102470329.039	5998865.294	-31.86392470	12.64966319	-.43348825
22	2.10000	62142747.601	102579329.105	5995102.779	-31.90474960	12.58240821	-.43673330
23	2.20000	61866912.984	102687747.409	5991312.216	-31.94544343	12.51499641	-.43998086
24	2.30000	61590727.342	102795582.598	5987493.584	-31.98600557	12.44742790	-.44323093
25	2.40000	61314191.814	102902833.319	5983646.860	-32.02643539	12.37970281	-.44648347
26	2.50000	61037307.547	103009498.218	5979772.024	-32.06673223	12.31182126	-.44973848
27	2.60000	60760075.692	103115575.945	5975869.054	-32.10689547	12.24378337	-.45299592
28	2.70000	60482497.407	103221065.150	5971937.929	-32.14692447	12.17558927	-.45625579
29	2.80000	60204573.853	103325964.483	5967978.628	-32.18681858	12.10723907	-.45951806
30	2.90000	59926306.200	103430272.596	5963991.131	-32.22657717	12.03873293	-.46278271
31	3.00000	59647695.620	103533988.142	5959975.418	-32.26619959	11.97007096	-.46604973
32	3.10000	59368743.293	103637109.776	5955931.467	-32.30568521	11.90125330	-.46931909
33	3.20000	59089450.405	103739636.154	5951859.258	-32.34503337	11.83228010	-.47259078
34	3.30000	58809818.144	103841565.931	5947758.773	-32.38425338	11.76313624	-.47588419
IMPULSIVE MODEL		58809736.965	103841435.727	5947750.012	-32.38480813	11.76219664	-.47592378

ELEMENTS AFTER ARC	SMA	ECC	OMEGA	INC	NODE	TA
SERIES OF PULSES	1.283416923E+08	1.7933473E-01	173.78856	2.87122	-35.94810	-77.37316
IMPULSIVE MODEL	1.283430587E+08	1.7996711E-01	173.79042	2.87122	-35.94760	-77.37550

```
SPACECRAFT PIERCED SPHERE OF INFLUENCE OF VENUS   AT DATE. . . . 2443857.39948677

        POSITION. . . . .   1.84943221199E+05   4.28881601958E+05   4.01894647432E+05   6.16167778450E+05
        VELOCITY. . . . .  -1.60842615751E+00  -3.50281023521E+00  -3.45387047506E+00   5.17551306698E+00

        B . . . .     1.67635924359E+04     B.T . . . .     1.11204243509E+04     B.R . . . .     1.25440899875E+04
        INCLINATION =    63.61



INTERPOLATED INFORMATION AT SPHERE OF INFLUENCE

SPACECRAFT PIERCED SPHERE OF INFLUENCE OFVENUS    AT DATE. . . . 2443857.39908847

        POSITION. . . . .   1.84998571953E+05   4.29002144133E+05   4.02013505444E+05   6.16345820018E+05
        VELOCITY. . . . .  -1.60842615751E+00  -3.50281023521E+00  -3.45387047506E+00   5.17551306698E+00

        B . . . .     1.67634932230E+04     B.T . . . .     1.11203573706E+04     B.R . . . .     1.25440167805E+04
        INCLINATION =    63.61
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    GUIDANCE EVENT AT   120.199 DAYS
    CALENDAR DATE   1978   12   15    9   35  15.657     JULIAN DATE    28837.89949

    EVENT CODES        KUR  3     KTYP  3     KMXQ  4     MDL  1

    CURRENT SPACECRAFT STATE
    REFERENCE       X-COMP          Y-COMP          Z-COMP          RADIUS        X-DOT        Y-DOT          Z-DOT       VELOCITY
INERTIAL       -28741310.05     103833709.73      3351068.81     107790221.45  -35.48288834 -13.13631803  -1.67332788  37.87345036
SUN            -28741310.05     103833709.73      3351068.81     107790221.45  -35.48288834 -13.13631803  -1.67332788  37.87345036
VENUS             115134.18        276881.58       251961.91        391668.34   -1.62747589  -3.54110303  -3.49288922   5.23338930
EARTH          -46523784.51     -42325152.81      3351068.81      62985004.15   -5.42591187 -16.62562017  -1.67332788  17.56848860


    INSERTION DECISION EVENT
    PLANAR OPTION
    TARGET PARAMETERS     A=    27000.000    E=     .750000   DPER=    5.000

COPLANAR INSERTION EVENT

EVENT              X/VX       Y/VY       Z/VZ       R/V          A/E       W/TA      I/N       RP/RA      TIME

DECISION         296116.8   -32265.1   254318.5   391668.3    -12625.2   -102.50     63.53    8621.21   -70537.94
                 -3.82332     .54708   -3.53148    5.23339     1.68285   -124.00   -161.06

TARGET ORBIT                                                   27000.0    -97.50     63.53    6750.00
                                                                .75000      0.     -161.06   47250.00

MODIFY RP

 PRE-INSERTION     1891.8     4452.2    -7223.3     8693.5    -12625.2   -102.50     63.53    8621.21     -140.55
                 -9.51316   -1.96433   -2.47045   10.02307     1.68285     -9.34   -161.06

 POST-INSERTION    1891.8     4452.2    -7223.3     8693.5     27916.3    -97.50     63.53    8582.67     -270.68
                 -7.53919   -1.55674   -1.95784    7.94330      .69256    -14.34   -161.06   47250.00

 INSERTION VEL    1.97396     .40759     .51261    2.07977

MODIFY RA
CANDIDATE SMA S =-1.448E+04      3.375E+03
SOLUTION INVALID

MODIFY SMA

 PRE-INSERTION     2093.5     4493.4    -7170.0     8716.8    -12625.2   -102.50     63.53    8621.21     -151.78
                 -9.49233   -1.91757   -2.54570   10.01308     1.68285    -10.73   -161.06

 POST-INSERTION    2093.5     4493.4    -7170.0     8716.8     34307.6    -97.50     63.53    8576.90     -292.40
                 -7.64670   -1.54473   -2.05073    8.06621      .75000    -15.73   -161.06   60038.33

 INSERTION VEL    1.84562     .37284     .49497    1.94687

SELECTED CORREC   1.97396     .40759     .51261    2.07977
TIME=  70397.39
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GUIDANCE EVENT AT 121.013 DAYS
CALENDAR DATE 1978 12 16 5 8 33.046 JULIAN DATE 28838.71427

EVENT CODES KUR 3 KTYP 3 KMXQ 2 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	-31236308.54	102857165.86	3219391.56	107543795.83	-34.13543085	-19.99588767	-.83882848	39.56471886
SUN	-31236308.54	102857165.86	3219391.56	107543795.83	-34.13543085	-19.99588767	-.83882848	39.56471886
VENUS	-4314.53	3150.83	-6978.19	8788.57	-.50571000	-9.61539699	-2.63463179	9.98262924
EARTH	-46901007.59	-43532275.83	3219391.56	64071273.15	-4.02949577	-23.04696731	-.83882848	23.41160335

EXECUTION EVENT

DELTA V = .09502502 2.00730507 .53584847 2.07976843

DOMINANT BODY ELEMENTS	SMA	ECC	OMEGA	INC	NODE	TA
PLANET ECLIPTIC						
BEFORE IMPULSE	-1.262552949E+04	1.6892768E+00	-103.90760	60.39051	-84.06486	-10.13130
AFTER IMPULSE	2.832781908E+04	6.9423570E-01	-98.77356	60.38419	-84.08115	-15.25729
PLANET EQUATORIAL						
BEFORE IMPULSE	-1.262552949E+04	1.6892768E+00	-102.64665	63.59727	-161.14760	-10.13130
AFTER IMPULSE	2.832781908E+04	6.9423570E-01	-97.51356	63.59127	-161.16356	-15.25729

```
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF VENUS    AT DATE. . . . . 2443858.71784429

        POSITION. . . . .  -4.33993733595E+03   7.47453026131E+02  -7.45891062252E+03   8.66193337431E+03
        VELOCITY. . . . .   2.50567350507E-01  -7.90460103986E+00  -9.95472606517E-01   7.97097655917E+00
        INCLINATION =   63.59


INTERPOLATED INFORMATION AT CLOSEST APPROACH
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF VENUS    AT DATE. . . . 2443858.71765341

        POSITION. . . .  -4.34377459084E+03   8.77762442151E+02  -7.44198654885E+03   8.66152459987E+03
        VELOCITY. . . .   2.14772172746E-01  -7.89790171744E+00  -1.05689567625E+00   7.97119859839E+00
        INCLINATION =   63.59
                 TACA=  2.83256689E+04
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Case N-3. Lunar Viking '76 Mission

TARGETING OF LUNAR PATCHED CONIC

```
ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 1    5.000    -3.698 -179.498    90.000  -7159.1  47964.2   11.823    .678     .616    .151    54290.5   -6313.9

 1    5.100    -3.698 -179.498    90.000  -7071.8  47708.3   11.823    .675     .625    .150    53946.9   -6370.1
 1    5.000    -3.698 -175.498    90.000  -7062.0  49913.5   12.379    .682     .618    .152    56065.9   -7276.5
 1    5.000      .302 -179.498    90.000  -7192.8  47666.8   15.326    .676     .613    .155    53333.5  -10647.4

          PHI MATRIX                              PHI-INVERSE                           ERRORS      TARGETS  CORRECTION
  8.731E+02  2.425E+01 -8.425E+00      9.510E-04 -5.001E-05  3.647E-05       -4.09E+01     -7200.0      1.000
 -3.435E+03  4.439E+02 -2.392E+02      5.336E-03  1.679E-03 -4.200E-04       -5.42E+04        96.0    -10.000
 -5.616E+02 -2.406E+02 -1.083E+03     -1.900E-03 -3.470E-04 -8.315E-04        8.95E+02     -5418.7     10.000

ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 2    6.000     6.302 -189.498    90.000  -6610.3  37790.3   21.381    .640     .695    .156    41370.9  -14702.6

 2    6.100     6.302 -189.498    90.000  -6525.7  37459.6   22.124    .638     .704    .156    40936.7  -14707.4
 2    6.000     6.302 -185.498    90.000  -6519.5  40778.4   22.251    .645     .698    .158    44082.6  -15852.9
 2    6.000    10.302 -189.498    90.000  -6634.9  37898.4   27.534    .639     .693    .161    39754.1  -18342.0

          PHI MATRIX                              PHI-INVERSE                           ERRORS      TARGETS  CORRECTION
  8.453E+02  2.269E+01 -6.151E+00      1.021E-03 -3.158E-05  6.116E-06       -5.90E+02     -7200.0       .759
 -4.341E+03  6.779E+02 -4.042E+02      5.605E-03  1.096E-03 -4.506E-04       -4.13E+04        92.8    -10.000
 -4.835E+01 -2.876E+02 -1.060E+03     -1.567E-03 -2.960E-04 -8.215E-04        9.47E+03     -5231.2      5.363

ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 3    6.759    11.664 -199.498    90.000  -6217.2  27075.7   32.984    .608     .755    .156    27858.3  -17136.9

 3    6.859    11.664 -199.498    90.000  -6135.7  26735.5   33.332    .605     .764    .156    27391.3  -17105.2
 3    6.759    11.664 -195.498    90.000  -6138.4  30629.9   32.107    .612     .758    .159    31200.6  -18459.5
 3    6.759    15.664 -199.498    90.000  -6232.2  28030.4   40.435    .607     .754    .161    26086.7  -21320.8

          PHI MATRIX                              PHI-INVERSE                           ERRORS      TARGETS  CORRECTION
  8.143E+02  1.969E+01 -3.771E+00      1.092E-03 -2.336E-05  5.357E-06       -9.83E+02     -7200.0      -.353
 -4.670E+03  8.356E+02 -4.429E+02      5.376E-03  9.100E-04 -4.047E-04       -2.78E+04        90.3    -10.000
  3.169E+02 -3.307E+02 -1.046E+03     -1.369E-03 -2.947E-04 -8.263E-04        1.20E+04     -5092.6      -.422

ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 4    6.407    11.242 -209.498    90.000  -6634.7  18312.4   33.865    .608     .718    .149    20818.7  -13322.2

 4    6.507    11.242 -209.498    90.000  -6609.4  18531.3   34.391    .605     .727    .148    20300.1  -13277.0
 4    6.407    11.242 -205.498    90.000  -6623.3  22713.8   32.431    .611     .720    .151    24485.0  -14740.5
 4    6.407    15.242 -209.498    90.000  -6707.0  20205.2   43.539    .607     .717    .154    19199.3  -17625.8

ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 6    6.206    11.353 -229.498    90.000  -7135.9   2580.9   70.996    .603     .693    .136     2172.9   -6226.9

 6    6.306    11.353 -229.498    90.000  -7048.7   2445.4   73.440    .600     .702    .136     1617.5   -6151.2
 6    6.206    11.353 -225.498    90.000  -7096.3   5084.0   51.552    .604     .694    .138     6231.6   -7692.2
 6    6.206    15.353 -229.498    90.000  -7142.8   5747.7   85.510    .603     .692    .141      851.3  -10696.8

          PHI MATRIX                              PHI-INVERSE                           ERRORS      TARGETS  CORRECTION
  8.725E+02  9.904E+00 -1.712E+00      1.081E-03 -1.007E-05  1.322E-06       -6.41E+01     -7200.0      -.047
 -5.554E+03  1.015E+03 -3.304E+02      5.561E-03  8.387E-04 -2.565E-04       -2.08E+03        95.6     -2.308
  7.567E+02 -3.663E+02 -1.117E+03     -1.091E-03 -2.818E-04 -8.099E-04        8.16E+02     -5410.9      -.006

ITR   ALPHA     DELTA    THETA     SIGMA     SMA      RCA       INC    VSI(1)   VSI(2)  VSI(3)     B.T       B.R
 7    6.159    11.347 -231.806    90.000  -7196.6   1813.1   83.103    .604     .589    .135       85.8   -5419.9
```

TARGETING OF LUNAR MULTI-CONIC

TARGETING SCHEME

TARGETS		TOLERANCES		PERTURBATIONS		MAX STEPS		
SMA	-7200.00	SMA	25.00	VX	.002000	VX	.10000	MAX ITERS 150
INC	89.000	B.T	25.00	VY	.002000	VY	.10000	MULTI-CONIC STEP 10.000
RCA	1820.00	B.R	25.00	VZ	.002000	VZ	.10000	INJ CALENDAR DATE 1976 6 16 18 19 10.366
TCA	27930.000	TCA	.0050	TI	.002000	TI	.10000	

ITER	JULIAN DATE	X	Y	Z	VX	VY	VZ	SMA	B.T	B.R	TCA
0	27926.26331	-6336.7875	-1579.0456	-655.3618	2.797551	-8.777029	-5.902328	-6048.0	1018.2	-4960.5	27929.91774
0	27926.26331	-6336.7875	-1579.0456	-655.3618	2.799551	-8.777029	-5.902328	-6002.4	-24.3	-4690.1	27929.90748
0	27926.26331	-6336.7875	-1579.0456	-655.3618	2.797551	-8.775029	-5.902328	-6198.0	4211.7	-6152.0	27929.96115
0	27926.26331	-6336.7875	-1579.0456	-655.3618	2.797551	-8.777029	-5.900328	-6148.7	3154.0	-5761.1	27929.94619
0	27926.26531	-6337.4795	-1576.2663	-655.3613	2.793701	-8.778256	-5.902327	-6043.1	1174.9	-4906.8	27329.91611

SENSITIVITY MATRIX				TARGETING MATRIX				ERRORS	TARGETS	PREDICT	CORRECT
2.28E+04	-7.50E+04	-5.04E+04	2.44E+03	2.10E-04	1.31E-06	-2.32E-05	-7.55E-03	-1.15E+03	-7200.000	-.24202	-.09026
-5.21E+05	1.60E+06	1.07E+06	7.83E+04	6.90E-05	-1.32E-06	5.46E-05	1.88E+00	-6.21E+02	397.390	.07280	.02715
1.35E+05	-5.96E+05	-4.00E+05	2.68E+04	-1.70E-05	2.96E-06	-9.22E-05	-2.81E+00	-5.64E+01	-5016.881	-.20791	-.07753
-5.13E+00	2.17E+01	1.42E+01	-8.14E-01	2.22E-04	8.15E-06	-9.81E-06	-1.03E-01	8.23E-02	27930.000	-.26815	-.10000

ITER	JULIAN DATE	X	Y	Z	VX	VY	VZ	SMA	B.T	B.R	TCA
1	27926.16331	-6300.5969	-1717.7625	-655.3865	2.899300	-8.686307	-5.979928	-6580.0	4050.4	-5666.0	27930.03214
1	27926.16331	-6300.5969	-1717.7625	-655.3865	2.899500	-8.686307	-5.979928	-6575.4	3921.0	-5636.5	27930.03067
1	27926.16331	-6300.5969	-1717.7625	-655.3865	2.899300	-8.686507	-5.979928	-6565.8	3676.1	-5543.4	27930.02726
1	27926.16331	-6300.5969	-1717.7625	-655.3865	2.899300	-8.686307	-5.980128	-6570.2	3792.0	-5582.0	27930.02879
1	27926.16351	-6300.6724	-1717.4855	-655.3864	2.898918	-8.686434	-5.979928	-6579.6	4063.0	-5660.3	27930.03197

SENSITIVITY MATRIX				TARGETING MATRIX				ERRORS	TARGETS	PREDICT	CORRECT
2.31E+04	-7.11E+04	-4.92E+04	2.26E+03	-4.25E-06	2.22E-06	-3.27E-05	-1.00E+00	-6.20E+02	-7200.000	.01178	.00021
-6.47E+05	1.87E+06	1.29E+06	6.30E+04	2.07E-03	-4.85E-05	1.02E-04	9.02E+00	-3.61E+03	435.975	-1.50584	-.02749
1.48E+05	-6.13E+05	-4.20E+05	2.90E+04	-3.00E-03	8.47E-06	-1.64E-04	-1.35E+01	4.63E+02	-5203.230	2.19131	.04000
-7.32E+00	2.44E+01	1.67E+01	-8.12E-01	1.78E-04	8.97E-06	-1.23E-05	-4.81E-01	-3.21E-02	27930.000	-.13275	-.00242

ITER	JULIAN DATE	X	Y	Z	VX	VY	VZ	SMA	B.T	B.R	TCA
100	27925.96466	-6219.4317	-1991.6911	-655.4356	3.161630	-9.596955	-4.183960	-7193.0	382.4	-5361.6	27929.99919
100	27925.96466	-6219.4317	-1991.6911	-655.4356	3.161501	-9.596955	-4.183960	-7196.8	483.1	-5378.2	27930.00001
100	27925.96466	-6219.4317	-1991.6911	-655.4356	3.161530	-9.595913	-4.183360	-7196.3	466.2	-5380.6	27930.00001
100	27925.96466	-6219.4317	-1991.6911	-655.4356	3.161630	-9.596955	-4.183877	-7196.4	466.4	-5380.9	27930.00001
100	27925.96446	-6219.3438	-1991.9657	-655.4356	3.162054	-9.596816	-4.183961	-7193.4	371.5	-5366.6	27929.99943

SENSITIVITY MATRIX				TARGETING MATRIX				ERRORS	TARGETS	PREDICT	CORRECT
2.99E+04	-9.34E+04	-4.08E+04	2.23E+03	3.62E-04	5.24E-06	-2.04E-05	4.89E-01	-7.05E+00	-7200.000	-.00071	-.00071
-7.82E+05	2.31E+06	1.01E+06	5.46E+04	1.08E-03	1.73E-05	5.36E-05	4.17E+00	8.50E+01	467.452	-.00584	-.00584
1.29E+05	-5.25E+05	-2.32E+05	2.51E+04	-2.21E-03	-3.65E-05	-1.61E-04	-9.18E+00	-4.92E+01	-5410.752	.01297	.01297
-6.35E+00	2.25E+01	9.78E+00	-1.19E+00	3.37E-04	1.07E-05	-9.94E-06	7.07E-02	8.08E-04	27930.000	-.00092	-.00092

ITER	JULIAN DATE	X	Y	Z	VX	VY	VZ	SMA	B.T	B.R	TCA
101	27925.96374	-6219.0275	-1992.9523	-655.4358	3.162868	-9.602158	-4.170989	-7199.1	444.4	-5405.7	27329.99977

SUMMARY OF MULTI-CONIC TARGETING

```
INJECTION DATE    1976  6 16 11  7 47.268      JULIAN DATE   27925.96374
INJECTION STATE              X              Y              Z              R            VX            VY            VZ            V
   EARTH ECLIPTIC  -6219.027516 -1992.952778  -655.435815  6563.365000    3.162868   -9.602158   -4.170989   10.936285
   BARYCENTER ECL  -9842.490840  1065.554292 -1076.631913  9958.371762    3.154381   -9.610995   -4.170867   10.941606

ZERO ITERATE PARAMETERS
     IZERO  10     ZDAT     -9.8424908396E+03    1.0655542919E+03   -1.0766319127E+03
                             3.1545808277E+00   -9.6109953127E+00   -4.1708666790E+00
                          LAUNCH PROFILE PARAMETERS
     RP    6553.4  A1    17.00  T1   500.0  LAT    28.32  THD    15.04  AZI    90.00
     FI     3.700  A2     8.00  T2   100.0  LON   279.46  RAT    15.04

GENERAL TARGETING SCHEME
     LEVELS  0     ACCYS        2.50E-05
     MAX ITERS  0 MAX BAD STEPS  0
     IBAST  0      MATRIX  0      ISTART  0
```

GUIDANCE EVENT SCHEDULE

EVENT INDEX	EVENT TYPE	REF TIME	REF CODE	EVENT CALENDAR DATE	EVENT JULIAN DAY	EVENT TRAJ DAY	TARGET CALENDAR DATE	TARGET JULIAN DAY	TARGET TRAJ DAY
1	1	0.	1	1976 6 16 11 7 47.268	27925.964	0.	1976 6 20 12 0 0.	27930.000	0.
2	3	.30	2	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	0.	0.
3	-1	1.00	3	0 0 0 0 0 0.	0.	0.	0 0 0 0 0 0.	-693991.500	0.

IND	IMP	MOD	TAR KEY	TAR1	TAR2	TAR3	TOL1	TOL2	TOL3	DVX	DVY	DVZ	MAT	BADITS	BIT
1	3	1	7 8 3	1820.00	89.00	27930.00	25.00	1.00	.01	0.	0.	0.	1	3 8	4
2	4	1	1 0 0	3000.00	.40	5.00	0.	0.	0.	0.	0.	0.	1	3 8	4
3	3	1	0 0 0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1	3 8	4

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    GUIDANCE EVENT AT      0.     DAYS
    CALENDAR DATE   1976    6    16    11     7  47.268     JULIAN DATE     27925.96374

    EVENT CODES        KUR  1      KTYP  1      KMXQ  3      MOL  1

    CURRENT SPACECRAFT STATE
    REFERENCE        X-COMP           Y-COMP           Z-COMP           RADIUS        X-DOT         Y-DOT        Z-DOT        VELOCITY
INERTIAL            -9842.49          1065.55         -1076.63          9958.37    3.15458083   -9.61099531  -4.17085668  10.94160591
EARTH               -6219.03         -1992.95          -655.44          6553.36    3.16286763   -9.60215803  -4.17098914  10.93628460
MOON              -304701.74        249951.50        -35351.45        395687.54    2.48024267  -10.33012884  -4.16090124  11.40948135
         N-BODY TARGETING EVENT


         STATE     -9.8424908396E+03    1.0655542919E+03    -1.0766319127E+03
                    3.1545808277E+00   -9.6109953127E+00    -4.1708666790E+00
         JULIAN DATE      2.7925963742E+04


         PARAMETER KEY DEFINITIONS
              1-TRF      4-TCA      7-RCA      10-XRF
              2-TSI      5-B.T      8-INC      11-YRF
              3-TCS      6-B.R      9-ASI      12-ZRF


         TARGETING SPECIFICATIONS
              KEY   TARGET VALUE      TOLERANCE
               7       1820.000          25.000
               8         89.000           1.000
               3      27930.000            .005


         TARGETING SCHEME
              LEVELS    2.500E-05
              DVMAX    1.0000000000E-01
              IBAST       3

    IND NOF PHS  KEYTAR       DTAR(1)       DTAR(2)       DTAR(3)    KAXTAR        DAUX(1)       DAUX(2)      DAUX(3)  ISTOP   DELT
     1   1   1   7  8  3      1820.00         89.00      27930.00    5  6  3       1820.00         89.00     27930.00    2      4.440

ACCURACY      VX           VY           VZ             TAR - 7-      TAR - 8-      TAR - 3-      AUX - 5-      AUX - 6-      AUX - 3- INCR    CPT
2.50E-05   3.1545808   -9.6109953   -4.1708667       1821.498        89.420     27930.002       428.010     -5421.798     27930.002  542    136


    EXECUTION EVENT

    DELTA V =      0.              0.              0.              0.

    DOMINANT BODY ELEMENTS        SMA               ECC            OMEGA          INC          NODE          TA
    PLANET ECLIPTIC
       BEFORE IMPULSE     2.143291105E+05    9.6940640E-01   -168.78924     23.04528      4.12243      3.56901
       AFTER IMPULSE      2.143291105E+05    9.6940640E-01   -168.78924     23.04528      4.12243      3.56901
    PLANET EQUATORIAL
       BEFORE IMPULSE     2.143291105E+05    9.6940640E-01   -166.52789     46.45843      2.22490      3.56901
       AFTER IMPULSE      2.143291105E+05    9.6940640E-01   -166.52789     46.45843      2.22490      3.56901
```

A.32

C.4.

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT

TRAJECTORY TIME = 0.   TOTAL TIME INCREMENTS = 0

SPACECRAFT INERTIAL TRAJECTORY

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
POSITION.	-9.84249083959E+03	1.06555429194E+03	-1.07663191273E+03	9.95837176209E+03
VELOCITY.	3.15458082767E+00	-9.61099531272E+00	-4.17086667904E+00	1.09416059129E+01

****

CALENDAR DATE = JUNE 16, 11 HR, 7 MIN, 47.268 SEC, 1976
JULIAN DATE = 2442945.96374153

EPHEMERIS DATA

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
POSITION OF EARTH	-3.62346332392E+03	3.05850706948E+03	-4.21196096638E+02	4.76039474263E+03
VELOCITY OF EARTH	-8.28679986450E-03	-8.83728076715E-03	1.22463146433E-04	1.21154273789E-02
POSITION OF MOON	2.94859247199E+05	-2.48885944589E+05	3.42748229734E+04	3.87377016049E+05
VELOCITY OF MOON	6.74338154220E-01	7.19133525400E-01	-9.96543581067E-03	9.85892632847E-01

****

SPACECRAFT RELATIVE TRAJECTORIES

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
POSITION REL. TO EARTH . . .	-6.21902751567E+03	-1.99295277754E+03	-6.55435816096E+02	6.56336499399E+03
VELOCITY REL. TO EARTH . . .	3.16286762754E+00	-9.60215803195E+00	-4.17098914219E+00	1.09362846033E+01
POSITION REL. TO MOON . . .	-3.04701738039E+05	2.49951498881E+05	-3.53514548861E+04	3.95687536220E+05
VELOCITY REL. TO MOON . . .	2.48024267346E+00	-1.03301288381E+01	-4.16090124323E+00	1.14094813505E+01

****

VIRTUAL MASS DATA

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
VIRTUAL MASS POSITION	-3.62344658410E+03	3.05849293966E+03	-4.21194150779E+02	4.76037275037E+03
VIRTUAL MASS VELOCITY	-8.28317285583E-03	-8.84026912532E-03	1.22879738739E-04	1.21151314561E-02
SPACECRAFT POS. REL. TO V.M.	-6.21904425549E+03	-1.99293864773E+03	-6.55437761955E+02	6.56337676544E+03
SPACECRAFT VEL. REL. TO V.M.	3.16286400053E+00	-9.60215504359E+00	-4.17098955878E+00	1.09362810894E+01
KEPLER (ANG. MOM.) VECTOR	2.01891127924E+03	-2.80126291571E+04	6.60196210683E+04	7.17452002649E+04
ECCENTRICITY VECTOR	-9.35972466389E-01	-2.41339059749E-01	-7.37795239294E-02	9.69397966653E-01

V.M. MAGN. = 3.98602140110E+05
V.M. MAGN. RATE = -4.75650325677E-03

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
V.M. RELATIVE POSITIONS				
POSITION REL. TO EARTH . . .	1.67398218618E-02	-1.41298141971E-02	1.94585869758E-03	2.19922634415E-02
POSITION REL. TO MOON . . .	-2.98482693783E+05	2.51944437529E+05	-3.46960171241E+04	3.92137388799E+05

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-1.97387596032E+01
INCLINATION TO PLANE OF SKY	1.75677511950E+00
GEOCENTRIC DECLINATION.	-1.22648148584E+01
TARGET PLANET ANGLE (ZAE)	5.68544803251E+01
ANTENNA AXIS - EARTH ANGLE.	-5.73125825807E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. .	6.73852862603E+01

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SPACECRAFT PIERCED SPHERE OF INFLUENCE OF MOON     AT DATE. . . . 2442949.39724678

        POSITION. . . . .  -2.79836969847E+04   4.76614731215E+04  -5.43436728687E+03   5.55358952827E+04
        VELOCITY. . . . .   4.61377667924E-01  -7.78970687735E-01   1.70198941133E-01   9.21212442584E-01

        B . . . .     5.47742642515E+03     B.T . . . .    -2.37838992168E+02     B.R . . . .    -5.47226030601E+03
        INCLINATION =    96.32


INTERPOLATED INFORMATION AT SPHERE OF INFLUENCE

SPACECRAFT PIERCED SPHERE OF INFLUENCE OFMOON      AT DATE. . . . 2442949.39694294

        POSITION. . . . .  -2.79958089263E+04   4.76819224154E+04  -5.43883523603E+03   5.55599853496E+04
        VELOCITY. . . . .   4.61377667924E-01  -7.78970687735E-01   1.70198941133E-01   9.21212442584E-01

        B . . . .     5.47711484512E+03     B.T . . . .    -2.37825246091E+02     B.R . . . .    -5.47194902927E+03
        INCLINATION =    95.32
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    GUIDANCE EVENT AT      3.734 DAYS
    CALENDAR DATE   1976    6   20    4   44   2.123     JULIAN DATE    27929.69725

    EVENT CODES        KUR  2      KTYP  3      KMXQ  4      MDL  1

    CURRENT SPACECRAFT STATE
    REFERENCE       X-COMP          Y-COMP          Z-COMP           RADIUS        X-DOT         Y-DOT         Z-DOT        VELOCITY
INERTIAL         381034.76        65110.96        19464.20        387047.52     .42354783     .10122376     .10557471     .44809043
EARTH            385910.24        55584.62        19714.97        391939.71     .42259457     .11290725     .10472154     .44987259
MOON             -15707.36        26566.43         -942.85         30876.94     .49298162    -.84952018     .17500141     .99766773

    INSERTION DECISION EVENT
    PLANAR OPTION
    TARGET PARAMETERS     A=     3000.000   E=    .400000   DPER=    5.000

COPLANAR INSERTION EVENT

EVENT              X/VX       Y/VY       Z/VZ        R/V          A/E      W/TA      I/N      RP/RA      TIME

DECISION        -23132.6   -20432.0      893.2    30876.9      -7224.0   135.50    90.70    1820.85  -26377.08
                  .74147     .65726     .11653     .99767      1.25206  -133.84  -138.53

TARGET ORBIT                                                    3000.0   140.50    90.70    1800.00
                                                                .40000     0.    -138.53    4200.00

MODIFY RP

 PRE-INSERTION     873.3      794.4     1391.7     1825.0      -7224.0   135.50    90.70    1820.85     -67.14
                 1.35677    1.17196   -1.68277    2.45887      1.25206    -5.19  -138.53

 POST-INSERTION    873.3      794.4     1391.7     1825.0       3008.4   140.50    90.70    1816.84    -167.09
                 1.06707     .92172   -1.32347    1.93385       .39608   -10.19  -138.53    4200.00

 INSERTION VEL   -.28970    -.25024     .35931     .52502

MODIFY RA

 PRE-INSERTION     455.4      432.2     1829.7     1934.4      -7224.0   135.50    90.70    1820.85    -357.32
                 1.50405    1.30784   -1.33035    2.39634      1.25206   -26.57  -138.53

 POST-INSERTION    455.4      432.2     1829.7     1934.4      15677.6   140.50    90.70    1800.00    -459.74
                 1.36820    1.18971   -1.21019    2.17989       .88519   -31.57  -138.53   29555.20

 INSERTION VEL   -.13585    -.11813     .12016     .21644

MODIFY SMA

 PRE-INSERTION     872.0      793.3     1393.4     1825.1      -7224.0   135.50    90.70    1820.85     -68.12
                 1.35746    1.17258   -1.68168    2.45880      1.25206    -5.27  -138.53

 POST-INSERTION    872.0      793.3     1393.4     1825.1       3028.0   140.50    90.70    1816.78    -168.09
                 1.06909     .92349   -1.32444    1.93647       .40000   -10.27  -138.53    4239.16

 INSERTION VEL   -.28837    -.24909     .35724     .52232

 SELECTED CORREC -.28970    -.25024     .35931     .52502               TIME=  26309.93
```

```
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MOON     AT DATE. . . . . 2442950.00142044

        POSITION. . . . .   5.33426293421E+02  -1.13122452789E+03   1.33939392900E+03   1.83429162223E+03
        VELOCITY. . . . .   1.04727564992E+00  -1.48735591313E+00  -1.64553378293E+00   2.45291567935E+00
        INCLINATION =    88.98


INTERPOLATED INFORMATION AT CLOSEST APPROACH
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MOON     AT DATE. . . . 2442950.00127019

        POSITION. . . .   5.25795146056E+02  -1.11184095585E+03   1.36066562143E+03   1.83413788469E+03
        VELOCITY. . . .   1.05276421258E+00  -1.49891332939E+00  -1.63162169076E+00   2.45300692988E+00
        INCLINATION =   88.98
                 TACA= -7.24629441E+03
```

****

GUIDANCE EVENT AT 4.038 DAYS

CALENDAR DATE 1976 6 20 12 2 32.053 JULIAN DATE 27930.00176

EVENT CODES KUR 2 KTYP 3 KMXO 2 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	394634.72	62426.51	19810.11	400032.59	.90183722	-.51794470	-1.74865940	2.03454830
EARTH	399477.30	63208.10	20037.69	404943.05	.90020847	-.50636125	-1.74955092	2.03167552
MOON	569.98	-1174.61	1290.71	1835.89	1.03437737	-1.45054808	-1.67611210	2.45203772

EXECUTION EVENT

DELTA V = -.22185357 .33752312 .33541619 .52501834

DOMINANT BODY ELEMENTS	SMA	ECC	OMEGA	INC	NODE	TA
PLANET ECLIPTIC						
BEFORE IMPULSE	-7.242496663E+03	1.2532630E+00	131.87761	85.12325	120.72348	3.24488
AFTER IMPULSE	3.028669855E+03	3.9405788E-01	132.13773	84.90631	120.94039	2.96591
PLANET EQUATORIAL						
BEFORE IMPULSE	-7.242496663E+03	1.2532630E+00	135.23037	88.97857	-138.59525	3.24488
AFTER IMPULSE	3.028669856E+03	3.9405788E-01	135.56532	88.74912	-138.39345	2.96591

```
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MOON     AT DATE. . . . . 2442950.00194252

        POSITION. . . . .   5.82758105222E+02  -1.19230039411E+03   1.26943381957E+03   1.83647746005E+03
        VELOCITY. . . . .   8.05326963470E-01  -1.10824803209E+00  -1.35667924985E+00   1.92804144294E+00
        INCLINATION =   88.75


INTERPOLATED INFORMATION AT CLOSEST APPROACH
SPACECRAFT REACHED POINT OF CLOSEST APPROACH OF MOON     AT DATE. . . . 2442950.00118881

        POSITION. . . .   5.29365916776E+02  -1.11816989365E+03   1.35560237335E+03   1.83526291837E+03
        VELOCITY. . . .   8.34009831544E-01  -1.16783784603E+00  -1.28897494834E+00   1.92895672611E+00
        INCLINATION =   88.75
                 TACA=  3.02903382E+03
```

Case E-1. Planetary Explorer Venus '78 Mission

```
LAUNCH DATE              8 17  4 49 15.201 1978     JULIAN DATE . . .2443737.70087038

FINAL DATE              12 16  5 53 10.465 1978     JULIAN DATE . . .2443858.74526000

INITIAL TRAJECTORY TIME =    0.

THE FOLLOWING QUANTITIES ARE TO BE AUGMENTED TO THE STATE VECTOR

SOLVE-FOR PARAMETERS
  MU PLN
  R-RATE

DYNAMIC CONSIDER PARAMETERS
  A
  I
  M

MEASUREMENT CONSIDER PARAMETERS
  RADIUS 1
  LAT  1
  LONG 1

INERTIAL FRAME IS HELIOCENTRIC ECLIPTIC

INITIAL STATE VECTOR
  GEOCENTRIC ECLIPTIC   COORDINATES
        6.55455973E+02
        4.62539153E+03
       -4.61581285E+03
       -1.08560236E+01
       -1.25168694E+00
       -3.27287461E+00

INITIAL STATE VECTOR
     INERTIAL COORDINATES
        1.22444854E+08
       -8.91391532E+07
       -4.61581286E+03
        6.19095585E+00
        2.27225787E+01
       -3.27287461E+00

NOMINAL TRAJECTORY CODE. . . 2

NOMINAL TRAJECTORY INFORMATION
  BODIES TO BECONSIDERED
    SUN
    VENUS
    EARTH

  TARGET PLANET. . .VENUS

UNITS
   1.49598500E+08/A.U.                    8.64000000E+04/DAY

ORBITAL ELEMENTS WILL BE CALCULATED AT EVERY TIME INTERVAL

OUTPUT FROM VIRTUAL MASS PROGRAM WILL BE SUPRESSED AT INITIAL AND FINAL STEPS

VIRTUAL MASS PROGRAM WILL INTEGRATE UNTIL REACHING ANORMAL STOPPING CONDITION

ACCURACY FIGURE. . . . . 2.50000E-05
```

```
ERROR ANALYSIS MODE-GUIDANCE            EVENT AT TRAJECTORY TIME       0.     DAYS
                                                                                   PROBLEM. .        10
*******************************************************************************************************

    STATE VECTOR AT TIME          0.     DAYS
             X 1.2244485426000E+08
             Y-8.9139153204999E+07
             Z-4.5158128562000E+03
            VX 5.1909558537136E+00
            VY 2.2722578676809E+01
            VZ-3.2728746052700E+00


*******************************************************************************************************
    2VBP

    LINEAR-GUIDANCE-

    IPC      IN-EFFECT        ----USE-LINEAR-GUIDANCE-

    SINGLE--IMPULSE-

    -COMPUTE--AND    -EXECUTE
    VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.488 DAYS
                                              X                 Y                 Z                RESULTANT
    POSITION RELATIVE TO TARGET PLANET    1.8041323232E+05   4.2735490946E+05   4.0583373049E+05   6.1634582000E+05
    VELOCITY RELATIVE TO TARGET PLANET   -1.5164795943E+00  -3.5386553471E+00  -3.4711552211E+00   5.2138283932E+00
    B =      1.4987905328E+04      B DOT T =      1.3736693529E+04      B DOT R =     5.9950443708E+03

    M MATRIX
      -9.0959023961E-01    4.1550643317E-01    0.                   -1.0841074997E+05   4.9522699427E+04   0.
       2.7662731033E-01    6.0556824491E-01  -7.4616649077E-01    3.4788016020E+04   7.0608552440E+04  -8.8182011511E+04
STATE TRANSITION MATRIX PARTITIONS OVER(     0.    ,  119.488)          --TRANSPOSES SHOWN

                        X(119.488)          Y(119.488)          Z(119.488)          VX(119.488)          VY(119.488)          VZ(119.488)
     X(  0.    )    5.1757055330E+00   3.6112699962E+00   3.1657631365E-01  -6.2193124982E-08   1.8452509114E-06   7.6837092066E-08
     Y(  0.    )   -1.2089015489E+00  -1.1747565226E+00  -6.1731481782E-02   5.7368105197E-08  -6.6131076362E-07  -1.9038528473E-08
     Z(  0.    )    1.2143401672E-01   8.2087623563E-02  -5.3167994842E-01   4.8692391509E-09   3.4270460438E-08  -1.4497128023E-07
    VX(  0.    )    2.2001410422E+07   1.6926772324E+07   1.2642206951E+06   2.1321064240E-01   8.2357549375E+00   3.7240794621E-01
    VY(  0.    )    4.2583778760E+06   1.0917407980E+07   4.6379146909E+05   1.0206558676E+00   4.0312112305E+00   2.3926363326E-01
    VZ(  0.    )    7.5400257605E+05   8.4366447578E+05   2.6253398074E+06   8.2242015651E-02   4.5577530797E-01  -1.1371217357E+00

   SOLVE-FOR PARAMETERS
   MU PLN          -1.6446113586E-02  -3.8013458252E-02  -6.0945004225E-02  -8.7268290372E-08  -2.1579865006E-07  -1.9813882091E-07
   R-RATE           0.                 0.                 0.                 0.                 0.                 0.

   DYNAMIC CONSIDER PARAMETERS


   A               -3.3703082800E-02  -3.1213603020E-02  -1.2944249958E-02  -6.4128355461E-08  -4.2197056018E-08  -1.0485454581E-07
   I               -1.6539947499E+05  -4.3043053840E+05  -1.1355787550E+05  -2.0869855343E+00  -5.4228457724E+00  -1.2718743192E+00
   M               -7.4315697542E+05   4.9230898862E+05   6.8166753289E+05  -5.3421716363E+00   5.6004805710E+00   7.6741371883E+00


    TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS BEFORE GUIDANCE CORRECTION APPLIED
        5.3545791106E+04              1.0000000000E+00   -8.6843474748E-01
        7.5363957658E+04             -8.6843474748E-01    1.0000000000E+00
```

```
BIASED AIMPOINT GUIDANCE EVENT

CAPTURE RADIUS=    1.3675480823E+04

PSIJ MATRIX
   -7.0317024070E-08    7.1589616840E-09
    1.4120341509E-07    1.1166157123E-07
   -2.5613302141E-08   -1.9303140821E-08

DVRB=    0.                 0.                 0.

EXECUTION ERROR MATRIX
    0.                 0.                 0.

    0.                 0.                 0.

    0.                 0.                 0.


   LAMBDA STAR=     2.8671517452E+09   -3.5045013227E+09
-3.5045013227E+09    5.6797261139E+09

PROBABILITY OF IMPACT=    3.7577281215E-02

ELLIPSE CONSTANTS=
    1.4188294106E-09U1*U1+     1.7508906051E-09 U1*U2+     7.1623158215E-10 U2*U2=     1.6899393205E+01

INITIAL XM=    8.5040058899E+04    3.7736172025E+04

    1.4122744664E+04    1.4514621370E+05   -7.0917314235E+04    1.0741004168E+05

    2.1959033214E+04    1.2637351929E+05    7.8362885499E+03   -1.8772694409E+04

    2.2336570565E+04    1.2551224025E+05    3.7753735147E+02   -8.6127903627E+02

    2.2337370955E+04    1.2551045484E+05    8.0038977100E-01   -1.7854190266E+00

    2.2337370958E+04    1.2551045483E+05    3.4377870076E-06   -7.5986667941E-06

MU SUPER I =    2.2337370958E+04    1.2551045483E+05

DELTA MU=     8.6740119156E+03    1.1944739615E+05

DVBIAS=    2.4518862762E-04    1.4562484038E-02   -2.5278799965E-03

   LAMBDA STAR=     2.8671517452E+09   -3.5045013227E+09
-3.5045013227E+09    5.6797261139E+09


PROBABILITY OF IMPACT=    1.0000000000E-05
*******************************************************************************************************************

CONTROL (AND KNOWLEDGE) CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST AFTER GUIDANCE CORRECTION AT TIME   0.    DAYS
              STD DEV              X             Y             Z             VX            VY            VZ
     X     1.41421356E+00     1.00000000
     Y     1.41421356E+00      .00000000    1.00000000
     Z     1.41421356E+00     -.00000000     .00000000    1.00000000
     VX    4.24264068E-03     -.00000002    -.00000000    -.00000001    1.00000000
     VY    4.24264068E-03     -.00000000     .00000000    -.00000000    -.00000000    1.00000000
     VZ    4.24264069E-03     -.00000001    -.00000000    -.00000000     .00000000    -.00000000    1.00000000
      TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER  GUIDANCE CORRECTION
  5.3545791106E+04          1.0000000000E+00    -8.6843474748E-01
  7.5363957658E+04         -8.6843474748E-01     1.0000000000E+00
```

MEASUREMENT NO 30 AT TRAJECTORY TIME 9.900 PROBLEM. . 10

RANGE-RATE WAS MEASURED FROM STATION 3 AT TRAJECTORY TIME 9.90000 DAYS

INITIAL TRAJECTORY TIME 9.600
FINAL TRAJECTORY TIME 9.900

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	133339906.22	-69895631.48	1162475.59	150553250.51	11.165669134	24.522482323	1.339508851	26.978113175
GEO-	-1573781.89	-1721719.15	1162475.59	2606234.02	-1.783224006	-1.956411358	1.339508851	2.966768818
PLANETO-	97906269.97	33007391.22	4632099.90	103424281.12	-21.710040689	13.238486338	3.079114510	25.613752818
FINAL								
INERTIAL	133627583.61	-69259082.84	1197171.63	150514400.89	11.031933609	24.593631589	1.337659615	26.987767732
GEO-	-1620011.15	-1772409.07	1197171.63	2683111.99	-1.782405878	-1.952827646	1.337659615	2.963079441
PLANETO-	97343021.84	33347901.45	4711766.58	103004597.84	-21.748230891	13.035848359	3.067960815	25.540776670

****

NAVIGATION PARAMETERS
FLIGHT PATH ANGLE . . . . -3.21145315162E+00
ANGLE BETWEEN RELATIVE VELOCITY
AND PLANE OF THE SKY. . . . . 8.96611849166E+01
GEOCENTRIC DECLINATION. . . . . . . 8.42808343793E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE 1.39822362674E+02
ANTENNA AXIS - EARTH ANGLE. . . . . 2.64993539548E+01
ANTENNA AXIS - LIMB OF SUN ANGLE. . 1.04763958861E+02
OCCULTATION RATIO FOR SUN IS 2.09930558240E+02
OCCULTATION RATIO FOR VENUS IS 1.09845276477E+04

STATE TRANSITION MATRIX PARTITIONS OVER(9.600, 9.900) --TRANSPOSES SHOWN

	X(9.900)	Y(9.900)	Z(9.900)	VX(9.900)	VY(9.900)	VZ(9.900)
X(9.600)	1.0000177331E+00	-1.6084879087E-05	2.7100403321E-07	1.3703936663E-09	-1.2399413407E-09	2.1026002362E-11
Y(9.600)	-1.6084880052E-05	9.9999533232E-01	-1.4152221173E-07	-1.2399414323E-09	-3.6211927502E-10	-1.0959324057E-11
Z(9.600)	2.7100399369E-07	-1.4152218242E-07	9.9998693474E-01	2.1025998616E-11	-1.0959321295E-11	-1.0082480323E-09
VX(9.600)	2.5320153449E+04	-1.3884202453E-01	2.3543428979E-03	1.0000177873E+00	-1.6054330772E-05	2.7398876168E-07
VY(9.600)	-1.3884017549E-01	2.5919959454E+04	-1.2270671723E-03	-1.6054331559E-05	9.9999528146E-01	-1.4254282754E-07
VZ(9.600)	2.3544185169E-03	-1.2271229280E-03	2.5919887103E+04	2.7398872948E-07	-1.4254280378E-07	9.9998693141E-01
SOLVE-FOR PARAMETERS						
MU PLN	0.	0.	0.	0.	0.	0.
R-RATE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
A	0.	0.	0.	0.	0.	0.
I	0.	0.	0.	0.	0.	0.
M	0.	0.	0.	0.	0.	0.

OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN

	RANGE-RATE(3)
X	-3.2051229044E-08
Y	3.6342180656E-08
Z	1.0532274209E-08
VX	-6.0218807363E-01
VY	-6.6088708856E-01
VZ	4.4788143538E-01

SOLVE-FOR PARAMETERS

MU PLN	0.
R-RATE	0.

DYNAMIC CONSIDER PARAMETERS

A	0.
I	0.
M	0.

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	0.
LAT 1	0.
LONG 1	0.

MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

3.0000000000E-06	1.0000000000E+00

MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

3.2215652702E-06	1.0000000000E+00

GAIN MATRIX PARTITIONS

K-MATRIX

5.5385872500E+04
2.8378002221E+06
4.2462113832E+06
9.5190563128E-03
3.2905733959E+00
4.8387181535E+00

S-MATRIX

0.
1.1122292173E-01

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.900 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	9.63646504E+00	1.00000000					
Y	3.48359493E+01	-.25838670	1.00000000				
Z	4.82461472E+01	.02523553	.95829748	1.00000000			
VX	1.14812391E-05	.99539278	-.28424994	-.00265604	1.00000000		
VY	3.98720987E-05	-.27482839	.99761289	.95115407	-.30638742	1.00000000	
VZ	5.42449594E-05	.01328776	.96049262	.99794214	-.01985896	.95730223	1.00000000

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	1.00000000E+00	1.00000000	
R-RATE	2.93175079E-06	0.	1.00000000

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.900 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	9.63481299E+00	1.00000000					
Y	3.36149416E+01	-.27285471	1.00000000				
Z	4.62662236E+01	.02084443	.95519319	1.00000000			
VX	1.14811981E-05	.99551755	-.29530232	-.00355944	1.00000000		
VY	3.84370571E-05	-.29024548	.99744064	.94734459	-.31856413	1.00000000	
VZ	5.19569264E-05	.00831911	.95761840	.99776828	-.02153492	.95402862	1.00000000

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	1.00000000E+00	1.00000000	
R-RATE	2.90977237E-06	0.	1.00000000

```
ERROR ANALYSIS MODE-GUIDANCE           EVENT AT TRAJECTORY TIME      10.000 DAYS
                                                                          PROBLEM. .        10
*****************************************************************************************************************

     STATE VECTOR AT TIME        10.000 DAYS
              X 1.3372270592511E+08
              Y-5.9046491649646E+07
              Z 1.2087263349909E+06
             VX 1.0987259581970E+01
             VY 2.4617203194930E+01
             VZ 1.3370435448021E+00


*****************************************************************************************************************
     2VBP

     LINEAR-GUIDANCE-

     IPC     IN-EFFECT        ----USE-LINEAR-GUIDANCE-

     SERIES-OF-IMPULSES

     -COMPUTE--AND   -EXECUTE
     VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.527 DAYS
                                              X                  Y                  Z              RESULTANT
     POSITION RELATIVE TO TARGET PLANET    1.7270402885E+05    4.4818858816E+05    3.8624147590E+05    6.1634582000E+05
     VELOCITY RELATIVE TO TARGET PLANET   -1.6117830977E+00   -3.5304690293E+00   -3.4651128137E+00    5.2027937814E+00
     B =      4.3465404103E+04      B DOT T =      2.9623370217E+04      B DOT R =      3.1807189294E+04

     M MATRIX
       -9.0968340567E-01    4.1530242167E-01    0.                  -1.1237690828E+05    5.1304005171E+04    0.
        2.7659557602E-01    6.0585826726E-01   -7.4594279091E-01     3.7219842018E+04    6.9532111762E+04   -8.8156229194E+04


STATE TRANSITION MATRIX PARTITIONS OVER(    10.000,    119.527)          --TRANSPOSES SHOWN

                     X(119.527)         Y(119.527)         Z(119.527)        VX(119.527)        VY(119.527)        VZ(119.527)
       X( 10.000)   4.6135987482E+00   3.5252339431E+00   2.9285521830E-01  -2.9015627498E-08   1.7468862904E-06   7.4678906365E-08
       Y( 10.000)  -2.9422680062E-01  -4.2382852611E-01  -7.8833396790E-03   7.3491995343E-08  -3.0372908951E-07  -2.6575165119E-09
       Z( 10.000)   1.3940951813E-01   1.0628936425E-01  -4.3780168934E-01   7.5496935271E-09   4.7369300463E-08  -1.8057829242E-07
      VX( 10.000)   1.7762665837E+07   1.3855486211E+07   9.9807636365E+05   2.4299966716E-01   6.6811131846E+00   3.0564361767E-01
      VY( 10.000)   4.8931856284E+06   1.1617517329E+07   4.9258264015E+05   9.6081986449E-01   4.4490258728E+00   2.4788745966E-01
      VZ( 10.000)   6.3831427133E+05   7.6076719018E+05   3.0418785501E+06   7.6251261957E-02   4.1918472171E-01  -9.9673855487E-01

    SOLVE-FOR PARAMETERS
    MU PLN         -3.4862756729E-02  -9.0661048889E-02  -5.8442056179E-02  -9.2531990958E-08  -2.4201142423E-07  -2.0275578549E-07
    R-RATE          0.                 0.                 0.                 0.                 0.                 0.


    DYNAMIC CONSIDER PARAMETERS
    A              -6.3086998463E-03  -4.6468400955E-03  -1.1617101282E-02  -6.4032342380E-08  -3.5499730870E-08  -1.0041959818E-07
    I              -1.5896984990E+05  -4.3259403749E+05  -9.6634400587E+04  -1.9531808928E+00  -5.4539664500E+00  -9.4291989517E-01
    M              -6.9523848613E+05   5.6217476720E+05   6.7362606825E+05  -5.4542734673E+00   5.8681641247E+00   7.4557824239E+00


     TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS BEFORE GUIDANCE CORRECTION APPLIED
         5.3458160579E+04              1.0000000000E+00   -8.6812215953E-01
         7.5431113792E+04             -8.6812215953E-01    1.0000000000E+00
```

```
GUIDANCE MATRIX -- TWO VARIABLE B-PLANE GUIDANCE POLICY
  -2.6106085714E-07   8.2368036654E-09  -1.0024971033E-08  -9.9978545303E-01  -2.9329133731E-03  -1.4349179760E-02
   9.6081583315E-09   2.8123340993E-08  -3.6829943607E-08  -2.9329133731E-03  -9.5990630484E-01   1.9615705133E-01
  -5.8672142677E-09  -5.6251397617E-09   7.3779971214E-09  -1.4349179760E-02   1.9615705133E-01  -4.0308242129E-02

 VELOCITY CORRECTION CORRELATION MATRIX AND STANDARD DEVIATIONS
5.2821404321E-03              1.0000000000E+00   -4.7140905625E-02    1.4205556702E-01
4.0161563387E-03             -4.7140905625E-02    1.0000000000E+00   -9.9545483701E-01
8.2837403263E-04              1.4205556702E-01   -9.9545483701E-01    1.0000000000E+00

            EIGENVALUES OF ABOVE MATRIX
               1    2.8015832976E-05
               2    1.6700889843E-05
               3    6.6871541642E-21

            EIGENVECTORS OF ABOVE MATRIX
               1    9.9507213267E-01   -9.3170584071E-02    3.3921866767E-02
               2    9.8065813666E-02    9.7530792425E-01   -1.9788266494E-01
               3   -1.4647421993E-02    2.0023410089E-01    9.7963858533E-01


 EXPECTED VALUE OF DELTA V. . .    5.9488240685E-03

 STANDARD DEVIATION OF EXPECTED VALUE OF DELTA V. . .    3.0542126679E-03

 EXPECTED VALUE OF VELOCITY CORRECTION
     5.9195090528E-03   -5.5425541300E-04    2.0179521747E-04
******************************************************************************************************************

 BIASED AIMPOINT GUIDANCE EVENT

 CAPTURE RADIUS=    1.3699758425E+04

 PSIJ MATRIX
   -9.1654671752E-08    5.7731374430E-09
    1.3750160331E-07    1.0685495838E-07
   -2.9475170738E-08   -2.1754395198E-08

 DELTA MU=     1.5960011174E+04    2.5744130614E+04

 DVRB=    1.3141851809E-03   -4.9454151306E-03    1.0304720457E-03

 EXECUTION ERROR MATRIX
     8.1858042565E-09    6.5631116141E-09   -1.4705440122E-09

     6.5631116141E-09    1.1828401679E-08    1.1180328233E-09

    -1.4705440122E-09    1.1180328233E-09    1.6567729505E-08

 LAMBDA STAR=    7.8586059809E+05   -1.5625441263E+06
-1.5625441263E+06    3.7655901290E+06

 PROBABILITY OF IMPACT=    0.
```

PULSING ARC DATA

THRUST 1.0000E-03 MASS 1.0000E+00 DJR 1.0000E+00 DV 1.0000E-03

DELTA V	X-COMP	Y-COMP	Z-COMP	MAG
IMPULSIVE	.007234	-.005500	.001232	.009170
NOM PULSE	.000789	-.000600	.000134	.001000
END PULSE	.000134	-.000102	.000023	.000170

PULSE ARC	JULIAN DATE	CALENDAR DATE
MIDPOINT	28727.70087	1978 8 27 4 4915.201
INITIATION	28727.25087	1978 8 26 18 115.201
TERMINATION	28728.15087	1978 8 27 15 3715.200

F AND G SERIES	F2	F3	F4	F5	F6	G3	G4	G5	G6
LAUNCH BODY	-2.0785E-14	-2.4272E-23	7.5364E-29	2.6409E-37	3.7769E-42	-6.9284E-15	-1.2136E-23	1.6417E-29	9.1977E-38
TARGET BODY	-5.3336E-14	-5.3022E-23	4.8269E-28	1.4396E-36	6.5521E-41	-1.7779E-14	-2.6511E-23	9.9962E-29	4.8842E-37

PULSING ARC COVARIANCE PROPAGATION

NOMINAL STATE TRANSITION MATRIX

1.000002E+00	-1.773834E-06	3.814697E-08	8.640006E+03	-5.006790E-03	1.907349E-04
-1.778603E-06	9.999995E-01	-1.307349E-08	-5.149841E-03	8.639998E+03	-9.536743E-05
3.129244E-08	-1.609325E-08	9.999985E-01	9.015203E-05	-4.619360E-05	8.639936E+03
4.606937E-10	-4.113025E-10	7.216840E-12	9.999997E-01	-5.928541E-07	1.038529E-08
-4.107824E-10	-1.244086E-10	-3.717560E-12	-5.906031E-07	9.999989E-01	-5.331913E-09
7.236594E-12	-3.734328E-12	-3.363139E-10	1.047056E-08	-5.405809E-09	9.999985E-01

ERROR MODEL VARIANCES

PROPORTION	4.0000000E-06
RESOLUTION	4.0000000E-10
POINTING A	1.0000000E-04
POINTING B	1.0000000E-04

DELTA V 7.8883268E-04 -5.9973780E-04 1.3437846E-04 1.0000000E-03

NOMINAL EXECUTION ERROR MATRIX

2.891661E-10	-1.438202E-10	3.222464E-11
-1.438202E-10	2.093444E-10	-2.449992E-11
3.222464E-11	-2.449992E-11	1.054895E-10

FINAL EXECUTION ERROR MATRIX

DELTA V 1.3420009E-04 -1.0203034E-04 2.2861124E-05 1.7012492E-04

2.500681E-10	-1.879226E-10	4.210632E-11
-1.879226E-10	1.457690E-10	-3.201281E-11
4.210632E-11	-3.201281E-11	1.006710E-11

ACCUMULATED EXECUTION ERROR COVARIANCE

6.152575E+00	-3.060147E+00	6.856052E-01	1.124443E-04	-5.592711E-05	1.252884E-05
-3.060147E+00	4.453901E+00	-5.212422E-01	-5.592950E-05	8.139539E-05	-9.525282E-06
6.856052E-01	-5.212422E-01	2.244187E+00	1.253041E-05	-9.526068E-06	4.101077E-05
1.124443E-04	-5.592950E-05	1.253041E-05	2.892060E-09	-1.438469E-09	3.222629E-10
-5.592711E-05	8.139539E-05	-9.526068E-06	-1.438469E-09	2.093498E-09	-2.450016E-10
1.252884E-05	-9.525282E-06	4.101077E-05	3.222629E-10	-2.450016E-10	9.593860E-10

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER GUIDANCE CORRECTION

5.8237685406E+02	1.0000000000E+00	-7.5182071677E-01
6.2292767555E+02	-7.5182071677E-01	1.0000000000E+00

RANGE-RATE WAS MEASURED FROM STATION 1 AT TRAJECTORY TIME 118.30000 DAYS

INITIAL TRAJECTORY TIME 116.300
FINAL TRAJECTORY TIME 118.300

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	-16685323.46	107548998.38	3812108.97	108902338.12	-36.255087241	-9.362629356	-1.478532790	37.473673939
GEO-	-44542731.13	-37090888.53	3812108.97	58088906.71	-6.517640545	-14.887945745	-1.478532790	16.319210335
PLANETO-	615532.25	1392527.20	1343406.71	2030456.49	-1.569820633	-3.537633644	-3.398192708	5.150427390
FINAL								
INERTIAL	-22921741.98	105764888.12	3549746.68	108278430.52	-35.907380162	-11.290400096	-1.560539209	37.672912910
GEO-	-45624104.88	-39739922.15	3549746.68	60608753.99	-5.988445260	-15.774205264	-1.560539209	16.944683856
PLANETO-	342162.00	783374.08	753428.23	1139475.27	-1.595862394	-3.520086430	-3.431690351	5.168586260

****

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-5.29725361432E+00
ANGLE BETWEEN RELATIVE VELOCITY AND PLANE OF THE SKY.	6.05787442611E+01
GEOCENTRIC DECLINATION.	-1.19529705738E+01
EARTH/SPACECRAFT/TARG PLANET ANGLE	1.29862142968E+02
ANTENNA AXIS - EARTH ANGLE.	3.35763737254E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. .	1.18442269991E+02
OCCULTATION RATIO FOR SUN IS	1.36157007769E+02
OCCULTATION RATIO FOR VENUS IS	1.44851339589E+02

STATE TRANSITION MATRIX PARTITIONS OVER(116.300, 118.300) --TRANSPOSES SHOWN

	X(118.300)	Y(118.300)	Z(118.300)	VX(118.300)	VY(118.300)	VZ(118.300)
X(116.300)	9.9859635151E-01	-7.8718912543E-04	-2.7386506612E-05	-1.6095896297E-08	-9.6372522113E-09	-3.3212625267E-10
Y(116.300)	-7.8727415763E-04	1.0029433226E+00	1.5623323230E-04	-9.6397214780E-09	3.3991843955E-08	1.7910956541E-09
Z(116.300)	-2.7389921770E-05	1.5623581809E-04	9.9846271035E-01	-3.3222542609E-10	1.7911707434E-09	-1.7840590050E-08
VX(116.300)	1.7271982622E+05	-4.7949425540E+01	-1.6535190897E+00	9.9862140383E-01	-8.7782663167E-04	-2.9995104759E-05
VY(116.300)	-4.7951881608E+01	1.7296907636E+05	8.9120750519E+00	-8.7791231694E-04	1.0029273622E+00	1.5319236142E-04
VZ(116.300)	-1.6536177290E+00	8.9121497367E+00	1.7271118014E+05	-2.9998546145E-05	1.5319496707E-04	9.9845363483E-01
SOLVE-FOR PARAMETERS						
MU PLN	-1.6272068024E-03	-3.8337707520E-03	-3.4722685814E-03	-2.2619133233E-08	-5.1118149713E-08	-4.9485109344E-08
R-RATE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
A	-7.7461123466E-04	-3.6047935486E-04	-1.2677167356E-03	-1.2695552414E-08	-5.0997692824E-09	-2.0238316196E-08
I	-2.4738166132E+04	-6.4810119401E+04	-1.4986283905E+04	-4.1329997500E-01	-1.0410079977E+00	-2.4608123510E-01
M	-7.0128095549E+04	7.1051503319E+04	9.3302052694E+04	-1.1082187756E+00	1.1202484479E+00	1.5247713933E+00

OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN

	RANGE-RATE(1)
X	8.3627528806E-08
Y	-9.9713380550E-08
Z	-4.1703798859E-08
VX	-7.5270122699E-01
VY	-6.5575516003E-01
VZ	5.8532324228E-02

SOLVE-FOR PARAMETERS

MU PLN	0.
R-RATE	1.0000000000E+00

DYNAMIC CONSIDER PARAMETERS

A	0.
I	0.
M	0.

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-5.5885189977E-05
LAT 1	2.5378207929E-01
LONG 1	9.9653805969E-02

MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

3.0000000000E-06 1.0000000000E+00

MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

3.7707872970E-06 1.0000000000E+00

GAIN MATRIX PARTITIONS

K-MATRIX

7.3685942691E+05
-1.0799099523E+06
-2.3501823298E+05
4.4126963658E-01
-8.0406581957E-01
-1.4322885703E-01

S-MATRIX

4.3243710373E+03
1.1888804690E-03

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 118.300 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	6.33020839E+00	1.00000000					
Y	7.30383090E+00	-.91309946	1.00000000				
Z	1.26593211E+01	.24768131	-.10012440	1.00000000			
VX	3.73978535E-06	.96949621	-.90432636	.14221637	1.00000000		
VY	5.41538577E-06	-.88898355	.98701622	-.02390943	-.91766269	1.00000000	
VZ	6.72288442E-06	.21702801	-.07803835	.96191355	.17449043	-.04032644	1.00000000

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	9.99976079E-01	1.00000000	
R-RATE	6.17284138E-07	-.00006843	1.00000000

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 118.300 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	5.68781584E+00	1.00000000					
Y	6.06332088E+00	-.89605861	1.00000000				
Z	1.26282640E+01	.31061440	-.16803589	1.00000000			
VX	3.34922764E-06	.96211995	-.88271782	.19405532	1.00000000		
VY	4.48704963E-06	-.86399238	.98112983	-.07634610	-.90096752	1.00000000	
VZ	6.70115531E-06	.28169443	-.14843723	.96175006	.23551075	-.10328723	1.00000000

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	9.99843120E-01	1.00000000	
R-RATE	6.17267859E-07	-.00018688	1.00000000

GUIDANCE EVENT AT 120.400 DAYS
CALENDAR DATE 1978 12 15 14 25 15.200 JULIAN DATE 28838.10087

EVENT CODES KUR 1 KTYP 3 KMXQ 4 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	-29336587.44	103526737.71	3253267.93	107668605.11	-35.48058349	-13.48174486	-1.79967503	37.99826416
SUN	-29336587.44	103526737.71	3253267.93	107668605.11	-35.48058349	-13.48174486	-1.79967503	37.99826416
VENUS	48470.21	138537.42	122551.44	191208.88	-1.67928816	-3.69443769	-3.61345376	5.43377646
EARTH	-46655952.88	-42691919.53	3253267.93	63324258.26	-5.41093069	-16.86527960	-1.79967503	17.80322042

INSERTION DECISION EVENT
PLANAR OPTION
TARGET PARAMETERS A= 27000.000 E= .750000 DPER= 5.000

COPLANAR INSERTION EVENT

EVENT	X/VX	Y/VY	Z/VZ	R/V	A/E	W/TA	I/N	RP/RA	TIME
DECISION	146027.3	-7483.4	123210.7	191208.9	-12432.7	-113.82	49.08	7264.53	-32290.85
	-3.98451	.55447	-3.65269	5.43378	1.58431	-124.70	-136.01		
TARGET ORBIT					27000.0	-108.82	49.08	6750.00	
					.75000	0.	-136.01	47250.00	
MODIFY RP									
PRE-INSERTION	286.7	5761.7	-4552.9	7349.0	-12432.7	-113.82	49.08	7264.53	-132.07
	-9.08559	-4.17898	-3.81063	10.70200	1.58431	-11.11	-136.01		
POST-INSERTION	286.7	5761.7	-4552.9	7349.0	27238.4	-108.82	49.08	7226.74	-232.73
	-7.42436	-3.41488	-3.11389	8.74521	.73469	-16.11	-136.01	47250.00	
INSERTION VEL	1.66124	.76410	.69675	1.95679					

MODIFY RA
CANDIDATE SMA S =-1.600E+04 3.375E+03
SOLUTION INVALID

EVENT	X/VX	Y/VY	Z/VZ	R/V	A/E	W/TA	I/N	RP/RA	TIME
MODIFY SMA									
PRE-INSERTION	334.7	5783.7	-4532.7	7355.8	-12432.7	-113.82	49.08	7264.53	-137.36
	-9.08425	-4.15405	-3.83026	10.69816	1.58431	-11.55	-136.01		
POST-INSERTION	334.7	5783.7	-4532.7	7355.8	28901.0	-108.82	49.08	7225.24	-238.11
	-7.45518	-3.40911	-3.14338	8.77967	.75000	-16.55	-136.01	50576.69	
INSERTION VEL	1.62907	.74494	.68688	1.91849					
SELECTED CORREC	1.66124	.76410	.69675	1.95679					

TIME= 32158.78

ORBITAL INSERTION WILL BE EXECUTED AT 1.2077220808E+02

```
STATE VECTOR AT TIME      120.772 DAYS
          X-3.0536227965981E+07
          Y 1.0306945206713E+08
          Z 3.1846594872672E+06
         VX-3.1997193700899E+01
         VY-1.9900571998239E+01
         VZ-2.2481100709743E+00
```

```
NAVIGATION PARAMETERS
    FLIGHT PATH ANGLE . . . . . . . . . .  -1.54464879548E+01
    ANGLE BETWEEN RELATIVE VELOCITY
    AND PLANE OF THE SKY. . . . . . . .     4.66736382554E+01
    GEOCENTRIC DECLINATION. . . . . . .    -1.29334123626E+01
    EARTH/SPACECRAFT/TARG PLANET ANGLE      6.69601982651E+01
    ANTENNA AXIS - EARTH ANGLE. . . . .     2.85993755734E+00
    ANTENNA AXIS - LIMB OF SUN ANGLE. .     1.15841304608E+02
    OCCULTATION RATIO FOR SUN         IS     1.38383645807E+02
    OCCULTATION RATIO FOR VENUS       IS     1.11767474033E+00
```

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PLANAR-ORBIT-INSERTION

IPC-NOT-IN-EFFECT

SINGLE--IMPULSE-

-EXECUTE-ONLY

DVUP=   -3.1346049738E-01    1.7838223924E+00    7.4076751365E-01     MAG. OF DVUP=    1.9567872445E+00

NOMINAL STATE RELATIVE TO TARGET PLANET IMMEDIATELY FOLLOWING ORBITAL INSERTION-       ECLIPTIC COORDINATES

POSITION   -5.7808998425E+03    1.7055905571E+03   -4.2026075664E+03         7.3477719408E+03

VELOCITY    1.3877391248E+00   -7.9752192565E+00   -3.3102787303E+00         8.7457353802E+00

NOMINAL STATE RELATIVE TO TARGET PLANET IMMEDIATELY FOLLOWING ORBITAL INSERTION-      EQUATORIAL COORDINATES

POSITION    3.0793037957E+02    5.7599935071E+03   -4.5516377464E+03         7.3477719408E+03

VELOCITY   -7.4303629711E+00   -3.4027840795E+00   -3.1142662005E+00         8.7457353802E+00

PLANETO-CENTRIC EQUATORIAL COORDINATES OF DVUP=     1.6612382619E+00    7.6409792605E-01    6.9674824491E-01

NOMINAL PLANETO-CENTRIC EQUATORIAL ORBITAL ELEMENTS IMMEDIATELY FOLLOWING ORBITAL INSERTION

A=    9.7861907070E-01E=    9.9999999890E-010=   -8.7639486733E+01
I=    2.0877423159E+01N=   -6.7825828911E+01T=   -1.7999995924E+02
```

Case E-2. Lunar Viking '76 Mission

```
LAUNCH DATE               6 16 11  7 50.055 1976     JULIAN DATE . . .2442945.96377377

FINAL DATE                6 20 19 30 43.022 1976     JULIAN DATE . . .2442950.31299794

INITIAL TRAJECTORY TIME =     0.

THE FOLLOWING QUANTITIES ARE TO BE AUGMENTED TO THE STATE VECTOR

SOLVE-FOR PARAMETERS
  MU PLN
  A
  RANGE

DYNAMIC CONSIDER PARAMETERS
  NODE
  OMEGA

MEASUREMENT CONSIDER PARAMETERS

  RADIUS 3
  LAT  3
  LONG 3
  ST ANG 1

INERTIAL FRAME IS BARYCENTRIC ECLIPTIC

  INITIAL STATE VECTOR
    GEOCENTRIC ECLIPTIC   COORDINATES
       -6.21904171E+03
       -1.99290848E+03
       -6.55435808E+02
        3.16289975E+00
       -9.60115329E+00
       -4.17327240E+00

  INITIAL STATE VECTOR
      INERTIAL COORDINATES
       -9.84252824E+03
        1.06557382E+03
       -1.07663155E+03
        3.15461302E+00
       -9.60999063E+00
       -4.17314993E+00

  NOMINAL TRAJECTORY CODE. . . 2

  NOMINAL TRAJECTORY INFORMATION
    BODIES TO BECONSIDERED
      EARTH
      MOON

    TARGET PLANET. . .MOON

  UNITS
    1.49598500E+08/A.U.                  8.64000000E+04/DAY

  ORBITAL ELEMENTS WILL BE CALCULATED AT EVERY TIME INTERVAL

  OUTPUT FROM VIRTUAL MASS PROGRAM WILL BE SUPRESSED AT INITIAL AND FINAL STEPS

  VIRTUAL MASS PROGRAM WILL INTEGRATE UNTIL REACHING ANORMAL STOPPING CONDITION

  ACCURACY FIGURE. . . . . 2.50000E-05
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ERROR ANALYSIS MOJE-GUIDANCE          EVENT AT TRAJECTORY TIME       1.000 DAYS
                                                                     PROBLEM. .        1
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STATE VECTOR AT TIME          1.000 DAYS
         X 1.9907853148322E+05
         Y 4.5262035190634E+03
         Z-5.6135461583041E+03
        VX 1.3856671854019E+00
        VY 3.2841562213061E-01
        VZ 1.0295098302246E-01
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NAVIGATION PARAMETERS
   FLIGHT PATH ANGLE . . . . . . . . . .    7.66727042276E+01
   ANGLE BETWEEN RELATIVE VELOCITY
   AND PLANE OF THE SKY. . . . . . . .      7.58383265880E+01
   GEOCENTRIC DECLINATION. . . . . . . .   -1.08914976323E+00
   EARTH/SPACECRAFT/TARG PLANET ANGLE       1.26825056131E+02
   ANTENNA AXIS - EARTH ANGLE. . . . .     -1.46868685603E+00
   ANTENNA AXIS - LIMB JF SUN ANGLE. .      9.39356977892E+01
   OCCULTATION RATIO FOR SUN        IS      2.17156085020E+02
   OCCULTATION RATIO FOR MOON       IS      1.10318010160E+02
```

STATE TRANSITION MATRIX PARTITIONS OVER(.900, 1.000) --TRANSPOSES SHOWN

	X(1.000)	Y(1.000)	Z(1.000)	VX(1.000)	VY(1.000)	VZ(1.000)
X(.900)	1.0039629880E+00	-2.0737352315E-05	-1.7852027668E-04	8.9964750316E-07	1.1414513779E-09	-3.7960568022E-08
Y(.900)	-1.5217810869E-05	9.9800657248E-01	-5.2186078392E-06	1.1763034991E-09	-4.4683321931E-07	-1.2200018773E-09
Z(.900)	-2.2432766855E-04	-1.9004801288E-05	9.9798878306E-01	-3.7600784708E-08	-1.2131806670E-09	-4.5075775557E-07
VX(.900)	8.6501653306E+03	-2.3650645744E-01	-5.3020194173E-01	1.0037670968E+00	1.8326495876E-05	-1.5268271092E-04
VY(.900)	-4.8801302910E-01	8.6343341216E+03	-4.0954910219E-02	1.9837642640E-05	9.9813087058E-01	-5.9285909515E-06
VZ(.900)	-1.2036412954E+00	-2.2522581276E-01	8.6343411793E+03	-1.4708660956E-04	-5.6791904512E-06	9.9811171363E-01
SOLVE-FOR PARAMETERS						
MU PLN	3.7622638047E-03	4.2053143261E-04	-2.1420040866E-04	8.5232905178E-07	9.3042942240E-08	-4.5097401369E-08
A	3.2022204250E-05	3.2842293149E-05	-8.5164181655E-06	7.3370176068E-09	7.6325670584E-09	-1.9511725924E-09
RANGE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
NODE	1.5259197986E+01	-8.4172886457E+00	4.5567341519E-01	3.4230278412E-03	-1.8979989437E-03	1.2204699464E-04
OMEGA	1.5391054792E+01	-8.4734037883E+00	6.1180794213E-01	3.4583697505E-03	-1.9094248684E-03	1.5620655896E-04

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DIAGONAL OF DYNAMIC NOISE MATRIX
      0.         0.         0.         0.         0.         0.
```

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT EVENT TIME 1.000 DAYS
PROPAGATED FORWARD FROM TIME .900 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.85354596E-03	1.00000000					
Y	6.36130997E-02	-.66716115	1.00000000				
Z	4.31822358E-02	.51193313	-.04082556	1.00000000			
VX	1.55185883E-07	.71487211	-.94116257	-.07110677	1.00000000		
VY	1.23976769E-06	-.55456293	.89075789	-.05171117	-.82496282	1.00000000	
VZ	1.52855412E-06	.52773546	-.17822504	.84121395	.11463358	-.01796384	1.00000000
SOLVE-FOR PARAMETERS							
MU PLN		.34715525	-.27762750	.00280527	.46679153	-.38488017	-.00133251
A		-.25675828	-.14980807	-.39032159	-.01014155	-.28601619	-.57352658
RANGE		.18861439	-.29439092	.34517938	.20697815	-.51855817	.13429914
DYNAMIC CONSIDER PARAMETERS							
NODE		.00599779	-.01036071	-.00974187	.01904233	-.02658538	-.01377998
OMEGA		.00688763	-.01088219	-.00938694	.01997315	-.02716803	-.01327722
MEASUREMENT CONSIDER PARAMETERS							
RADIUS 3		-.14210334	-.07930789	-.14809101	.05511990	-.07435258	-.08313806
LAT 3		-.07880884	-.04040910	-.08081868	.02877790	-.03700608	-.04255874
LONG 3		-.14494649	.10991840	-.08249419	-.04127249	.14789857	.09648664
ST ANG 1		0.	0.	0.	0.	0.	0.

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	5.41539449E-02	1.00000000		
A	5.85995413E+00	-.56878834	1.00000000	
RANGE	1.02089440E-03	.19049450	.15574905	1.00000000
DYNAMIC CONSIDER PARAMETERS				
NODE		-.00693375	-.02535530	.00360183
OMEGA		-.00709728	-.02543702	.00396404
MEASUREMENT CONSIDER PARAMETERS				
RADIUS 3		-.00207737	.07471394	.03954807
LAT 3		-.00040618	.03624105	.02028657
LONG 3		.03606609	-.19314169	-.04773865
ST ANG 1		0.	0.	0.

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	1.0970705609334E-06	1	1.0474113619E-03
2	4.0539818305835E-03	2	6.3670886837E-02
3	1.8596938581657E-03	3	4.3124167913E-02

POSITION EIGENVECTORS

1	9.9960485901817E-01	1.8859396937155E-02	-2.0843439601294E-02
2	-1.9912325470085E-02	9.9847343818966E-01	-5.1519826514471E-02
3	1.9839987944033E-02	5.1914510272896E-02	9.9845443486495E-01

VELOCITY EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	7.3734465946447E-15	1	8.5868775135E-08
2	1.5517826468894E-12	2	1.2457056123E-06
3	2.3384281931146E-12	3	1.5291920166E-06

VELOCITY EIGENVECTORS

1	9.9463215572527E-01	1.0297922262905E-01	-1.0107151130888E-02
2	-1.0240324672314E-01	9.9364822266215E-01	4.6656024915289E-02
3	1.4847553934123E-02	-4.5370577548143E-02	9.9885988048129E-01

STATE TRANSITION MATRIX PARTITIONS OVER(0. , 1.000) --TRANSPOSES SHOWN

	X(1.000)	Y(1.000)	Z(1.000)	VX(1.000)	VY(1.000)	VZ(1.000)
X(0.)	-2.7553385271E+02	1.4074173095E+02	6.7202552774E+01	-4.7751941151E-03	1.3258354347E-03	6.9846073709E-04
Y(0.)	-8.8292909237E+01	6.8733035528E+01	4.4451663440E+01	-1.5798027640E-03	5.8558829457E-04	3.8813640753E-04
Z(0.)	-2.9358153917E+01	3.7473183602E+01	-1.2860604930E+01	-5.3142344242E-04	3.0101731417E-04	-7.4926361200E-05
VX(0.)	9.9530360475E+04	-1.9596040441E+04	-1.1165985474E+04	1.6639818185E+00	-2.7310041162E-01	-1.6552116406E-01
VY(0.)	-3.0290608564E+05	1.7022850653E+05	7.8946998471E+04	-5.2578404556E+00	1.5850690211E+00	8.2525793745E-01
VZ(0.)	-1.3146763984E+05	7.0359892090E+04	3.9771962704E+04	-2.2828443164E+00	6.7708241218E-01	3.6524033185E-01
SOLVE-FOR PARAMETERS						
MU PLN	-1.5064202173E+02	6.4342182688E+01	2.0642343620E+01	-2.5674785513E-03	6.3311883766E-04	2.6601453137E-04
A	-1.9455382088E+00	8.3109165472E-01	2.6611876934E-01	-3.3178806062E-05	8.1987692606E-06	3.4248767018E-06
RANGE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
NODE	-1.1682291238E+06	6.7682379290E+05	3.6736419485E+05	-2.0373773098E+01	6.1849978084E+00	3.5512394292E+00
OMEGA	-1.1714036864E+06	6.7711339513E+05	3.6991708980E+05	-2.0428095765E+01	6.1907984478E+00	3.5722575556E+00

DIAGONAL OF DYNAMIC NOISE MATRIX

0.	0.	0.	0.	0.	0.

CONTROL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST BEFORE GUIDANCE CORRECTION AT TIME 1.000 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.07496704E+03	1.00000000					
Y	5.78646670E+02	-.98234118	1.00000000				
Z	2.79496812E+02	-.97987184	.99032201	1.00000000			
VX	1.86102448E-02	.99994739	-.98417214	-.98155449	1.00000000		
VY	5.44139875E-03	-.99069495	.99861987	.99126003	-.99201189	1.00000000	
VZ	2.86743790E-03	-.99127244	.99283321	.99696117	-.99238178	.99594279	1.00000000

SOLVE-FOR PARAMETERS

	X	Y	Z	VX	VY	VZ
MU PLN	-.00840818	.00667166	.00443132	-.00827763	.00698113	.00556625
A	-.01809858	.01436268	.00952135	-.01782825	.01506739	.01194403
RANGE	0.	0.	0.	0.	0.	0.

DYNAMIC CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
NODE	-.00108676	.00116967	.00131438	-.00109476	.00113666	.00123847
OMEGA	-.00108971	.00117017	.00132351	-.00109768	.00113772	.00124580

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 3	0.	0.	0.	0.	0.	0.
LAT 3	0.	0.	0.	0.	0.	0.
LONG 3	0.	0.	0.	0.	0.	0.
ST ANG 1	0.	0.	0.	0.	0.	0.

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	6.00000000E-02	1.00000000		
A	1.00000000E+01	0.	1.00000000	
RANGE	3.00000000E-03	0.	0.	1.00000000

DYNAMIC CONSIDER PARAMETERS

	MU PLN	A	RANGE
NODE	0.	0.	0.
OMEGA	0.	0.	0.

MEASUREMENT CONSIDER PARAMETERS

	MU PLN	A	RANGE
RADIUS 3	0.	0.	0.
LAT 3	0.	0.	0.
LONG 3	0.	0.	0.
ST ANG 1	0.	0.	0.

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	1.5571806513287E+06	1	1.2478704465E+03
2	1.0126380792271E+04	2	1.0062991997E+02
3	1.1975483597946E+03	3	3.4605611681E+01

POSITION EIGENVECTORS

1	8.6046336976431E-01	-4.5909437434265E-01	-2.2098675241009E-01
2	5.0875298376857E-01	7.9783232625736E-01	3.2347176180515E-01
3	2.7806308643948E-02	-3.9076327184842E-01	9.2007112473651E-01

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3VBP

LINEAR-GUIDANCE-

IPC-NOT-IN-EFFECT

SINGLE--IMPULSE-

-COMPUTE--AND   -EXECUTE
VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME     3.433 DAYS
                                          X                  Y                  Z                 RESULTANT
POSITION RELATIVE TO TARGET PLANET   -2.7995222279E+04   4.7681876379E+04   -5.4422571441E+03   5.5559985315E+04
VELOCITY RELATIVE TO TARGET PLANET    4.6134264250E-01  -7.7895184389E-01    1.7023246623E-01   9.2118516132E-01
B =      5.4759221786E+03     B DOT T =     -2.3695805520E+02      B DOT R =    -5.4707928663E+03

M MATRIX
  -8.6041671295E-01  -5.0959109105E-01   0.                 -5.2549973399E+04  -3.1123289304E+04   0.
   9.4171022116E-02  -1.5900262529E-01  -9.8277667033E-01    5.6949021339E+03  -9.5311313455E+03  -5.9046278055E+04

VARIATION MATRIX
  -2.5012645219E+00  -2.8286408087E-01   4.1091727326E-03  -3.3861903441E+05  -1.3310806363E+05  -2.5428907102E+03
   2.3083676060E-01  -4.1790836258E-02  -3.3614948043E-01   3.2770536607E+04  -3.9707642456E+04  -2.4467291610E+05
  -1.2596137822E-05   5.9604644775E-06  -7.2177499533E-07  -1.6249250621E+00   2.0710285753E+00  -2.4994369596E-01

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS
   8.1060639083E+03              1.0000000000E+00    -9.9653316172E-01     9.9876898595E-01
   1.8888516087E+03             -9.9653316172E-01     1.0000000000E+00    -9.9894432190E-01
   5.7472793704E-02              9.9876898595E-01    -9.9894432190E-01     1.0000000000E+00

                    EIGENVALUES           SQUARE ROOTS OF EIGENVALUES
               1     6.9252601545615E+07          1     8.3218147988E+03
               2     2.3430941844525E+04          2     1.5307168858E+02
               3     1.8117306943258E-06          3     1.3460054585E-03


             EIGENVECTORS
               1     9.7406516609654E-01      -2.2626765599554E-01       6.8990069012899E-06
               2     2.2626765607565E-01       9.7406516598969E-01      -1.4815325371817E-05
               3    -3.3678533577767E-06       1.5992114489877E-05       9.9999999986645E-01

  GUIDANCE MATRIX -- THREE VARIABLE B-PLANE GUIDANCE POLICY
   -7.4689106320E-06   2.1394885689E-07  -3.6498845949E-08  -1.0000000000E+00   0.                  0.
    2.1097562551E-07  -2.6749218211E-06   1.5052834557E-07   0.                 -1.0000000000E+00    0.
   -9.1145328788E-08   2.9196211414E-07  -1.4031904241E-06   0.                  0.                 -1.0000000000E+00

  VELOCITY CORRECTION CORRELATION MATRIX AND STANDARD DEVIATIONS
 2.6750556907E-02              1.0000000000E+00    -9.9084239462E-01    -9.9050454472E-01
 7.1702603974E-03             -9.9084239462E-01     1.0000000000E+00     9.9464556575E-01
 2.9939159022E-03             -9.9050454472E-01     9.9464556575E-01     1.0000000000E+00

             EIGENVALUES  OF ABOVE MATRIX          SQUARE ROOTS OF EIGENVALUES
               1    7.7494022275E-04          1     2.7837748162E-02
               2    9.5225143663E-07          2     9.7583371362E-04
               3    7.5987213288E-08          3     2.7565778293E-04

             EIGENVECTORS OF ABOVE MATRIX
               1    9.6089669864E-01   -2.5554971949E-01   -1.0663899575E-01
               2    2.7600194079E-01    9.1499812964E-01    2.9428107558E-01
               3    2.2371035345E-02   -3.1220628378E-01    9.4975090057E-01
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EXPECTED VALUE OF DELTA V. . . 2.2240491109E-02

STANDARD DEVIATION OF EXPECTED VALUE OF DELTA V. . . 1.6772865487E-02

EXPECTED VALUE OF VELOCITY CORRECTION

2.1370814483E-02 -5.6835512641E-03 -2.3717036369E-03

EXECUTION ERROR CORRELATION MATRIX AND STANDARD DEVIATIONS

1.1893346739E-04	1.0000000000E+00	1.5286429986E-01	6.2982305942E-02
1.5486503304E-04	1.5286429986E-01	1.0000000000E+00	-1.2863761383E-02
1.5684891607E-04	6.2982305942E-02	-1.2863761383E-02	1.0000000000E+00

CONTROL (AND KNOWLEDGE) CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST AFTER GUIDANCE CORRECTION AT TIME 1.000 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.85354596E-03	1.00000000					
Y	6.36130997E-02	-.66716115	1.00000000				
Z	4.31822358E-02	.51193313	-.04082556	1.00000000			
VX	1.18933569E-04	.00093277	-.00122804	-.00009278	1.00000000		
VY	1.54869995E-04	-.00443940	.00713071	-.00041396	.15285065	1.00000000	
VZ	1.56856364E-04	.00514274	-.00173679	.00819757	.06298072	-.01286414	1.00000000

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER GUIDANCE CORRECTION

4.7985974800E+01	1.0000000000E+00	5.2693582725E-02	-4.9175547845E-03
3.8648225420E+01	5.2693582725E-02	1.0000000000E+00	-1.7296656510E-02
3.5226562455E-04	-4.9175547846E-03	-1.7296656510E-02	1.0000000000E+00

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	2.3142915115323E+03	1	4.8107083798E+01
2	1.4820475940087E+03	2	3.8497371261E+01
3	1.2405194827981E-07	3	3.5221009111E-04

POSITION EIGENVECTORS

1	9.9298360430460E-01	1.1825211026550E-01	-4.7698695035124E-08
2	-1.1825211026550E-01	9.9298360430458E-01	-1.5114380194773E-07
3	2.9490948582733E-08	1.5572378857117E-07	9.9999999999999E-01

GUIDANCE EVENT AT 3.830 DAYS
CALENDAR DATE 1976 6 20 7 3 2.054 JULIAN DATE 27929.79377

EVENT CODES KUR 1 KTYP 3 KMXQ 4 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	384579.57	65770.54	20337.43	390692.85	.43239532	.04720771	.10473621	.44739687
EARTH	389446.95	66342.08	20580.97	395592.94	.43129540	.05886478	.10387047	.44751521
MOON	-11494.55	19260.78	519.72	22435.96	.52190141	-.90138610	.17518597	1.05620458

INSERTION DECISION EVENT
PLANAR OPTION
TARGET PARAMETERS A= 3000.000 E= .400000 DPER= 5.000

COPLANAR INSERTION EVENT

EVENT	X/VX	Y/VY	Z/VZ	R/V	A/E	W/TA	I/N	RP/RA	TIME
DECISION	-16751.2	-14809.7	1855.4	22436.0	-7214.9	135.48	89.90	1820.31	-18009.82
	.78696	.69529	.11329	1.05620	1.25230	-130.74	-138.53		
TARGET ORBIT					3000.0	140.48	89.90	1800.00	
					.40000	0.	-138.53	4200.00	
MODIFY RP									
PRE-INSERTION	885.6	779.5	1391.7	1824.5	-7214.9	135.48	89.90	1820.31	-67.13
	1.34192	1.18990	-1.68281	2.45937	1.25230	-5.19	-138.53		
POST-INSERTION	885.6	779.5	1391.7	1824.5	3008.1	140.48	89.90	1816.30	-167.03
	1.05538	.93583	-1.32349	1.93422	.39621	-10.19	-138.53	4200.00	
INSERTION VEL	-.28654	-.25408	.35933	.52514					
MODIFY RA									
PRE-INSERTION	486.0	425.4	1816.6	1928.1	-7214.9	135.48	89.90	1820.31	-347.57
	1.48925	1.31934	-1.34219	2.40000	1.25230	-25.91	-138.53		
POST-INSERTION	486.0	425.4	1816.6	1928.1	14821.8	140.48	89.90	1800.00	-449.91
	1.35248	1.19817	-1.21893	2.17959	.87856	-30.91	-138.53	27843.61	
INSERTION VEL	-.13677	-.12117	.12327	.22041					
MODIFY SMA									
PRE-INSERTION	884.3	778.4	1393.3	1824.6	-7214.9	135.48	89.90	1820.31	-68.07
	1.34260	1.19050	-1.68175	2.45930	1.25230	-5.27	-138.53		
POST-INSERTION	884.3	778.4	1393.3	1824.6	3027.1	140.48	89.90	1816.24	-168.00
	1.05733	.93755	-1.32443	1.93676	.40000	-10.27	-138.53	4237.90	
INSERTION VEL	-.28526	-.25295	.35733	.52253					
SELECTED CORREC	-.28654	-.25408	.35933	.52514					

TIME= 17942.69

ORBITAL INSERTION WILL BE EXECUTED AT 4.0376700789E+00

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ERROR ANALYSIS MODE-GUIDANCE           EVENT AT TRAJECTORY TIME       4.038 DAYS
                                                                            PROBLEM. .          1
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STATE VECTOR AT TIME         4.038 DAYS
         X 3.9458316135420E+05
         Y 6.2472215465729E+04
         Z 1.9890444669031E+04
        VX 9.2274798833918E-01
        VY-5.6134190636143E-01
        VZ-1.6985772249288E+00


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NAVIGATION PARAMETERS
   FLIGHT PATH ANGLE . . . . . . . . . .   2.15124231860E+01
   ANGLE BETWEEN RELATIVE VELOCITY
   AND PLANE OF THE SKY. . . . . . . .   2.15546106039E+01
   GEOCENTRIC DECLINATION. . . . . . .   6.18456732025E+00
   EARTH/SPACECRAFT/TARG PLANET ANGLE    7.71267830131E+01
   ANTENNA AXIS - EARTH ANGLE. . . . .   2.84793940861E+00
   ANTENNA AXIS - LIMB OF SUN ANGLE. .   9.93118184051E+01
   OCCULTATION RATIO FOR SUN        IS    2.14686840639E+02
   OCCULTATION RATIO FOR MOON       IS    1.02902729869E+00

PLANAR-ORBIT-INSERTION

IPC-NOT-IN-EFFECT

SINGLE--IMPULSE-

-EXECUTE-ONLY

DVUP=  -2.2620753587E-01    3.3513980294E-01    3.3509334950E-01     MAG. OF DVUP=    5.2514387522E-01

NOMINAL STATE RELATIVE TO TARGET PLANET IMMEDIATELY FOLLOWING ORBITAL INSERTION-       ECLIPTIC COORDINATES

POSITION    5.1977785819E+02   -1.1030265276E+03    1.3690428490E+03         1.8333343571E+03

VELOCITY    8.2901545648E-01   -1.1688159835E+00   -1.2909396456E+00         1.9287100868E+00

NOMINAL STATE RELATIVE TO TARGET PLANET IMMEDIATELY FOLLOWING ORBITAL INSERTION-      EQUATORIAL COORDINATES

PLANETO-CENTRIC EQUATORIAL COORDINATES OF DVUP=    -2.8653778926E-01   -2.5407800514E-01    3.5932791752E-01

POSITION    9.8533070506E+02    8.3810748827E+02    1.2991134906E+03         1.8333343571E+03

VELOCITY    9.9175054789E-01    9.1437156919E-01   -1.3784985484E+00         1.9287100868E+00

NOMINAL PLANETO-CENTRIC EQUATORIAL ORBITAL ELEMENTS IMMEDIATELY FOLLOWING ORBITAL INSERTION

A=     3.0167834275E+03E=     3.9248059041E-01O=     1.3758170815E+02
I=     8.8868624703E+01N=    -1.3848131946E+02T=    -2.7146155515E+00
```

Case S-1. Planetary Explorer Venus '78 Mission

```
LAUNCH DATE             8 17  4 49 15.201 1978     JULIAN DATE . . .2443737.70087038

FINAL DATE             12 16  5 53 10.465 1978     JULIAN DATE . . .2443858.74526000

INITIAL TRAJECTORY TIME =    0.

THE FOLLOWING QUANTITIES ARE TO BE AUGMENTED TO THE STATE VECTOR

SOLVE-FOR PARAMETERS
  MU PLN
  R-RATE

DYNAMIC CONSIDER PARAMETERS
  A
  I
  M

MEASUREMENT CONSIDER PARAMETERS
  RADIUS 1
  LAT  1
  LONG 1

INERTIAL FRAME IS HELIOCENTRIC ECLIPTIC

INITIAL STATE VECTOR
  GEOCENTRIC ECLIPTIC   COORDINATES
        6.55455973E+02
        4.62539153E+03
       -4.61581286E+03
       -1.08560236E+01
       -1.25168694E+00
       -3.27287461E+00

INITIAL STATE VECTOR
     INERTIAL COORDINATES
        1.22444854E+08
       -8.91391532E+07
       -4.61581286E+03
        6.19095585E+00
        2.27225787E+01
       -3.27287461E+00

NOMINAL TRAJECTORY CODE. . . 2

NOMINAL TRAJECTORY INFORMATION
  BODIES TO BECONSIDERED
    SUN
    VENUS
    EARTH

  TARGET PLANET. . .VENUS

UNITS
   1.49598500E+08/A.U.                 8.64000000E+04/DAY

ORBITAL ELEMENTS WILL BE CALCULATED AT EVERY TIME INTERVAL

OUTPUT FROM VIRTUAL MASS PROGRAM WILL BE SUPRESSED AT INITIAL AND FINAL STEPS

VIRTUAL MASS PROGRAM WILL INTEGRATE UNTIL REACHING ANORMAL STOPPING CONDITION
```

```
DYNAMIC CONSTANT BIASES TO BE USED IN THE DETERMINATION OF THE ACTUAL TRAJECTORY
   GRAVITATIONAL CONSTANT OF THE SUN. . . . . . . 0.
   GRAVITATIONAL CONSTANT OF TARGET PLANET. . 8.0000000000000E-01
   SEMI-MAJOR AXIS OF TARGET PLANET . . . . . 1.5000000000000E+01
   ECCENTRICITY OF TARGET PLANET. . . . . . . 0.

   INCLINATION  OF TARGET PLANET. . . . . . . 1.5000000000000E-07
   LONGITUDE OF ASCENDING NODE. . . . . . . . 0.
   ARGUMENT OF PERIAPSIS. . . . . . . . . . . 0.
   MEAN ANOMALY OF TARGET PLANET. . . . . . .-1.2000000000000E-07
ACTUAL UNMODELLED ACCELERATION TO BE USED TO CALCULATE THE ACTUAL DYNAMIC NOISE BY THE FOLLOWING SCHEDULE
                                                                     X                         Y                         Z
   FROM   0.    DAYS THROUGH  121.044 DAYS. . .     0.                        0.                        0.

BIASES IN LOCATIONS OF ROTATING STATIONS
              ALTITUDE                  LATITUDE                  LONGITUDE
   1      8.0000000000000E-04      -1.0000000000000E-07      3.0000000000000E-07
   2      0.                        0.                        0.
   3      0.                        0.                        0.

ACTUAL DEVIATION OF STATE VECTOR AT INITIAL TIME
           1.00000000E+00

          -5.00000000E-01

           1.00000000E+00

          -2.00000000E-03

           2.00000000E-03

          -1.50000000E-03

MU PLN     8.00000000E-01

R-RATE     6.00000000E-06


THE ACTUAL MEASUREMENT NOISE WILL BE CALCULATED FROM THE FOLLOWING CONSTANTS
   RANGE      (GEO CENTRIC) 0.
   RANGE-RATE (GEO CENTRIC) 0.
   RANGE      (STATION 1  ) 2.5000000000000E-07
   RANGE-RATE (STATION 1  ) 9.0000000000000E-14
   RANGE      (STATION 2  ) 2.5000000000000E-07
   RANGE-RATE (STATION 2  ) 9.0000000000000E-14
   RANGE      (STATION 3  ) 2.5000000000000E-07
   RANGE-RATE (STATION 3  ) 9.0000000000000E-14
   STAR PLANE ANGLE 1       2.5000000000000E-11
   STAR PLANE ANGLE 2       2.5000000000000E-11
   STAR PLANE ANGLE 3       2.5000000000000E-11
   APPARENT PLANET DIAMETER 2.5000000000000E-11
```

```
SIMULATION MODE -- GUIDANCE          EVENT AT TRAJECTORY TIME       0.     DAYS
                                                                         PROBLEM. .      16010
*********************************************************************************************
STATE VECTOR
                TARGETED NOMINAL        MOST RECENT NOMINAL          ACTUAL
      X          1.2244485426E+08         1.2244485426E+08        1.2244485526E+08
      Y         -8.9139153205E+07        -8.9139153205E+07       -8.9139153705E+07
      Z         -4.6158128562E+03        -4.6158128562E+03       -4.6148128562E+03
      VX         6.1909558537E+00         6.1909558537E+00        6.1889558537E+00
      VY         2.2722578677E+01         2.2722578677E+01        2.2724578677E+01
      VZ        -3.2728746053E+00        -3.2728746053E+00       -3.2743746053E+00

2 VBP

    NON-LINEAR-GUIDANCE-

----USE-    NON-LINEAR-GUIDANCE-FOR-BIASED-AIMP OINT

SINGLE--IMPULSE-

-COMPUTE--AND   -EXECUTE

VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.488 DAYS
                                             X                  Y                  Z                RESULTANT
POSITION RELATIVE TO TARGET PLANET    1.8041323232E+05   4.2735490946E+05   4.0583373049E+05   6.1634582000E+05
VELOCITY RELATIVE TO TARGET PLANET   -1.6164795943E+00  -3.5386553471E+00  -3.4711552211E+00   5.2138283932E+00
B =     1.4987905328E+04     B DOT T =     1.3736693529E+04     B DOT R =     5.9950443708E+03

M MATRIX
  -9.0959023961E-01   4.1550643317E-01   0.                  -1.0841074997E+05   4.9522699427E+04   0.
   2.7662731033E-01   6.0556824491E-01  -7.4616649077E-01   3.4788016020E+04   7.0608552440E+04  -8.8182011511E+04

VEHICLE REACHED SPHERE OF INFLUENCE ON MOST RECENT NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.488 DAYS
                                             X                  Y                  Z                RESULTANT
POSITION RELATIVE TO TARGET PLANET    1.8041323232E+05   4.2735490946E+05   4.0583373049E+05   6.1634582000E+05
VELOCITY RELATIVE TO TARGET PLANET   -1.6164795943E+00  -3.5386553471E+00  -3.4711552211E+00   5.2138283932E+00
B =     1.4987905328E+04     B DOT T =     1.3736693529E+04     B DOT R =     5.9950443708E+03
STATE TRANSITION MATRIX PARTITIONS OVER(    0.    ,   119.488)          --TRANSPOSES SHOWN

                   X(119.488)         Y(119.488)         Z(119.488)         VX(119.488)        VY(119.488)        VZ(119.488)
   X(  0.   )   5.1757055330E+00   3.6112699962E+00   3.1657631365E-01  -6.2193124982E-08   1.8452509114E-06   7.6837092066E-08
   Y(  0.   )  -1.2089015489E+00  -1.1747565226E+00  -6.1731481782E-02   5.7368105197E-08  -6.6131076362E-07  -1.9038528473E-08
   Z(  0.   )   1.2143401672E-01   8.2087623563E-02  -5.3167994842E-01   4.8692391509E-09   3.4270460438E-08  -1.4497128023E-07
  VX(  0.   )   2.2001410422E+07   1.6926772924E+07   1.2642206951E+06   2.1321064240E-01   8.2357549375E+00   3.7240794621E-01
  VY(  0.   )   4.2583778760E+06   1.0917407980E+07   4.6379146909E+05   1.0206558676E+00   4.0312112305E+00   2.3926363326E-01
  VZ(  0.   )   7.5400257605E+05   8.4366447578E+05   2.6253398074E+06   8.2242015651E-02   4.5577530797E-01  -1.1371217357E+00

SOLVE-FOR PARAMETERS
MU PLN          1.0545969009E-01   4.9962997437E-02  -5.6762397289E-02  -8.6592990556E-08  -1.7376123651E-07  -1.9474263979E-07
R-RATE          0.                 0.                 0.                 0.                 0.                 0.

DYNAMIC CONSIDER PARAMETERS
A              -6.0948455334E-03  -4.6081447601E-03  -1.2448314428E-02  -6.3860425144E-08  -3.1548112247E-08  -1.1550577831E-07
I              -1.5893573802E+05  -4.8583434614E+05  -1.3830266982E+05  -2.0042613925E+00  -6.1703816296E+00  -1.7540978775E+00
M              -7.7398596701E+05   5.5156326589E+05   6.9583296238E+05  -6.7779706579E+00   5.4005445763E+00   7.9361043868E+00

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS BEFORE GUIDANCE CORRECTION APPLIED
   5.3545791106E+04            1.0000000000E+00   -8.6843474748E-01
   7.5363957658E+04           -8.6843474748E-01    1.0000000000E+00
```

```
BIASED AIMPOINT GUIDANCE EVENT

CAPTURE RADIUS=    1.3675480823E+04

PSIJ MATRIX
    -7.0317024070E-08    7.1589616840E-09
     1.4120341509E-07    1.1166157123E-07
    -2.5313302141E-08   -1.9303140821E-06

DVRB=    0.                    0.                    0.

EXECUTION ERROR MATRIX
     0.                    0.                    0.

     0.                    0.                    0.

     0.                    0.                    0.


     LAMBDA STAR=    2.8671517452E+09   -3.5045013227E+09
 -3.5045013227E+09    5.6797261139E+09


PROBABILITY OF IMPACT=    3.7577281215E-02


ELLIPSE CONSTANTS=
     1.4188294106E-09U1*U1+     1.7508906051E-09 U1*U2+     7.1623158215E-10 U2*U2=     1.6899393205E+01

INITIAL XM=    8.5040058899E+04    3.7736172025E+04

     8.5040058899E+04    3.7736172025E+04   -7.0917314235E+04    1.0741004168E+05

     1.4122744664E+04    1.4514621370E+05    7.8362885499E+03   -1.8772694409E+04

     2.1959033214E+04    1.2637351929E+05    3.7753735147E+02   -8.6127903627E+02

     2.2336570565E+04    1.2551224025E+05    8.0038977100E-01   -1.7854190266E+00

     2.2337370955E+04    1.2551045404E+05    3.4377870076E-06   -7.5986667941E-06

MU SUPER I =    2.2337370958E+04    1.2551045483E+05

DELTA MU=    8.6740119156E+03    1.1944739615E+05

DVBIAS=    2.4518862762E-04    1.4562484038E-02   -2.5278799965E-03

     LAMBDA STAR=    2.8671517452E+09   -3.5045013227E+09
 -3.5045013227E+09    5.6797261139E+09


PROBABILITY OF IMPACT=    1.0000000000E-05
*******************************************************************************************************************

COMMANDED VELOCITY CORRECTION WILL BE RECOMPUTED USING NON-LINEAR GUIDANCE

ZERO ITERATE PARAMETERS
   IZERO

IND IMP MOD   TAR KEY     TAR1      TAR2       TAR3      TOL1     TOL2     TOL3    DVX     DVY     DVZ    MAT BADITS BIT
 1   4   1    5  6  2   22337.37  125510.45  28837.19   100.00   100.00    .01    0.      0.      0.      1  2  8  4
```

```
GUIDANCE EVENT AT      0.     DAYS
CALENDAR DATE   1978    8    17     4    49  15.201     JULIAN DATE    28717.70087

EVENT CODES        KUR  1     KTYP  1     KMXQ  4     MDL  1

CURRENT SPACECRAFT STATE
REFERENCE        X-COMP           Y-COMP            Z-COMP          RADIUS        X-DOT          Y-DOT          Z-DOT        VELOCITY
INERTIAL     122444854.26     -89139153.20          -4615.81     151454715.97    6.19095585   22.72257868   -3.27287461   23.77719967
SUN          122444854.26     -89139153.20          -4615.81     151454715.97    6.19095585   22.72257868   -3.27287461   23.77719967
VENUS        115206234.80      19393117.86        1917002.09     116842819.44  -28.51652459   20.51756583   -1.30180665   35.15476330
EARTH              655.46          4625.39          -4615.81          6567.31  -10.85602362   -1.25168694   -3.27287461   11.40752721
      N-BODY TARGETING EVENT


      STATE      1.2244485426E+08   -8.9139153205E+07   -4.6158128562E+03
                 6.1909558537E+00    2.2722578677E+01   -3.2728746053E+00
      JULIAN DATE     2.8717700870E+04


      PARAMETER KEY DEFINITIONS
           1-TRF      4-TCA      7-RCA      10-XRF
           2-TSI      5-B.T      8-INC      11-YRF
           3-TCS      6-B.R      9-ASI      12-ZRF


      TARGETING SPECIFICATIONS
           KEY   TARGET VALUE      TOLERANCE
             5     22337.371         100.000
             6    125510.455         100.000


      TARGETING SCHEME
           LEVELS   2.500E-05
           DVMAX    5.00000000E-02
           IBAST      2

    IND NOF PHS  KEYTAR       DTAR(1)      DTAR(2)      DTAR(3)   KAXTAR       DAUX(1)      DAUX(2)      DAUX(3)  ISTOP  DELT
      1   1   1   5  6  2    22337.37    125510.45     28837.19    5  6  2    22337.37    125510.45     28837.19    2   129.488

ACCURACY      VX          VY          VZ          TAR - 5-     TAR - 6-     TAR - 2-    AUX - 5-     AUX - 6-     AUX - 2-  INCR   CPT
2.50E-05   6.1909559  22.7225787  -3.2728746    13736.694    5995.044        0.      13736.694    5995.044         0.      1009   401
2.50E-05   6.1909659  22.7225787  -3.2728746    13339.580    6687.046        0.      13339.580    6687.046         0.      1009   416
2.50E-05   6.1909559  22.7225887  -3.2728746    13725.729    6045.844        0.      13725.729    6045.844         0.      1009   431

   SENSITIVITY MATRIX                  TARGETING MATRIX           AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-3.97E+07 -1.10E+06  0.          -4.04E-08 -8.71E-09  0.           8.60E+03    -1.39E-03     22337.371      22337.371      100.000
 6.92E+07  5.08E+06  0.           5.50E-07  3.16E-07  0.           1.20E+05     4.24E-02    125510.455     125510.455      100.000

ACCURACY      VX          VY          VZ          TAR - 5-     TAR - 6-     TAR - 2-    AUX - 5-     AUX - 6-     AUX - 2-  INCR   CPT
2.50E-05   6.1895675  22.7650177  -3.2728746    34984.900   111336.367       0.      34984.900   111336.367        0.      1007   447
2.50E-05   6.1895775  22.7650177  -3.2728746    34581.005   112064.860       0.      34581.005   112064.860        0.      1007   462
2.50E-05   6.1895675  22.7650277  -3.2728746    34982.586   111377.321       0.      34982.586   111377.321        0.      1007   478

   SENSITIVITY MATRIX                  TARGETING MATRIX           AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-4.04E+07 -2.31E+05  0.          -2.76E-08 -1.56E-09  0.          -1.26E+04     3.27E-04     22337.371      22337.371      100.000
```

```
 7.20E+07  4.10E+06  0.            4.90E-07  2.72E-07  0.          1.42E+04   -2.35E-03    125510.455    125510.455    100.000

ACCURACY      VX          VY          VZ         TAR - 5-     TAR - 6-     TAR - 2-     AUX - 5-     AUX - 6-     AUX - 2-  INCR   CPT
2.50E-05    6.1898941  22.7626692  -3.2728746    23784.045   123518.487      0.         23784.045   123518.487      0.      1008   493
2.50E-05    6.1899041  22.7626692  -3.2728746    23396.475   124220.334      0.         23396.475   124220.334      0.      1008   508
2.50E-05    6.1898941  22.7626792  -3.2728746    23789.218   123543.315      0.         23789.218   123543.315      0.      1008   524

     SENSITIVITY MATRIX                  TARGETING MATRIX           AUX ERROR    VEL COR     DES AUX VAL   DES TAR VAL    TAR TOL
-3.88E+07  5.17E+05  0.            -1.87E-08  3.90E-09  0.          -1.45E+03    3.49E-05     22337.371     22337.371    100.000
 7.02E+07  2.48E+06  0.             5.30E-07  2.92E-07  0.           1.99E+03   -1.84E-04    125510.455    125510.455    100.000

ACCURACY      VX          VY          VZ         TAR - 5-     TAR - 6-     TAR - 2-     AUX - 5-     AUX - 6-     AUX - 2-  INCR   CPT
2.50E-05    6.1899290  22.7624856  -3.2728746    22553.595   125115.215      0.         22553.595   125115.215      0.      1008   539
2.50E-05    6.1899390  22.7624856  -3.2728746    22159.669   125831.495      0.         22159.669   125831.495      0.      1008   554
2.50E-05    6.1899290  22.7624956  -3.2728746    22537.178   125183.630      0.         22537.178   125183.630      0.      1008   570

     SENSITIVITY MATRIX                  TARGETING MATRIX           AUX ERROR    VEL COR     DES AUX VAL   DES TAR VAL    TAR TOL
-3.94E+07 -1.64E+06  0.            -4.50E-08 -1.08E-08  0.          -2.16E+02    5.47E-06     22337.371     22337.371    100.000
 7.16E+07  6.84E+06  0.             4.72E-07  2.59E-07  0.           3.95E+02    5.39E-07    125510.455    125510.455    100.000

ACCURACY      VX          VY          VZ         TAR - 5-     TAR - 6-     TAR - 2-     AUX - 5-     AUX - 6-     AUX - 2-  INCR   CPT
2.50E-05    6.1899345  22.7624861  -3.2728746    22327.566   125528.042      0.         22327.566   125528.042      0.      1008   585

      DVUP=   -1.0213745230E-03    3.9907459511E-02    0.                     MAG. OF DVUP=    3.9920527684E-02


CONTROL (AND KNOWLEDGE) CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST AFTER GUIDANCE CORRECTION AT    0.

             STD DEV                X             Y              Z              VX             VY             VZ
      X    1.41421356E+00      1.00000000
      Y    1.41421356E+00       .00000000    1.00000000
      Z    1.41421356E+00      -.00000000     .00000000     1.00000000
     VX    4.24264068E-03      -.00000002    -.00000000     -.00000001     1.00000000
     VY    4.24264068E-03      -.00000000     .00000000     -.00000000     -.00000000     1.00000000
     VZ    4.24264069E-03      -.00000001    -.00000000     -.00000000      .00000000     -.00000000     1.00000000


        TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER GUIDANCE CORRECTION
     5.3545791106E+04              1.0000000000E+00     -8.6843474748E-01
     7.5363957658E+04             -8.6843474748E-01      1.0000000000E+00


      ACTUAL TARGET ERROR

              DUE TO                         DUE TO
      NAVIGATIONAL UNCERTAINTY          EXECUTION ERROR      TOTAL

        2.7171381187E+04         0.                          2.7171381187E+04

       -1.4753416061E+04         0.                         -1.4753416061E+04
```

```
MOST RECENT NOMINAL TRAJECTORY
            1.2244485426E+08

           -8.9139153205E+07

           -4.6158128562E+03

            6.1899344792E+00

            2.2762486136E+01

           -3.2728746053E+00

TARGETED NOMINAL TRAJECTORY AFTER GUIDANCE CORRECTION
            1.2244485426E+08

           -8.9139153205E+07

           -4.6158128562E+03

            6.1899344792E+00

            2.2762486136E+01

           -3.2728746053E+00

ACTUAL DEVIATIONS JUST AFTER GUIDANCE CORRECTION
            9.9999952315E-01

           -5.0000000000E-01

            1.0000000000E+00

           -2.0000000000E-03

            2.0000000000E-03

           -1.5000000000E-03

ESTIMATED DEVIATIONS JUST AFTER GUIDANCE CORRECTION
            0.

            0.

            0.

            0.

            0.

            0.
```

MEASUREMENT NO 30 AT TRAJECTORY TIME 9.900 PROBLEM. 16010

RANGE-RATE WAS MEASURED FROM STATION 3 AT TRAJECTORY TIME 9.90000 DAYS

INITIAL TRAJECTORY TIME 9.600
FINAL TRAJECTORY TIME 9.900

TARG NOM	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	133340479.97	-69088619.79	1159046.05	150550477.13	11.166798824	24.531015563	1.335245649	26.986126095
GEO-	-1573208.14	-1714707.47	1159046.05	2599729.46	-1.782094316	-1.947878115	1.335245649	2.958541912
PLANETO-	97906843.73	33014402.91	4628670.36	103426908.67	-21.708911000	13.247019581	3.074851308	25.616694852
FINAL								
INERTIAL	133628186.60	-69251849.96	1193631.59	150514580.07	11.033061450	24.602164985	1.333396852	26.995794377
GEO-	-1619408.15	-1765176.19	1193631.59	2676394.24	-1.781278037	-1.944294250	1.333396852	2.954856806
PLANETO-	97343624.84	33355134.33	4700226.54	103007347.70	-21.747103051	13.044361755	3.063698053	25.543661292

MOST RECENT NOM	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	133336281.84	-69890416.34	1159498.94	150547596.43	11.161589703	24.528669021	1.335969164	26.981873586
GEO-	-1577406.27	-1716504.01	1159498.94	2603657.88	-1.787303437	-1.950224661	1.335969164	2.963552498
PLANETO-	97902645.59	33012606.36	4629123.25	103422381.40	-21.714120121	13.244673035	3.075574824	25.619983156
FINAL								
INERTIAL	133623853.39	-69253707.31	1194103.27	150508591.30	11.027847165	24.599820929	1.334122572	26.991563235
GEO-	-1623741.36	-1767033.54	1194103.27	2680452.60	-1.786492322	-1.946638306	1.334122572	2.959871374
PLANETO-	97339291.63	33353276.98	4708698.21	103002672.88	-21.752317335	13.042037699	3.064423773	25.546991014

ACTUAL TRAJ	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	133336240.71	-69890455.68	1159403.59	150547577.53	11.161535736	24.528618485	1.335870584	26.981800440
GEO-	-1577447.40	-1716543.35	1159403.59	2603666.27	-1.787357404	-1.950275196	1.335870584	2.963573864
PLANETO-	97902604.46	33012567.02	4629027.90	103422325.64	-21.714174088	13.244622500	3.075476243	25.619990937
FINAL								
INERTIAL	133623810.87	-69253747.96	1194005.36	150508571.47	11.027793202	24.599770473	1.334024150	26.991490338
GEO-	-1623783.89	-1767074.19	1194005.36	2680461.54	-1.786546284	-1.946688762	1.334024150	2.959892767
PLANETO-	97339249.10	33353236.34	4708600.31	103002615.05	-21.752371298	13.041987243	3.064325351	25.546999397

****

NAVIGATION PARAMETERS
FLIGHT PATH ANGLE . . . . -3.22381081655E+00
ANGLE BETWEEN RELATIVE VELOCITY
AND PLANE OF THE SKY. . . . . 8.96617900103E+01
GEOCENTRIC DECLINATION. . . . . . . 8.41956687045E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE 1.39958937982E+02
ANTENNA AXIS - EARTH ANGLE. . . . . 2.64519843212E+01
ANTENNA AXIS - LIMB OF SUN ANGLE. . 1.04917505475E+02
OCCULTATION RATIO FOR SUN IS 2.09798879702E+02
OCCULTATION RATIO FOR VENUS IS 1.09533765749E+04

STATE TRANSITION MATRIX PARTITIONS OVER(9.600, 9.900) --TRANSPOSES SHOWN

	X(9.900)	Y(9.900)	Z(9.900)	VX(9.900)	VY(9.900)	VZ(9.900)
X(9.600)	1.0000177358E+00	-1.6086270470E-05	2.7035368610E-07	1.3706003270E-09	-1.2400488841E-09	2.0975553290E-11
Y(9.600)	-1.6086271102E-05	9.9999533115E-01	-1.4117578595E-07	-1.2400489758E-09	-3.6220981002E-10	-1.0932497633E-11
Z(9.600)	2.7035366057E-07	-1.4117576685E-07	9.9998693324E-01	2.0975549552E-11	-1.0932494876E-11	-1.0083641519E-09
VX(9.600)	2.5920153471E+04	-1.3885471765E-01	2.3486587925E-03	1.0000177900E+00	-1.6055727231E-05	2.7333145936E-07
VY(9.600)	-1.3885266391E-01	2.5919959442E+04	-1.2241262302E-03	-1.6055727730E-05	9.9999528028E-01	-1.4219390110E-07
VZ(9.600)	2.3487425497E-03	-1.2241879813E-03	2.5919887089E+04	2.7333143826E-07	-1.4219388578E-07	9.9998692990E-01
SOLVE-FOR PARAMETERS						
MU PLN	0.	0.	0.	0.	0.	0.
R-RATE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
A	0.	0.	0.	0.	0.	0.
I	0.	0.	0.	0.	0.	0.
M	0.	0.	0.	0.	0.	0.

DIAGONAL OF DYNAMIC NOISE MATRIX

0. 0. 0. 0. 0. 0.

OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN

	RANGE-RATE(3)
X	-3.2328654153E-08
Y	3.6659369865E-08
Z	1.0389407636E-08
VX	-6.0418082777E-01
VY	-6.5953994824E-01
VZ	4.4718294246E-01
SOLVE-FOR PARAMETERS	
MU PLN	0.
R-RATE	0.
DYNAMIC CONSIDER PARAMETERS	
A	0.
I	0.
M	0.
MEASUREMENT CONSIDER PARAMETERS	
RADIUS 1	0.
LAT 1	0.
LONG 1	0.

MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

3.00000000E-06 1.00000000E+00

GAIN MATRIX PARTITIONS

K-MATRIX

4.8662184407E+04

2.8214596587E+06
4.2099754312E+06
1.4237045564E-03
3.2733284550E+00
4.7992000804E+00

S-MATRIX

0.
1.1133747634E-01

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.900 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	9.60813371E+00	1.00000000					
Y	3.47280134E+01	-.25804206	1.00000000				
Z	4.80621681E+01	.02706652	.95787182	1.00000000			
VX	1.14427632E-05	.99539022	-.28426239	-.00120172	1.00000000		
VY	3.97532011E-05	-.27431214	.99759293	.95073604	-.30625318	1.00000000	
VZ	5.40425869E-05	.01521156	.96004241	.99792071	-.01833611	.95689856	1.00000000

SOLVE-FOR PARAMETERS

	X	Y	Z	VX	VY	VZ
MU PLN	0.	0.	0.	0.	0.	0.
R-RATE	-.57533608	.82525484	.67584106	-.57779703	.81989477	.67567199

DYNAMIC CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
A	0.	0.	0.	0.	0.	0.
I	0.	0.	0.	0.	0.	0.
M	0.	0.	0.	0.	0.	0.

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 1	-.00371906	.00525602	.00430670	-.00375702	.00522390	.00428253
LAT 1	.00188624	-.00270271	-.00221582	.00189596	-.00268371	-.00220994
LONG 1	.00665303	-.00943071	-.00770261	.00670547	-.00938841	-.00771369

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	1.00000000E+00	1.00000000	
R-RATE	2.93246111E-06	0.	1.00000000

DYNAMIC CONSIDER PARAMETERS

	MU PLN	R-RATE
A	0.	0.
I	0.	0.
M	0.	0.

MEASUREMENT CONSIDER PARAMETERS

	MU PLN	R-RATE
RADIUS 1	0.	-.00027155
LAT 1	0.	.00014514
LONG 1	0.	.00055755

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CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.900 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	9.60685595E+00	1.00000000					
Y	3.35186036E+01	-.27180907	1.00000000				
Z	4.61107974E+01	.02342064	.95474835	1.00000000			
VX	1.14427523E-05	.99551616	-.29462769	-.00137036	1.00000000		
VY	3.83304599E-05	-.28901684	.99742071	.94691244	-.31773080	1.00000000	
VZ	5.17860554E-05	.01100937	.95714302	.99774725	-.01925464	.95360452	1.00000000

SOLVE-FOR PARAMETERS

	X	Y	Z	VX	VY	VZ
MU PLN	0.	0.	0.	0.	0.	0.
R-RATE	-.58177055	.82810692	.67355328	-.58221331	.82288279	.67368576

DYNAMIC CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
A	0.	0.	0.	0.	0.	0.
I	0.	0.	0.	0.	0.	0.
M	0.	0.	0.	0.	0.	0.

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 1	-.00373223	.00523503	.00426049	-.00375733	.00520411	.00423724
LAT 1	.00189300	-.00269210	-.00219231	.00189612	-.00267363	-.00218720
LONG 1	.00667692	-.00938878	-.00761401	.00670604	-.00934912	-.00762901

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	R-RATE
MU PLN	1.00000000E+00	1.00000000	
R-RATE	2.91046432E-06	0.	1.00000000

DYNAMIC CONSIDER PARAMETERS

	MU PLN	R-RATE
A	0.	0.
I	0.	0.
M	0.	0.

MEASUREMENT CONSIDER PARAMETERS

	MU PLN	R-RATE
RADIUS 1	0.	-.00036933
LAT 1	0.	.00019537
LONG 1	0.	.00073546

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ACTUAL DYNAMIC NOISE
0.
0.

0.
0.
0.
0.

ACTUAL MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

3.00000000E-07 1.00000000E+00

ACTUAL MEASUREMENT NOISE

-1.12488510E-07

MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

3.2199820583E-06 1.0000000000E+00

MEASUREMENT

ESTIMATED	ACTUAL	RESIDUAL
2.6030678527E+00	2.6030753716E+00	7.5188395385E-06

POSITION/VELOCITY DEVIATIONS

	FROM MOST RECENT NOMINAL		FROM TARGETED NOMINAL		ACTUAL ORBIT ESTIMATION ERROR
	ESTIMATED	ACTUAL	ESTIMATED	ACTUAL	(ESTIMATED-ACTUAL)
X	-4.50820980E+01	-4.25294290E+01	-4.37828934E+03	-4.37573667E+03	-2.55266901E+00
Y	-3.42962316E+01	-4.06469913E+01	-1.89164171E+03	-1.89799247E+03	6.35075961E+00
Z	-8.72827793E+01	-9.79074202E+01	3.84392635E+02	3.73767995E+02	1.06246409E+01
VX	-5.71144701E-05	-5.39625063E-05	-5.27139907E-03	-5.26824711E-03	-3.15196378E-06
VY	-2.40184740E-05	-5.04556560E-05	-2.36807449E-03	-2.39451167E-03	2.64371821E-05
VZ	-7.94817013E-05	-9.84225359E-05	6.46238492E-04	6.27297657E-04	1.89408346E-05

SOLVE-FOR PARAMETER DEVIATIONS (MOST RECENT NOMINAL=TARGETED NOMINAL FOR SOLVE-FOR PARAMETERS)

	ESTIMATED	ACTUAL	ESTIMATION ERROR (ESTIMATED-ACTUAL)
MU PLN	0.	8.00000000E-01	-8.00000000E-01
R-RATE	3.97383724E-06	6.00000000E-06	-2.02616276E-06

SIMULATION MODE -- GUIDANCE   EVENT AT TRAJECTORY TIME   10.000 DAYS
PROBLEM. .   16010

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STATE VECTOR

	TARGETED NOMINAL	MOST RECENT NOMINAL	ACTUAL
X	1.3372331866E+08	1.3371894039E+08	1.3371889740E+08
Y	-6.9039185041E+07	-6.9041062636E+07	-6.9041103719E+07
Z	1.2051494696E+06	1.2056274183E+06	1.2055286607E+06
VX	1.0988386716E+01	1.0983170674E+01	1.0983116712E+01
VY	2.4625736545E+01	2.4623393408E+01	2.4623342980E+01
VZ	1.3327809891E+00	1.3335074058E+00	1.3334090356E+00

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2VBP

NON-LINEAR-GUIDANCE-

----USE-   NON-LINEAR-GUIDANCE-FOR-BIASED-AIMP OINT

SERIES-OF-IMPULSES

-COMPUTE--AND   -EXECUTE

VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.761 DAYS

	X	Y	Z	RESULTANT
POSITION RELATIVE TO TARGET PLANET	2.0264569378E+05	4.9154696458E+05	3.1176670741E+05	6.1634582455E+05
VELOCITY RELATIVE TO TARGET PLANET	-1.6072602660E+00	-3.4896514232E+00	-3.4532614611E+00	5.1658462363E+00

B =   1.2767455672E+05   B DOT T =   2.2051888161E+04   B DOT R =   1.2575574207E+05

M MATRIX

-9.0829067377E-01	4.1833963707E-01	0.	-1.2559150622E+05	5.7844814054E+04	0.
2.7965140275E-01	6.0717354636E-01	-7.4373071575E-01	3.6080069885E+04	6.9364107338E+04	-8.6887894817E+04

VEHICLE REACHED SPHERE OF INFLUENCE ON MOST RECENT NOMINAL TRAJECTORY AT TRAJECTORY TIME   119.474 DAYS

	X	Y	Z	RESULTANT
POSITION RELATIVE TO TARGET PLANET	1.1831992548E+05	4.6197352441E+05	3.9046514422E+05	6.1634582084E+05
VELOCITY RELATIVE TO TARGET PLANET	-1.6019041270E+00	-3.5413384962E+00	-3.4613366731E+00	5.2046159072E+00

B =   8.6870518087E+04   B DOT T =   8.4274755216E+04   B DOT R =   2.1077299307E+04

STATE TRANSITION MATRIX PARTITIONS OVER(10.000,   119.474)   --TRANSPOSES SHOWN

	X(119.474)	Y(119.474)	Z(119.474)	VX(119.474)	VY(119.474)	VZ(119.474)
X(10.000)	4.6128656237E+00	3.5190591813E+00	2.9175899260E-01	-2.6828290478E-08	1.7452197970E-06	7.4475484366E-08
Y(10.000)	-2.9395088759E-01	-4.2232321509E-01	-7.8163988879E-03	7.3333535535E-08	-3.0327812942E-07	-2.6282833998E-09
Z(10.000)	1.3899986358E-01	1.0585099655E-01	-4.3727707402E-01	7.5939697306E-09	4.7216428243E-08	-1.8079875670E-07
VX(10.000)	1.7756444466E+07	1.3829535845E+07	9.9399232847E+05	2.5146049135E-01	6.6734828511E+00	3.0469736621E-01
VY(10.000)	4.8894013182E+06	1.1602725931E+07	4.9038160746E+05	9.6465398472E-01	4.4423164204E+00	2.4698650302E-01
VZ(10.000)	6.3612180680E+05	7.5716952233E+05	3.0447398414E+06	7.6404131333E-02	4.1747192822E-01	-9.9544749714E-01

SOLVE-FOR PARAMETERS

MU PLN	-3.8591623306E-02	-9.3832015991E-02	-5.9963464737E-02	-6.8819190346E-08	-2.5858184927E-07	-2.1768826741E-07
R-RATE	0.	0.	0.	0.	0.	0.

DYNAMIC CONSIDER PARAMETERS

A	-5.7490873337E-03	-5.6017494202E-03	-1.2498729676E-02	-5.5564667036E-08	-4.6328764256E-08	-1.1516960207E-07
I	-1.2821967241E+05	-4.7933254791E+05	-1.1202158020E+05	-1.4142229280E+00	-5.9991842206E+00	-1.2176433425E+00
M	-8.0601742136E+05	5.1920377393E+05	6.2449647974E+05	-7.2389567522E+00	4.7724871500E+00	6.6530219414E+00

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS BEFORE GUIDANCE CORRECTION APPLIED

5.3893405869E+04	1.0000000000E+00	-8.6948308550E-01
7.4983254954E+04	-8.6948308550E-01	1.0000000000E+00

GUIDANCE MATRIX -- TWO VARIABLE B-PLANE GUIDANCE POLICY

-2.6113797717E-07	8.2881224235E-09	-9.8193271225E-09	-9.9975353306E-01	-3.1971474731E-03	-1.5368293486E-02
9.7026163768E-09	2.7797418533E-08	-3.7227613630E-08	-3.1971474731E-03	-9.5852688455E-01	1.9935614963E-01
-6.2064518968E-09	-5.6499245221E-09	7.5871814539E-09	-1.5368293486E-02	1.9935614963E-01	-4.1719582394E-02

VELOCITY CORRECTION CORRELATION MATRIX AND STANDARD DEVIATIONS

5.2823240694E-03	1.0000000000E+00	-4.6922117517E-02	1.4693164540E-01
4.0136016762E-03	-4.6922117517E-02	1.0000000000E+00	-9.9495149736E-01
8.4320270757E-04	1.4693164540E-01	-9.9495149736E-01	1.0000000000E+00

DEVIATION OF STATE VECTOR FROM TARGETED NOMINAL TRAJECTORY

ESTIMATED	ACTUAL
-4.4238401276E+03	-4.4212601867E+03
-1.9120987453E+03	-1.9186779056E+03
3.8997931879E+02	3.7919112990E+02
-5.2731636748E-03	-5.2700032901E-03
-2.3671317616E-03	-2.3935651144E-03
6.4696428244E-04	6.2804655888E-04

COMMANDED CORRECTION	PERFECT CORRECTION
6.4050449658E-03	6.4016382879E-03
2.3042025908E-03	2.3260019684E-03
-3.7663541800E-04	-3.8122509209E-04

COMMANDED DELTA V. . . 6.8173165419E-03

ERROR IN CORRECTION DUE TO NAVIGATION UNCERTAINTY

-3.4066779125E-06
2.1799377569E-05
-4.5896740888E-06

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BIASED AIMPOINT GUIDANCE EVENT

CAPTURE RADIUS=    1.3781926171E+04

PSIJ MATRIX
   -9.1591985416E-08    5.2541439194E-09
    1.3686519469E-07    1.0798407776E-07
   -2.9941685354E-08   -2.2380236873E-08

DELTA MU=     8.3885291180E+03    1.1969268339E+05

DVRB=    1.3943945203E-04   -1.4073001701E-02    2.9299173056E-03

EXECUTION ERROR MATRIX
    3.0054856581E-08    1.3515808508E-08   -2.9323016511E-09

    1.3515808508E-08    1.3265657035E-08    5.2730920967E-09

   -2.9323816511E-09    5.2730920967E-09    3.6426815771E-08


LAMBDA STAR=    2.9997975496E+06   -5.0180483632E+06
-5.0180483632E+06    8.9713215002E+06

PROBABILITY OF IMPACT=    0.

COMMANDED VELOCITY CORRECTION WILL BE RECOMPUTED USING NON-LINEAR GUIDANCE

ZERO ITERATE PARAMETERS
    IZERO

IND IMP MOD  TAR KEY    TAR1      TAR2      TAR3     TOL1    TOL2    TOL3   DVX    DVY    DVZ   MAT BADITS BIT

 1   4   1   5  6  2  13663.36   6063.06  28837.19  100.00  100.00   .01   0.     0.     0.     1  2  8  4
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GUIDANCE EVENT AT    10.000 DAYS
CALENDAR DATE   1970    8   27    4   49  15.201     JULIAN DATE    28727.70087

EVENT CODES        KUR  1     KTYP  1     KMXQ  4     MDL  1

CURRENT SPACECRAFT STATE
REFERENCE          X-COMP          Y-COMP          Z-COMP          RADIUS       X-DOT         Y-DOT         Z-DOT        VELOCITY
INERTIAL       133718894.82    -69041097.14      1205539.45    150495412.72   10.98311355   24.62336941   1.33342795   26.99476124
SUN            133718894.82    -69041097.14      1205539.45    150495412.72   10.98311355   24.62336941   1.33342795   26.99476124
VENUS           97151245.19     33465631.92      4735070.83    102862694.20  -21.76470044   12.97450405   3.06060121   25.52268051
EARTH           -1639226.51     -1783891.01      1205539.45      2706040.66   -1.78629507   -1.94546241   1.33342795    2.95860594
      N-BODY TARGETING EVENT


      STATE      1.3371889682E+08   -6.9041097140E+07    1.2055394489E+06
                 1.0983113552E+01    2.4623369413E+01    1.3334279534E+00
      JULIAN DATE     2.8727700870E+04


      PARAMETER KEY DEFINITIONS
           1-TRF      4-TCA      7-RCA      10-XRF
           2-TSI      5-B.T      8-INC      11-YRF
           3-TCS      6-B.R      9-ASI      12-ZRF


      TARGETING SPECIFICATIONS
           KEY   TARGET VALUE     TOLERANCE
            5      13663.359        100.000
            6       6063.059        100.000


      TARGETING SCHEME
           LEVELS   2.500E-05
           DVMAX    5.00000000E-02
           IBAST      2

   IND NOF PHS  KEYTAR        DTAR(1)       DTAR(2)       DTAR(3)   KAXTAR       DAUX(1)      DAUX(2)       DAUX(3)   ISTOP   DELT
    1   1   1   5  6  2      13663.36      6063.06      28837.19    5  6  2     13663.36      6063.06      28837.19     2    119.488

ACCURACY      VX         VY           VZ          TAR - 5-     TAR - 6-     TAR - 2-      AUX - 5-     AUX - 6-      AUX - 2- INCR    CPT
2.50E-05  10.9831136  24.6233694   1.3334280   84981.798    20076.105        0.       84981.798    20076.105         0.       328    679
2.50E-05  10.9831236  24.6233694   1.3334280   84880.744    20207.021        0.       84880.744    20207.021         0.       328    684
2.50E-05  10.9831136  24.6233794   1.3334280   84986.194    20160.536        0.       84986.194    20160.536         0.       328    689

    SENSITIVITY MATRIX                   TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-1.01E+07  4.40E+05  0.             -9.27E-08  4.83E-09  0.           -7.13E+04     6.54E-03      13663.359      13663.359      100.000
 1.31E+07  8.44E+06  0.              1.44E-07  1.11E-07  0.           -1.40E+04    -1.18E-02       6063.059       6063.059      100.000

ACCURACY      VX         VY           VZ          TAR - 5-     TAR - 6-     TAR - 2-      AUX - 5-     AUX - 6-      AUX - 2- INCR    CPT
2.50E-05  10.9896574  24.6115630   1.3334280   13641.580     6176.368         0.       13641.580     6176.368          0.       330    694
2.50E-05  10.9896674  24.6115630   1.3334280   13540.592     6307.378         0.       13540.592     6307.378          0.       330    699
2.50E-05  10.9896574  24.6115730   1.3334280   13646.052     6260.658         0.       13646.052     6260.658          0.       330    704

    SENSITIVITY MATRIX                   TARGETING MATRIX             AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL      TAR TOL
-1.01E+07  4.47E+05  0.             -9.26E-08  4.92E-09  0.            2.18E+01    -2.57E-06      13663.359      13663.359      100.000
```

```
1.31E+07  8.43E+06  0.           1.44E-07  1.11E-07  0.          -1.13E+02    -9.44E-06       6063.059       6063.059      100.000

ACCURACY     VX          VY            VZ           TAR - 5-      TAR - 6-      TAR - 2-     AUX - 5-      AUX - 6-      AUX - 2- INCR   CPT
2.50E-05  10.9896548  24.6115536   1.3334280     13663.365      6063.058         0.        13663.365      6063.058         0.     330    709

     DVUP=    6.5412569837E-03   -1.1815822986E-02    0.                         MAG. OF DVUP=    1.3505617933E-02


     EXECUTION ERROR MATRIX=
  1.7024298350E-04               1.0000000000E+00     7.2573510734E-01      0.
  1.0961796008E-04               7.2573510734E-01     1.0000000000E+00      0.
  1.9099828049E-04               0.                   0.                    1.0000000000E+00


  PULSING ARC DATA

  THRUST  1.0000E-03    MASS  1.0000E+00    DUR  1.0000E+00    DV  1.0000E-03

  DELTA V           X-COMP         Y-COMP          Z-COMP          MAG
  IMPULSIVE         .006541        -.011816        0.              .013506
  NOM PULSE         .000484        -.000875        0.              .001000
  END PULSE         .000245        -.000442        0.              .000506

  PULSE ARC        JULIAN DATE          CALENDAR DATE
  MIDPOINT          28727.70087     1978  8 27  4 4915.201
  INITIATION        28727.05087     1978  8 26 13 1315.200
  TERMINATION       28728.35087     1978  8 27 20 2515.200

  F AND G SERIES      F2           F3           F4           F5           F6           G3           G4           G5           G6
  LAUNCH BODY    -1.9217E-14 -4.9211E-23  5.9482E-29  4.5761E-37  3.2032E-42 -6.4057E-15 -2.4606E-23  1.1069E-29  1.4745E-37
  TARGET BODY    -5.1394E-14  4.1261E-23  4.3186E-28 -1.0402E-36  6.0577E-41 -1.7131E-14  2.0631E-23  8.3026E-29 -3.4004E-37


  PULSING ARC COVARIANCE PROPAGATION

  NOMINAL STATE TRANSITION MATRIX
        1.000002E+00      -8.869171E-07      -5.722046E-07       8.640006E+03      -2.717972E-03      -1.716614E-03
       -8.821487E-07       9.999997E-01      -6.675720E-07      -2.527237E-03       8.639999E+03      -1.859665E-03
       -5.710870E-07      -6.713718E-07       9.999982E-01      -1.636893E-03      -1.925975E-03       8.639935E+03
        4.780344E-10      -2.060364E-10      -1.315442E-10       9.999998E-01       2.897991E-07      -5.862375E-07
       -2.055174E-10      -7.239805E-11      -1.547005E-10       2.920274E-07       9.999991E-01      -6.545974E-07
       -1.315268E-10      -1.547198E-10      -4.056700E-10      -5.861018E-07      -6.546230E-07       9.999982E-01

  ERROR MODEL VARIANCES
       PROPORTION        4.0000000E-06
       RESOLUTION        4.0000000E-10
       POINTING A        1.0000000E-04
       POINTING B        1.0000000E-04

  DELTA V          4.8433600E-04    -8.7488207E-04      0.                      1.0000000E-03

  NOMINAL EXECUTION ERROR MATRIX
        1.713127E-10      -1.288160E-10       0.
       -1.288160E-10       3.326873E-10       0.
        0.                 0.                 1.000000E-10

  FINAL EXECUTION ERROR MATRIX

  DELTA V          2.4488897E-04    -4.4235606E-04      0.                      5.0561793E-04
        1.136403E-10      -1.590953E-10       0.
       -1.590953E-10       3.129472E-10       0.
        0.                 0.                 2.556495E-11
```

ACCUMULATED EXECUTION ERROR COVARIANCE

1.047550E+01	-7.876783E+00	-1.532305E-04	1.347320E-04	-1.012976E-04	-2.201001E-09
-7.876783E+00	2.033969E+01	-4.775871E-04	-1.013174E-04	2.615694E-04	-1.221157E-08
-1.532305E-04	-4.775871E-04	6.113024E+00	-4.361613E-09	-8.308909E-09	7.860728E-05
1.347320E-04	-1.013174E-04	-4.361613E-09	2.399046E-09	-1.803888E-09	-5.633505E-14
-1.012976E-04	2.615694E-04	-8.308909E-09	-1.803888E-09	4.657574E-09	-1.761278E-13
-2.201001E-09	-1.221157E-08	7.860728E-05	-5.633505E-14	-1.761278E-13	1.325278E-09

PULSING ARC EXECUTION

PULSE	TIME	X-COMP	Y-COMP	Z-COMP	X-DOT	Y-DOT	Z-DOT
0	0.	133093944.282	-70419621.562	1130541.812	11.27260888	24.46887579	1.33743054
1	0.	133093944.282	-70419621.562	1130541.812	11.27309321	24.46800091	1.33743054
2	.10000	133191152.123	-70208114.389	1142094.452	11.22921257	24.49111100	1.33678024
3	.20000	133287980.809	-69996407.734	1153641.271	11.18531458	24.51417024	1.33609497
4	.30000	133384429.992	-69784502.162	1165182.180	11.14136460	24.53715627	1.33541237
5	.40000	133480499.223	-69572398.307	1176717.203	11.09736295	24.56006927	1.33473223
6	.50000	133576188.058	-69360096.799	1188246.359	11.05330992	24.58290942	1.33405432
7	.60000	133671496.053	-69147598.265	1199769.667	11.00920578	24.60567688	1.33337845
8	.70000	133766422.769	-68934903.335	1211287.144	10.96505082	24.62837180	1.33270443
9	.80000	133860967.767	-68722012.633	1222798.804	10.92084529	24.65099434	1.33203206
10	.90000	133955130.611	-68508926.784	1234304.662	10.87658945	24.67354462	1.33136118
11	1.00000	134048910.869	-68295646.413	1245804.729	10.83228355	24.69602278	1.33069162
12	1.10000	134142308.108	-68082172.141	1257299.016	10.78792782	24.71842893	1.33002320
13	1.20000	134235321.900	-67868504.591	1268787.533	10.74352250	24.74076318	1.32935577
14	1.30000	134327951.815	-67654644.384	1280270.286	10.69882837	24.76345817	1.32868919
STATE PROP BACK		133718890.160	-69041135.504	1205556.173	10.99092558	24.61239163	1.33218962
IMPULSIVE MODEL		133718894.818	-69041097.140	1205539.449	10.98965481	24.61155359	1.33342795

ELEMENTS AFTER ARC	SMA	ECC	OMEGA	INC	NODE	TA
SERIES OF PULSES	1.281826871E+08	1.8263410E-01	174.44116	2.89638	-36.41824	-165.31948
IMPULSIVE MODEL	1.281745111E+08	1.8271395E-01	174.43238	2.89913	-36.40938	-165.31953

CONTROL (AND KNOWLEDGE) CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST AFTER GUIDANCE CORRECTION AT 10.000

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.02307721E+01	1.00000000					
Y	3.41480455E+01	-.27853758	1.00000000				
Z	4.66227675E+01	.02182944	.94504408	1.00000000			
VX	5.03008765E-05	.47682004	-.12576546	-.00060649	1.00000000		
VY	7.82723202E-05	-.26094090	.58200983	.46304176	-.49371687	1.00000000	
VZ	6.32886343E-05	.00829511	.77607411	.84168770	-.00381105	.38191785	1.00000000

SOLVE-FOR PARAMETERS

MU PLN	0.	0.	0.	0.	0.	0.
R-RATE	-.55192378	.82082299	.67262118	-.13272082	.40295513	.55107667

DYNAMIC CONSIDER PARAMETERS

A	0.	0.	0.	0.	0.	0.
I	0.	0.	0.	0.	0.	0.
M	0.	0.	0.	0.	0.	0.

ACTUAL EXECUTION ERROR
-1.1476243591E-04   1.1202422530E-04   1.3505617933E-04

ACTUAL VELOCITY CORRECTION
6.4264945478E-03   -1.1703798760E-02   1.3505617933E-04

PULSING ARC DATA

THRUST 1.0000E-03   MASS 1.0000E+00   DUR 1.0000E+00   DV 1.0000E-03

DELTA V	X-COMP	Y-COMP	Z-COMP	MAG
IMPULSIVE	.006426	-.011704	.000135	.013353
NOM PULSE	.000481	-.000877	.000010	.001000
END PULSE	.000170	-.000309	.000004	.000353

PULSE ARC	JULIAN DATE	CALENDAR DATE
MIDPOINT	28727.70087	1978 8 27 4 4915.201
INITIATION	28727.05087	1978 8 26 13 1315.200
TERMINATION	28728.35087	1978 8 27 20 2515.200

F AND G SERIES	F2	F3	F4	F5	F6	G3	G4	G5	G6
LAUNCH BODY	-1.9217E-14	-4.9211E-23	5.9482E-29	4.5761E-37	3.2032E-42	-6.4057E-15	-2.4606E-23	1.1069E-29	1.4745E-37
TARGET BODY	-5.1394E-14	4.1261E-23	4.3186E-28	-1.0402E-36	6.0577E-41	-1.7131E-14	2.0631E-23	8.3026E-29	-3.4004E-37

PULSING ARC EXECUTION

PULSE	TIME	X-COMP	Y-COMP	Z-COMP	X-DOT	Y-DOT	Z-DOT
0	0.	133093946.685	-70419626.656	1130532.087	11.27261201	24.46884935	1.33741159
1	0.	133093946.685	-70419626.656	1130532.087	11.27309330	24.46797284	1.33742170
2	.10000	133191154.527	-70208119.726	1142084.651	11.22920961	24.49108131	1.33678153
3	.20000	133287983.188	-69996413.327	1153631.481	11.18530857	24.51413893	1.33610638
4	.30000	133384432.318	-69784508.026	1165172.489	11.14135555	24.53712333	1.33543390
5	.40000	133480501.471	-69572404.456	1176707.698	11.09735085	24.56003471	1.33476387
6	.50000	133576190.201	-69360103.246	1188237.127	11.05329476	24.58287324	1.33409608
7	.60000	133671498.066	-69147605.025	1199760.796	11.00918758	24.60563908	1.33343033
8	.70000	133766424.624	-68934910.421	1211278.721	10.96502957	24.62833239	1.33276643
9	.80000	133860969.439	-68722020.059	1222790.917	10.92082099	24.65095330	1.33210418
10	.90000	133955132.073	-68508934.565	1234297.398	10.87656211	24.67350196	1.33144342
11	1.00000	134048912.095	-68295654.563	1245798.176	10.83225316	24.69597849	1.33078397
12	1.10000	134142309.072	-68082180.674	1257293.261	10.78789438	24.71838302	1.33012567
13	1.20000	134235322.574	-67868513.520	1268782.662	10.74348602	24.74071565	1.32946836
14	1.30000	134327952.174	-67654653.723	1280266.389	10.69871679	24.76354378	1.32880535
STATE PROP BACK		133718896.786	-69041149.651	1205545.752	10.99081397	24.61247723	1.33230576
IMPULSIVE MODEL		133718897.398	-69041103.719	1205528.661	10.98954321	24.61163918	1.33354409

ELEMENTS AFTER ARC	SMA	ECC	OMEGA	INC	NODE	TA
SERIES OF PULSES	1.281829611E+08	1.8263332E-01	174.43885	2.89662	-36.41739	-165.31801
IMPULSIVE MODEL	1.281747749E+08	1.8271320E-01	174.43008	2.89937	-36.40853	-165.31808

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER GUIDANCE CORRECTION

5.4337478064E+02	1.0000000000E+00	-5.0645197795E-01
6.3649115905E+02	-5.0645197795E-01	1.0000000000E+00

	EIGENVALUES		SQUARE ROOTS OF EIGENVALUES
1	1.6661865057522E+05	1	4.0818947877E+02
2	5.3375849720738E+05	2	7.3058777516E+02

EIGENVECTORS

1	8.0599169278208E-01	5.9192684612735E-01
2	-5.9192684612735E-01	8.0599169278208E-01

FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
4.555E-06 X**2 + 3.939E-06 XY + 3.320E-06 Y**2 = 9

ACTUAL TARGET ERROR

DUE TO NAVIGATIONAL UNCERTAINTY	DUE TO EXECUTION ERROR	TOTAL
-4.5468698042E+01	1.1826517641E+03	1.1371830660E+03
-1.4424622299E+02	-7.5730446838E+02	-9.0155069137E+02

MOST RECENT NOMINAL TRAJECTORY
1.3371889016E+08
-6.9041135504E+07
1.2055561726E+06
1.0990925581E+01
2.4612391634E+01
1.3321896225E+00

TARGETED NOMINAL TRAJECTORY AFTER GUIDANCE CORRECTION
1.3371889016E+08
-6.9041135504E+07
1.2055561726E+06
1.0990925581E+01
2.4612391634E+01
1.3321896225E+00

ACTUAL DEVIATIONS JUST AFTER GUIDANCE CORRECTION
6.6263551712E+00
-1.4147167683E+01
-1.0420651421E+01
-1.1161552499E-04
8.5599524823E-05
1.1613869344E-04

ESTIMATED DEVIATIONS JUST AFTER GUIDANCE CORRECTION
0.
0.
0.
0.
0.
0.

Case S-2. Lunar Viking '76 Mission

```
LAUNCH DATE              6 16 11  7 50.055 1976     JULIAN DATE . . .2442945.96377377
FINAL DATE               6 20 19 30 43.022 1976     JULIAN DATE . . .2442950.31299794

INITIAL TRAJECTORY TIME =     0.

THE FOLLOWING QUANTITIES ARE TO BE AUGMENTED TO THE STATE VECTOR

SOLVE-FOR PARAMETERS
  MU PLN
  A
  RANGE

DYNAMIC CONSIDER PARAMETERS
  NODE
  OMEGA

MEASUREMENT CONSIDER PARAMETERS
  RADIUS 3
  LAT  3
  LONG 3
  ST ANG 1

INERTIAL FRAME IS BARYCENTRIC ECLIPTIC

INITIAL STATE VECTOR
  GEOCENTRIC ECLIPTIC   COORDINATES
       -6.21904171E+03
       -1.99290848E+03
       -6.55435808E+02
        3.16289975E+00
       -9.60115329E+00
       -4.17327240E+00

INITIAL STATE VECTOR
     INERTIAL COORDINATES
       -9.84252824E+03
        1.06557382E+03
       -1.07663156E+03
        3.15461302E+00
       -9.60999063E+00
       -4.17314993E+00

NOMINAL TRAJECTORY CODE. . . 2

NOMINAL TRAJECTORY INFORMATION
  BODIES TO BECONSIDERED
    EARTH
    MOON

  TARGET PLANET. . .MOON

UNITS
   1.49598500E+08/A.U.                    8.64000000E+04/DAY

ORBITAL ELEMENTS WILL BE CALCULATED AT EVERY TIME INTERVAL

OUTPUT FROM VIRTUAL MASS PROGRAM WILL BE SUPRESSED AT INITIAL AND FINAL STEPS

VIRTUAL MASS PROGRAM WILL INTEGRATE UNTIL REACHING ANORMAL STOPPING CONDITION

ACCURACY FIGURE. . . . . 2.50000E-05
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DYNAMIC CONSTANT BIASES TO BE USED IN THE DETERMINATION OF THE ACTUAL TRAJECTORY
  GRAVITATIONAL CONSTANT OF THE SUN. . . . . . . . 0.
  GRAVITATIONAL CONSTANT OF TARGET PLANET. . 4.0000000000000E-02
  SEMI-MAJOR AXIS OF TARGET PLANET . . . . . 5.0000000000000E+00
  ECCENTRICITY OF TARGET PLANET. . . . . . . 0.

  INCLINATION  OF TARGET PLANET. . . . . . . 0.
  LONGITUDE OF ASCENDING NODE. . . . . . . . 5.0000000000000E-06
  ARGUMENT OF PERIAPSIS. . . . . . . . . . .-6.0000000000000E-06
  MEAN ANOMALY OF TARGET PLANET. . . . . . . 0.
ACTUAL UNMODELLED ACCELERATION TO BE USED TO CALCULATE THE ACTUAL DYNAMIC NOISE BY THE FOLLOWING SCHEDULE
                                                                     X                         Y                         Z
  FROM   0.    DAYS THROUGH    4.349 DAYS. . .      0.                        0.                        0.

BIASES IN LOCATIONS OF ROTATING STATIONS
              ALTITUDE                  LATITUDE                  LONGITUDE
  1     0.                         0.                         0.
  2     0.                         0.                         0.
  3     8.0000000000000E-04       -7.0000000000000E-08       2.5000000000000E-07

ACTUAL DEVIATION OF STATE VECTOR AT INITIAL TIME
               3.00000000E-01

              -3.00000000E-01

               3.00000000E-01

              -1.50000000E-03

               1.50000000E-03

              -1.50000000E-03

MU PLN         4.00000000E-02

A              5.00000000E+00

RANGE         -5.00000000E-03


THE ACTUAL MEASUREMENT NOISE WILL BE CALCULATED FROM THE FOLLOWING CONSTANTS
  RANGE      (GEO CENTRIC) 0.
  RANGE-RATE (GEO CENTRIC) 0.
  RANGE      (STATION 1  ) 2.5000000000000E-07
  RANGE-RATE (STATION 1  ) 9.0000000000000E-14
  RANGE      (STATION 2  ) 2.5000000000000E-07
  RANGE-RATE (STATION 2  ) 9.0000000000000E-14
  RANGE      (STATION 3  ) 2.5000000000000E-07
  RANGE-RATE (STATION 3  ) 9.0000000000000E-14
  STAR PLANE ANGLE 1       2.5000000000000E-11
  STAR PLANE ANGLE 2       2.5000000000000E-11
  STAR PLANE ANGLE 3       2.5000000000000E-11
  APPARENT PLANET DIAMETER 2.5000000000000E-11
```

SIMULATION MODE -- GUIDANCE   EVENT AT TRAJECTORY TIME   1.000 DAYS

PROBLEM. .   16022

STATE VECTOR

	TARGETED NOMINAL	MOST RECENT NOMINAL	ACTUAL
X	1.9907853073E+05	1.9860655461E+05	1.9860646929E+05
Y	4.5262036957E+03	4.7384119473E+03	4.7381063514E+03
Z	-5.6135461489E+03	-5.5349786993E+03	-5.5350179372E+03
VX	1.3856671812E+00	1.3775783054E+00	1.3775788081E+00
VY	3.2841662795E-01	3.3050039544E-01	3.3049672719E-01
VZ	1.0295098234E-01	1.0395621146E-01	1.0396003840E-01

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE . . . .   7.65703507126E+01
ANGLE BETWEEN RELATIVE VELOCITY
AND PLANE OF THE SKY. . . . .   7.57328482952E+01
GEOCENTRIC DECLINATION. . . . . . .   -1.04752984681E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE   1.26831168864E+02
ANTENNA AXIS - EARTH ANGLE. . . . .   -1.44992044121E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. .   9.39972339765E+01
OCCULTATION RATIO FOR SUN   IS   2.17138578028E+02
OCCULTATION RATIO FOR MOON   IS   1.10512349738E+02

STATE TRANSITION MATRIX PARTITIONS OVER(.900,   1.000)   --TRANSPOSES SHOWN

	X(1.000)	Y(1.000)	Z(1.000)	VX(1.000)	VY(1.000)	VZ(1.000)
X(.900)	1.0068234429E+00	7.9565244960E-04	3.2182433642E-05	8.8474635618E-07	2.2016166668E-09	-3.7237648520E-08
Y(.900)	3.9696134627E-03	9.9912964768E-01	2.8935523005E-04	-2.6728983471E-08	-4.5042879648E-07	-4.5506265423E-10
Z(.900)	3.8150697947E-04	1.5379773686E-04	9.9802035082E-01	-4.1908663206E-08	-1.3314505054E-09	-4.5364253243E-07
VX(.900)	8.6643997580E+03	3.7682533730E+00	4.9885420594E-01	1.0036900768E+00	2.1304025211E-05	-1.4900769507E-04
VY(.900)	1.0007899255E+01	8.6372728285E+03	7.2852999438E-01	-5.0648196748E-05	9.9811618899E-01	-3.9036773813E-06
VZ(.900)	3.3127702773E+01	9.5762021374E+00	8.6368446791E+03	-3.9965399878E-04	-1.0947687201E-05	9.9810581027E-01
SOLVE-FOR PARAMETERS						
MU PLN	7.3767360300E-03	1.4618985006E-03	5.1363313105E-05	8.3003421025E-07	9.5607948225E-08	-4.4639856256E-08
A	3.3643906936E-05	3.3235135197E-05	-8.3929012180E-06	7.3901288289E-09	7.6387471637E-09	-1.9423572706E-09
RANGE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
NODE	1.8848742106E+01	-7.4240865992E+00	7.1410730340E-01	3.4086853366E-03	-1.9048147881E-03	1.2066663794E-04
OMEGA	1.9734914353E+01	-7.2643147963E+00	9.2878042182E-01	3.4384529843E-03	-1.9162264598E-03	1.5561400787E-04

DIAGONAL OF DYNAMIC NOISE MATRIX

0.   0.   0.   0.   0.   0.

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT EVENT TIME 1.000 DAYS
PROPAGATED FORWARD FROM TIME .900 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.85406613E-03	1.00000000					
Y	6.35615720E-02	-.61521713	1.00000000				
Z	4.30718411E-02	.53054763	-.03633943	1.00000000			
VX	1.57612748E-07	.67905150	-.94442426	-.08069683	1.00000000		
VY	1.23779178E-06	-.52381843	.89027521	-.04868618	-.82877030	1.00000000	
VZ	1.52322379E-06	.53377423	-.17494352	.84043316	.10436700	-.01509338	1.00000000

SOLVE-FOR PARAMETERS

	X	Y	Z	VX	VY	VZ
MU PLN	.42746357	-.27635288	.00267357	.45617959	-.38378562	-.00128437
A	-.33562503	-.15256196	-.38929424	.00664421	-.28795935	-.57235190
RANGE	.19231208	-.29300610	.34425018	.20736322	-.51832088	.13256067

DYNAMIC CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
NODE	.00577664	-.01026968	-.00985165	.01879896	-.02658506	-.01395012
OMEGA	.00702772	-.01079128	-.00950568	.01968891	-.02717258	-.01345292

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 3	-.15174009	-.07961452	-.14831730	.05711110	-.07447310	-.08314986
LAT 3	-.08358596	-.04051588	-.08080708	.02973418	-.03703154	-.04252620
LONG 3	-.13318712	.11040158	-.08311443	-.04477526	.14808503	.09587618
ST ANG 1	0.	0.	0.	0.	0.	0.

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	5.41611933E-02	1.00000000		
A	5.85532730E+00	-.57028093	1.00000000	
RANGE	1.02120105E-03	.18942217	.15727957	1.00000000

DYNAMIC CONSIDER PARAMETERS

	MU PLN	A	RANGE
NODE	-.00691535	-.02545206	.00352042
OMEGA	-.00707851	-.02552667	.00388936

MEASUREMENT CONSIDER PARAMETERS

	MU PLN	A	RANGE
RADIUS 3	-.00203203	.07455088	.03954752
LAT 3	-.00039278	.03614869	.02025977
LONG 3	.03580133	-.19213981	-.04779557
ST ANG 1	0.	0.	0.

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	1.2465432322667E-06	1	1.1164870050E-03
2	4.0459618182004E-03	2	6.3607875442E-02
3	1.8514861360363E-03	3	4.3028898848E-02

POSITION EIGENVECTORS

1	9.9960843451698E-01	1.7404442665161E-02	-2.1910340436119E-02
2	-1.8392074082348E-02	9.9878532420612E-01	-4.5712227701188E-02
3	2.1088130629834E-02	4.6097304975139E-02	9.9871433814708E-01

VELOCITY EIGENVALUES / SQUARE ROOTS OF EIGENVALUES

	VELOCITY EIGENVALUES		SQUARE ROOTS OF EIGENVALUES
1	7.4851223350583E-15	1	8.6516601500E-08
2	1.5480380608069E-12	2	1.2442017766E-06
3	2.3216577951962E-12	3	1.5236987219E-06

VELOCITY EIGENVECTORS

1	9.9439770897438E-01	1.0527755469487E-01	-9.4780200439049E-03
2	-1.0482067856308E-01	9.9368547476715E-01	4.0022525936310E-02
3	1.3631644510467E-02	-3.8804815605998E-02	9.9915382427017E-01

STATE TRANSITION MATRIX PARTITIONS OVER(0. , 1.000) --TRANSPOSES SHOWN

	X(1.000)	Y(1.000)	Z(1.000)	VX(1.000)	VY(1.000)	VZ(1.000)
X(0.)	-2.7553385271E+02	1.4074173095E+02	6.7202552774E+01	-4.7751941151E-03	1.3258354347E-03	6.9846073709E-04
Y(0.)	-8.8292909237E+01	6.8733035528E+01	4.4451663440E+01	-1.5798027640E-03	5.8558829457E-04	3.8813640753E-04
Z(0.)	-2.9958153917E+01	3.7473183602E+01	-1.2860604930E+01	-5.3142344242E-04	3.0101731417E-04	-7.4926361200E-05
VX(0.)	9.9530360475E+04	-1.9596040441E+04	-1.1165985474E+04	1.6639818185E+00	-2.7310041162E-01	-1.6552116406E-01
VY(0.)	-3.0290608564E+05	1.7022850653E+05	7.8946998471E+04	-5.2578404556E+00	1.5850690211E+00	8.2525793745E-01
VZ(0.)	-1.3146763984E+05	7.0359892090E+04	3.9771962704E+04	-2.2828443164E+00	6.7708241218E-01	3.6524033185E-01
SOLVE-FOR PARAMETERS						
MU PLN	-1.5064202173E+02	6.4342182688E+01	2.0642343620E+01	-2.5674785513E-03	6.3311883766E-04	2.6601453137E-04
A	-1.9455382088E+00	8.3109165472E-01	2.6611876934E-01	-3.3178806062E-05	8.1987692606E-06	3.4248767018E-06
RANGE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
NODE	-1.1682291238E+06	6.7682379290E+05	3.6736419485E+05	-2.0373773098E+01	6.1849978084E+00	3.5512394292E+00
OMEGA	-1.1714036864E+06	6.7711339513E+05	3.6991708980E+05	-2.0428095765E+01	6.1907984478E+00	3.5722575556E+00

DIAGONAL OF DYNAMIC NOISE MATRIX

0.	0.	0.	0.	0.	0.

CONTROL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST BEFORE GUIDANCE CORRECTION AT TIME 1.000 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.07496704E+03	1.00000000					
Y	5.78646570E+02	-.98234118	1.00000000				
Z	2.79496812E+02	-.97987184	.99032201	1.00000000			
VX	1.86102448E-02	.99994739	-.98417214	-.98155449	1.00000000		
VY	5.44139875E-03	-.99069495	.99861987	.99126003	-.99201189	1.00000000	
VZ	2.86743790E-03	-.99127244	.99283321	.99696117	-.99238178	.99594279	1.00000000
SOLVE-FOR PARAMETERS							
MU PLN		-.00840818	.00667166	.00443132	-.00827763	.00698113	.00556625
A		-.01809858	.01436268	.00952135	-.01782825	.01506739	.01194403
RANGE		0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS							
NODE		-.00108676	.00116967	.00131438	-.00109476	.00113666	.00123847
OMEGA		-.00108971	.00117017	.00132351	-.00109768	.00113772	.00124580
MEASUREMENT CONSIDER PARAMETERS							
RADIUS 3		0.	0.	0.	0.	0.	0.
LAT 3		0.	0.	0.	0.	0.	0.
LONG 3		0.	0.	0.	0.	0.	0.
ST ANG 1		0.	0.	0.	0.	0.	0.

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	6.00000000E-02	1.00000000		
A	1.00000000E+01	0.	1.00000000	
RANGE	3.00000000E-03	0.	0.	1.00000000
DYNAMIC CONSIDER PARAMETERS				
NODE		0.	0.	0.
OMEGA		0.	0.	0.
MEASUREMENT CONSIDER PARAMETERS				
RADIUS 3		0.	0.	0.
LAT 3		0.	0.	0.
LONG 3		0.	0.	0.
ST ANG 1		0.	0.	0.

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3VBP

    NON-LINEAR-GUIDANCE-

IPC-NOT-IN-EFFECT

SINGLE--IMPULSE-

-COMPUTE--AND   -EXECUTE


VEHICLE REACHED SPHERE OF INFLUENCE ON TARGETED NOMINAL TRAJECTORY AT TRAJECTORY TIME     3.433 DAYS
                                             X                   Y                   Z                RESULTANT
POSITION RELATIVE TO TARGET PLANET   -2.7995223703E+04   4.7681875576E+04   -5.4422568509E+03   5.5559985315E+04
VELOCITY RELATIVE TO TARGET PLANET    4.6134263051E-01  -7.7895184163E-01    1.7023246538E-01   9.2118515325E-01
B =      5.4759224594E+03      B DOT T =     -2.3695558776E+02      B DOT R =     -5.4707932543E+03

M MATRIX
  -8.6041671811E-01  -5.0959108234E-01   0.                  -5.2549974217E+04  -3.1123289070E+04   0.
   9.4171020858E-02  -1.5900262684E-01  -9.8277667020E-01    5.6949017209E+03  -9.5311317468E+03  -5.9046278542E+04

VEHICLE REACHED SPHERE OF INFLUENCE ON MOST RECENT NOMINAL TRAJECTORY AT TRAJECTORY TIME     3.459 DAYS
                                             X                   Y                   Z                RESULTANT
POSITION RELATIVE TO TARGET PLANET   -3.0070928301E+04   4.6464597290E+04   -4.8674891987E+03   5.5559985433E+04
VELOCITY RELATIVE TO TARGET PLANET    4.4607575538E-01  -7.7999423775E-01    1.7022694275E-01   9.1452271842E-01
B =      7.0761463767E+03      B DOT T =      3.4219893834E+03      B DOT R =     -6.1936932604E+03

VARIATION MATRIX
  -2.5858700261E+00  -2.8211554454E-01   1.1191266822E-03  -3.4945438828E+05  -1.3049452471E+05  -2.7348242729E+03
   2.1797534719E-01  -3.9554759860E-02  -3.2114222704E-01   3.0941870180E+04  -4.1129389661E+04  -2.4603556510E+05
  -1.3911630958E-05   5.6810677052E-06  -6.6356733441E-07  -1.7915153876E+00   2.0505394787E+00  -2.3026950657E-01

TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATION BEFORE GUIDANCE CORRECTION
    8.4117606693E+03             1.0000000000E+00   -9.9644023298E-01    9.9894810399E-01
    1.8472835995E+03            -9.9644023298E-01    1.0000000000E+00   -9.9879859785E-01
    6.1785945802E-02             9.9894810399E-01   -9.9879859785E-01    1.0000000000E+00

                   EIGENVALUES           SQUARE ROOTS OF EIGENVALUES
              1     7.4147030969754E+07          1     8.6108670278E+03
              2     2.3143289465355E+04          2     1.5212918676E+02
              3     1.7936447723290E-06          3     1.3392702387E-03


                   EIGENVECTORS
              1     9.7687001092728E-01    -2.1383400501218E-01    7.1688654494243E-06
              2     2.1383400509806E-01     9.7687001082203E-01   -1.4842394580385E-05
              3    -3.8292409920661E-06     1.6032037366987E-05    9.9999999986416E-01


GUIDANCE MATRIX -- THREE VARIABLE B-PLANE GUIDANCE POLICY
  -7.4861134261E-06   1.6035091601E-07  -3.8666846042E-08  -1.0000000000E+00   0.                  0.
   2.3329443265E-07  -2.5974564785E-06   1.4007054224E-07   0.                 -1.0000000000E+00   0.
  -9.4515848611E-08   2.9361038502E-07  -1.3335456902E-06   0.                  0.                 -1.0000000000E+00

VELOCITY CORRECTION CORRELATION MATRIX AND STANDARD DEVIATIONS
    2.6737943902E-02             1.0000000000E+00   -9.9091518496E-01   -9.9050593957E-01
    7.1521271284E-03            -9.9091518496E-01    1.0000000000E+00    9.9467589415E-01
    2.9699599663E-03            -9.9050593957E-01    9.9467589415E-01    1.0000000000E+00
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C.5

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DEVIATION OF STATE VECTOR FROM TARGETED NOMINAL TRAJECTORY
          ESTIMATED                  ACTUAL
      -4.7197559167E+02    -4.7206143198E+02
       2.1182812615E+02     2.1190265573E+02
       7.8570060405E+01     7.8528211740E+01
      -8.0882677135E-03    -8.0883731177E-03
       2.0793244039E-03     2.0800992402E-03
       1.0090937149E-03     1.0090560654E-03

    COMMANDED CORRECTION            PERFECT CORRECTION
       1.1652459305E-02                 1.1653220888E-02
      -2.7286426694E-03                -2.7296369809E-03
      -1.0070663691E-03                -1.0069429165E-03
COMMANDED DELTA V. . .     1.2009974244E-02
    ERROR IN CORRECTION DUE TO NAVIGATION UNCERTAINTY
       7.6158352663E-07
      -9.9431152376E-07
       1.2345259486E-07

VELOCITY CORRECTION CORRELATION MATRIX AND STANDARD DEVIATIONS
    6.8298562917E-05              1.0000000000E+00     1.0385181855E-01     3.8006005994E-02
    8.4096931294E-05              1.0385181855E-01     1.0000000000E+00    -7.2279097451E-03
    8.4811247000E-05              3.8006005994E-02    -7.2279097451E-03     1.0000000000E+00

                         EIGENVALUES           SQUARE ROOTS OF EIGENVALUES
                  1      4.5059870334645E-09            1    6.7126649205E-05
                  2      7.2119740669291E-09            2    8.4923342297E-05
                  3      7.2119740669292E-09            3    8.4923342297E-05

                         EIGENVECTORS
                  1      9.7023183132276E-01    -2.2719804505786E-01     -8.3852500320295E-02
                  2      2.2837988254818E-01     9.7356097185169E-01      4.6543887323106E-03
                  3      8.0578053683100E-02    -2.3666060277958E-02      9.9646730746953E-01

                         FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                                 THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
      2.170E+08 X**2 +  1.430E+08 Y**2 +  1.392E+08 Z**2 + -3.671E+07 XY + -1.355E+07 XZ +  3.173E+06 YZ =   9
                XY HYPERELLIPSOID. . . . . .  2.170E+08 X**2 + -3.671E+07 XY +  1.430E+08 Y**2 =   9
                XZ HYPERELLIPSOID. . . . . .  2.170E+08 X**2 + -1.355E+07 XZ +  1.392E+08 Z**2 =   9
                YZ HYPERELLIPSOID. . . . . .  1.430E+08 Y**2 +  3.173E+06 YZ +  1.392E+08 Z**2 =   9

  COMMANDED VELOCITY CORRECTION WILL BE RECOMPUTED USING NON-LINEAR GUIDANCE

  ZERO ITERATE PARAMETERS
     IZERO

  IND IMP MOD   TAR KEY      TAR1       TAR2       TAR3      TOL1     TOL2     TOL3    DVX     DVY     DVZ   MAT BADITS BIT

   1   4   1    5  6  2    -236.96   -5470.79   27929.40   100.00   100.00     .01    0.      0.      0.     1  2  8  4
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GUIDANCE EVENT AT 1.000 DAYS
CALENDAR DATE 1976 6 17 11 7 50.054 JULIAN DATE 27926.96377

EVENT CODES KUR 1 KTYP 1 KMXQ 4 MDL 1

CURRENT SPACECRAFT STATE

REFERENCE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INERTIAL	198606.56	4738.03	-5534.98	198740.15	1.37757891	.33049595	.10396008	1.42047842
EARTH	202854.58	2516.22	-5134.86	202935.16	1.38363511	.34083277	.10360367	1.42875708
MOON	-147076.77	185537.53	-38094.25	239806.01	.88475625	-.51066227	.13296278	1.03016924

N-BODY TARGETING EVENT

STATE 1.9860655513E+05 4.7380318219E+03 -5.5349760885E+03
1.3775789135E+00 3.3049595235E-01 1.0396007605E-01
JULIAN DATE 2.7926963774E+04

PARAMETER KEY DEFINITIONS

1-TRF	4-TCA	7-RCA	10-XRF
2-TSI	5-B.T	8-INC	11-YRF
3-TCS	6-B.R	9-ASI	12-ZRF

TARGETING SPECIFICATIONS

KEY	TARGET VALUE	TOLERANCE
5	-236.956	100.000
6	-5470.793	100.000
2	27929.397	.005

TARGETING SCHEME
LEVELS 2.500E-05
DVMAX 1.00000000E-02
IBAST 2

IND	NOF	PHS	KEYTAR	DTAR(1)	DTAR(2)	DTAR(3)	KAXTAR	DAUX(1)	DAUX(2)	DAUX(3)	ISTOP	DELT
1	1	1	5 6 2	-236.96	-5470.79	27929.40	5 6 2	-236.96	-5470.79	27929.40	2	12.433

ACCURACY	VX	VY	VZ	TAR - 5-	TAR - 6-	TAR - 2-	AUX - 5-	AUX - 6-	AUX - 2-	INCR	CPT
2.50E-05	1.3775789	.3304960	.1039601	3422.451	-6194.428	27929.422	3422.451	-6194.428	27929.422	136	382
2.50E-05	1.3776789	.3304960	.1039601	3387.513	-6191.332	27929.422	3387.513	-6191.332	27929.422	136	384
2.50E-05	1.3775789	.3305960	.1039601	3409.404	-6198.541	27929.423	3409.404	-6198.541	27929.423	136	386
2.50E-05	1.3775789	.3304960	.1040601	3422.179	-6219.031	27929.422	3422.179	-6219.031	27929.422	136	388

SENSITIVITY MATRIX			TARGETING MATRIX			AUX ERROR	VEL COR	DES AUX VAL	DES TAR VAL	TAR TOL
-3.49E+05	-1.30E+05	-2.72E+03	-2.16E-06	1.49E-07	-1.34E-01	-3.66E+03	5.70E-03	-236.956	-236.956	100.000
3.10E+04	-4.11E+04	-2.46E+05	-1.88E-06	-3.17E-07	3.62E-01	7.24E+02	-1.24E-03	-5470.793	-5470.793	100.000
-1.79E+00	2.05E+00	-2.30E-01	4.26E-08	-3.99E-06	-7.74E-02	-2.53E-02	-5.46E-04	27929.397	27929.397	.005

ACCURACY	VX	VY	VZ	TAR - 5-	TAR - 6-	TAR - 2-	AUX - 5-	AUX - 6-	AUX - 2-	INCR	CPT
2.50E-05	1.3832825	.3292578	.1034141	1603.317	-5833.751	27929.410	1603.317	-5833.751	27929.410	140	390
2.50E-05	1.3833825	.3292578	.1034141	1568.919	-5830.567	27929.410	1568.919	-5830.567	27929.410	140	392
2.50E-05	1.3832825	.3293578	.1034141	1590.128	-5837.783	27929.410	1590.128	-5837.783	27929.410	140	395
2.50E-05	1.3832825	.3292578	.1035141	1603.053	-5858.279	27929.410	1603.053	-5858.279	27929.410	140	397

SENSITIVITY MATRIX			TARGETING MATRIX			AUX ERROR	VEL COR	DES AUX VAL	DES TAR VAL	TAR TOL
-3.44E+05	-1.32E+05	-2.64E+03	-2.21E-06	1.58E-07	-1.38E-01	-1.84E+03	5.90E-03	-236.956	-236.956	100.000
3.18E+04	-4.03E+04	-2.45E+05	-1.83E-06	-3.33E-07	3.62E-01	3.63E+02	-1.42E-03	-5470.793	-5470.793	100.000
-1.71E+00	2.06E+00	-2.39E-01	1.41E-08	-4.00E-06	-7.75E-02	-1.29E-02	-4.81E-04	27929.397	27929.397	.005

ACCURACY	VX	VY	VZ	TAR - 5-	TAR - 6-	TAR - 2-	AUX - 5-	AUX - 6-	AUX - 2-	INCR	CPT
2.50E-05	1.3891803	.3278384	.1029331	-226.285	-5472.027	27929.397	-226.285	-5472.027	27929.397	135	399

DVUP= 1.1601428223E-02 -2.6575539835E-03 -1.0269405486E-03 MAG. OF DVUP= 1.1946143180E-02

EXECUTION ERROR MATRIX=

6.7966885003E-05	1.0000000000E+00	1.0132810774E-01	3.8845303419E-02
8.3686869475E-05	1.0132810774E-01	1.0000000000E+00	-7.2268526483E-03
8.4355216374E-05	3.8845303419E-02	-7.2268526483E-03	1.0000000000E+00

CONTROL (AND KNOWLEDGE) CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS JUST AFTER GUIDANCE CORRECTION AT 1.000

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.85406613E-03	1.00000000					
Y	6.35615720E-02	-.61521713	1.00000000				
Z	4.30718411E-02	.53054763	-.03633943	1.00000000			
VX	6.79670678E-05	.00157469	-.00219008	-.00018713	1.00000000		
VY	8.36960229E-05	-.00774682	.01316640	-.00072003	.10128833	1.00000000	
VZ	8.43689679E-05	.00963693	-.00315849	.01517344	.03884324	-.00722891	1.00000000
SOLVE-FOR PARAMETERS							
MU PLN		.42746357	-.27635288	.00267357	.00105786	-.00567586	-.00002319
A		-.33562503	-.15256196	-.38929424	.00001541	-.00425867	-.01033342
RANGE		.19231208	-.29300610	.34425018	.00048087	-.00766552	.00239329
DYNAMIC CONSIDER PARAMETERS							
NODE		.00577664	-.01026968	-.00985165	.00004359	-.00039317	-.00025186
OMEGA		.00702772	-.01079128	-.00950568	.00004566	-.00040186	-.00024288
MEASUREMENT CONSIDER PARAMETERS							
RADIUS 3		-.15174009	-.07961452	-.14831730	.00013244	-.00110139	-.00150121
LAT 3		-.08358596	-.04051588	-.08080708	.00006895	-.00054766	-.00076778
LONG 3		-.13318712	.11040158	-.08311443	-.00010383	.00219005	.00173098
ST ANG 1		0.	0.	0.	0.	0.	0.

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	5.41611933E-02	1.00000000		
A	5.85532730E+00	-.57028093	1.00000000	
RANGE	1.02120105E-03	.18942217	.15727957	1.00000000
DYNAMIC CONSIDER PARAMETERS				
NODE		-.00691535	-.02545206	.00352042

```
OMEGA                              -.00707851     -.02552667      .00388936

      MEASUREMENT CONSIDER PARAMETERS
RADIUS 3                           -.00203203      .07455088      .03954752
LAT  3                             -.00039278      .03614869      .02025977
LONG 3                              .03580133     -.19213981     -.04779557
ST ANG 1                           0.             0.             0.

            POSITION EIGENVALUES            SQUARE ROOTS OF EIGENVALUES
               1      1.5571806513287E+06          1    1.2478704465E+03
               2      1.0126380792271E+04          2    1.0062991997E+02
               3      1.1975483597946E+03          3    3.4605611681E+01

            POSITION EIGENVECTORS
               1      8.6046336976431E-01     -4.5909437434265E-01     -2.2098675241009E-01
               2      5.0875298376857E-01      7.9783232625736E-01      3.2347176180515E-01
               3      2.7806308643948E-02     -3.9076327184842E-01      9.2007112473651E-01

                   FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                        THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
      2.668E-05 X**2 +  1.905E-04 Y**2 +  7.173E-04 Z**2 +  6.151E-05 XY +  7.499E-05 XZ + -5.493E-04 YZ =    9
            XY HYPERELLIPSOID. . . . . .  2.668E-05 X**2 +  6.151E-05 XY +  1.905E-04 Y**2 =   9
            XZ HYPERELLIPSOID. . . . . .  2.668E-05 X**2 +  7.499E-05 XZ +  7.173E-04 Z**2 =   9
            YZ HYPERELLIPSOID. . . . . .  1.905E-04 Y**2 + -5.493E-04 YZ +  7.173E-04 Z**2 =   9

            VELOCITY EIGENVALUES            SQUARE ROOTS OF EIGENVALUES
               1      3.8362913410283E-04          1    1.9586452821E-02
               2      4.9440043112745E-07          2    7.0313613982E-04
               3      4.8698397835358E-08          3    2.2067713483E-04

            VELOCITY EIGENVECTORS
               1      9.5009348701281E-01     -2.7598309109717E-01     -1.4544998922061E-01
               2      3.1073001811918E-01      8.7863122643111E-01      3.6256588888063E-01
               3      2.7734847673624E-02     -3.8966716742445E-01      9.2053803661549E-01

                   FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                        THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
      2.134E+05 X**2 +  4.680E+06 Y**2 +  1.767E+07 Z**2 +  6.592E+05 XY +  1.504E+06 XZ + -1.344E+07 YZ =    9
            XY HYPERELLIPSOID. . . . . .  2.134E+05 X**2 +  6.592E+05 XY +  4.680E+06 Y**2 =   9
            XZ HYPERELLIPSOID. . . . . .  2.134E+05 X**2 +  1.504E+06 XZ +  1.767E+07 Z**2 =   9
            YZ HYPERELLIPSOID. . . . . .  4.680E+06 Y**2 + -1.344E+07 YZ +  1.767E+07 Z**2 =   9

    ACTUAL EXECUTION ERROR
      -1.2884181177E-05     2.3515365960E-05     1.1868461547E-04

    ACTUAL VELOCITY CORRECTION
       1.1588544042E-02    -2.6340386175E-03    -9.0825593316E-04

    TARGET CONDITION CORRELATION MATRIX AND STANDARD DEVIATIONS AFTER GUIDANCE CORRECTION
  2.7136908394E+01              1.0000000000E+00      2.7856470803E-02      1.3918916610E-01
  2.1006550283E+01              2.7856470803E-02      1.0000000000E+00     -5.7296480316E-02
  2.0164028821E-04              1.3918916610E-01     -5.7296480316E-02      1.0000000000E+00

                  EIGENVALUES               SQUARE ROOTS OF EIGENVALUES
               1      7.3726373413190E+02          1    2.7152600872E+01
               2      4.4042321784873E+02          2    2.0986262598E+01
               3      3.9718824499842E-08          3    1.9929582158E-04
```

EIGENVECTORS

1	9.9856396105918E-01	5.3572527220344E-02	1.0139287272904E-06
2	-5.3572527219710E-02	9.9856396105952E-01	-6.4290064263244E-07
3	-1.0469144983326E-06	5.8765868793292E-07	9.9999999999928E-01

FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION

1.387E-03 X**2 + 2.277E-03 Y**2 + 2.518E+07 Z**2 + -1.288E-04 XY + -5.272E+01 XZ + 2.959E+01 YZ = 9

XY HYPERELLIPSOID. . . . . . 1.387E-03 X**2 + -1.288E-04 XY + 2.277E-03 Y**2 = 9

XZ HYPERELLIPSOID. . . . . . 1.387E-03 X**2 + -5.272E+01 XZ + 2.518E+07 Z**2 = 9

YZ HYPERELLIPSOID. . . . . . 2.277E-03 Y**2 + 2.959E+01 YZ + 2.518E+07 Z**2 = 9

ACTUAL TARGET ERROR

DUE TO NAVIGATIONAL UNCERTAINTY	DUE TO EXECUTION ERROR	TOTAL
1.3672411686E-01	1.1092255801E+00	1.2459496969E+00
-3.4086515775E-02	-3.0566469748E+01	-3.0600556263E+01
3.4316910085E-06	4.3971947249E-05	4.7403638257E-05

MOST RECENT NOMINAL TRAJECTORY

1.9860655513E+05

4.7380318219E+03

-5.5349760885E+03

1.3891803418E+00

3.2783839837E-01

1.0293313550E-01

TARGETED NOMINAL TRAJECTORY AFTER GUIDANCE CORRECTION

1.9860655513E+05

4.7380318219E+03

-5.5349760885E+03

1.3891803418E+00

3.2783839837E-01

1.0293313550E-01

ACTUAL DEVIATIONS JUST AFTER GUIDANCE CORRECTION

-8.5840309162E-02

7.4529576210E-02

-4.1848664389E-02

-1.2989585371E-05

2.4290202322E-05

1.1864696591E-04

ESTIMATED DEVIATIONS JUST AFTER GUIDANCE CORRECTION

0.

0.

0.

0.

0.

0.

MEASUREMENT NO 42 AT TRAJECTORY TIME 3.300 PROBLEM. . 16022

RANGE AND RANGE-RATE WERE MEASURED FROM STATION 2 AT TRAJECTORY TIME 3.30000 DAYS

INITIAL TRAJECTORY TIME 3.250
FINAL TRAJECTORY TIME 3.300

TARG NOM	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	362194.62	58402.24	15155.17	367185.84	.490135501	.199031576	.103746134	.539082218
GEO-	367079.96	58383.46	15440.54	372014.43	.490525836	.210772721	.102961592	.543729552
PLANETO-	-35349.68	59930.42	-8066.83	70045.19	.458371976	-.756403886	.167588273	.900187500
FINAL								
INERTIAL	364290.49	59249.56	15603.34	369407.00	.480236853	.193170986	.103743436	.527925340
GEO-	369177.23	59281.79	15885.27	374243.90	.480498139	.204911981	.102951367	.532415595
PLANETO-	-33368.09	56627.02	-7338.67	66135.50	.458974687	-.762252188	.168198011	.905525666

MOST RECENT NOM	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	362194.62	58402.24	15155.17	367185.84	.490135501	.199031576	.103746134	.539082218
GEO-	367079.96	58383.46	15440.54	372014.43	.490525836	.210772721	.102961592	.543729552
PLANETO-	-35349.68	59930.42	-8066.83	70045.19	.458371976	-.756403886	.167588273	.900187500
FINAL								
INERTIAL	364290.49	59249.56	15603.34	369407.00	.480236853	.193170986	.103743436	.527925340
GEO-	369177.23	59281.79	15885.27	374243.90	.480498139	.204911981	.102951367	.532415595
PLANETO-	-33368.09	56627.02	-7338.67	66135.50	.458974687	-.762252188	.168198011	.905525666

ACTUAL TRAJ	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	362194.51	58402.28	15155.19	367185.75	.490135523	.199031474	.103746330	.539082238
GEO-	367079.85	58383.50	15440.56	372014.33	.490525858	.210772620	.102961787	.543729569
PLANETO-	-35349.78	59930.47	-8066.82	70045.28	.458371997	-.756403987	.167588468	.900187633
FINAL								
INERTIAL	364290.38	59249.61	15603.36	369406.91	.480236866	.193170895	.103743627	.527925357
GEO-	369177.13	59281.83	15885.29	374243.81	.480498153	.204911889	.102951558	.532415609
PLANETO-	-33368.19	56627.06	-7338.65	66135.59	.458974701	-.762252280	.168198202	.905525786

****

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	7.45917431457E+01
ANGLE BETWEEN RELATIVE VELOCITY AND PLANE OF THE SKY.	7.36259622374E+01
GEOCENTRIC DECLINATION.	5.85206072659E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE	1.11517872907E+02
ANTENNA AXIS - EARTH ANGLE.	2.43272815196E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. .	1.00151433905E+02
OCCULTATION RATIO FOR SUN IS	2.14121159595E+02
OCCULTATION RATIO FOR MOON IS	3.54242186694E+01

STATE TRANSITION MATRIX PARTITIONS OVER(3.250, 3.300) --TRANSPOSES SHOWN

	X(3.300)	Y(3.300)	Z(3.300)	VX(3.300)	VY(3.300)	VZ(3.300)
X(3.250)	1.0001044534E+00	-1.4865305275E-04	3.3074175008E-05	4.7794195268E-08	-7.1580412708E-08	1.5616143934E-08
Y(3.250)	-1.4957040548E-04	1.0001013475E+00	-3.9636506699E-05	-7.1324954831E-08	4.9945434455E-08	-1.8841999072E-08
Z(3.250)	3.3117830753E-05	-3.9590522647E-05	9.9979360006E-01	1.5597869663E-08	-1.8847057248E-08	-9.7594567983E-08
VX(3.250)	4.3201627210E+03	-2.1175947040E-01	4.8440415412E-02	1.0000973303E+00	-1.6343699727E-04	3.4376768099E-05
VY(3.250)	-2.6207417250E-01	4.3201279826E+03	-5.8434670791E-02	-1.5064429704E-04	1.0001198568E+00	-4.1794034900E-05
VZ(3.250)	5.2899122238E-02	-5.5227428675E-02	4.3196964893E+03	3.3131009047E-05	-4.2555736712E-05	9.9978477781E-01
SOLVE-FOR PARAMETERS						
MU PLN	1.1000037193E-03	-1.8356926739E-03	2.4508044589E-04	5.1851705152E-07	-8.7037911101E-07	1.1527963029E-07
A	3.4425202757E-05	1.9124755403E-04	-1.6867694212E-05	1.6510750296E-08	9.1220614626E-08	-7.9578400936E-09
RANGE	0.	0.	0.	0.	0.	0.
DYNAMIC CONSIDER PARAMETERS						
NODE	7.2954042308E+01	-6.6985576851E+01	1.6333682555E+01	3.4597900082E-02	-3.2273252003E-02	7.7676734295E-03
OMEGA	7.3618820370E+01	-6.7770037439E+01	1.2627941306E+01	3.4913108831E-02	-3.2646023864E-02	5.9927193156E-03

DIAGONAL OF DYNAMIC NOISE MATRIX

0. 0. 0. 0. 0. 0.

OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN

	RANGE(2)	RANGE-RATE(2)
X	9.8784767052E-01	-1.7614774431E-07
Y	1.5209743540E-01	1.1750125383E-06
Z	3.1989842164E-02	-1.4721094064E-07
VX	0.	9.8784767052E-01
VY	0.	1.5209743540E-01
VZ	0.	3.1989842164E-02
SOLVE-FOR PARAMETERS		
MU PLN	0.	0.
A	0.	0.
RANGE	0.	0.
DYNAMIC CONSIDER PARAMETERS		
NODE	0.	0.
OMEGA	0.	0.
MEASUREMENT CONSIDER PARAMETERS		
RADIUS 3	0.	0.
LAT 3	0.	0.
LONG 3	0.	0.
ST ANG 1	0.	0.

MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

1.00000000E-03	1.00000000E+00	0.
1.00000000E-06	0.	1.00000000E+00

GAIN MATRIX PARTITIONS

K-MATRIX

1.6810420288E+00	-5.1176088764E+03
-6.1944130141E+00	2.6873337518E+04
7.2642625441E+00	3.1131979568E+04
4.6626054210E-05	-1.4867304005E-01
-1.2340265169E-04	7.7001811635E-01
2.8786056171E-04	1.1593022142E+00

S-MATRIX

1.6239122147E+00	-3.1984200322E+03
-2.2238635261E+02	3.6333578198E+05
-3.3533120190E-02	-1.9139930394E+01

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 3.300 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	3.61718379E-02	1.00000000					
Y	1.66378942E-01	-.96701327	1.00000000				
Z	3.94775386E-01	-.82229289	.67894368	1.00000000			
VX	1.25456024E-06	.96873031	-.89350460	-.89527282	1.00000000		
VY	5.32916959E-06	-.96533485	.95017436	.79627965	-.96657197	1.00000000	
VZ	1.50303577E-05	-.81488268	.67163798	.99482064	-.89372757	.79059863	1.00000000
SOLVE-FOR PARAMETERS							
MU PLN		.50369615	-.60006749	-.12174598	.32223127	-.41455410	-.09683241
A		-.56734319	.67468369	.12282583	-.42808279	.55215946	.10116289
RANGE		.01799803	-.08954131	.01716783	-.02392038	-.04878053	.01588528
DYNAMIC CONSIDER PARAMETERS							
NODE		.10178632	-.14931939	.01361005	.10260053	-.15505179	.02250052
OMEGA		.10341225	-.15114187	.01264796	.10404380	-.15674504	.02171158
MEASUREMENT CONSIDER PARAMETERS							
RADIUS 3		-.00128050	.00005292	.00606984	.00077379	.00098133	-.00069273
LAT 3		-.00444158	.00316582	.00740797	-.00044942	.00091504	-.00024946
LONG 3		.01995364	.01152629	-.05386140	.04928791	-.05375859	-.02916136
ST ANG 1		-.01827529	.02019319	.00961738	-.01415150	.01769562	.00879370

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	2.48325488E-02	1.00000000		
A	2.65925615E+00	-.69370127	1.00000000	
RANGE	5.01366979E-04	.19608282	-.09988898	1.00000000
DYNAMIC CONSIDER PARAMETERS				
NODE		-.07324282	-.35316106	.01490069
OMEGA		-.07392363	-.35617972	.01531290

MEASUREMENT CONSIDER PARAMETERS

RADIUS 3	-.03238927	.00281813	.00365794
LAT 3	-.02600477	.00144500	-.00066959
LONG 3	.00144154	-.07257355	-.08250356
ST ANG 1	-.01715652	.02429003	-.00213511

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 3.300 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	3.51089113E-02	1.00000000					
Y	1.62253525E-01	-.96643526	1.00000000				
Z	3.91745988E-01	-.86055260	.70233870	1.00000000			
VX	1.23042588E-06	.96830501	-.88968850	-.92476603	1.00000000		
VY	5.25107505E-06	-.96979507	.95034294	.81059503	-.96811328	1.00000000	
VZ	1.49125186E-05	-.85390348	.69569299	.99474609	-.92405409	.80546631	1.00000000

SOLVE-FOR PARAMETERS

	X	Y	Z	VX	VY	VZ
MU PLN	.46671531	-.57907199	-.14582215	.28241339	-.39602810	-.12063099
A	-.53375697	.66552907	.15935329	-.39352380	.55105901	.13721962
RANGE	.07806488	-.13914591	.05234938	.02020957	-.07450157	.05197062

DYNAMIC CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
NODE	.10074509	-.14892283	.01461083	.10124980	-.15395723	.02351912
OMEGA	.10238852	-.15075282	.01366624	.10269478	-.15563954	.02274855

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 3	-.00270443	.00110502	.00543258	-.00030135	.00159414	-.00140503
LAT 3	-.00525131	.00377083	.00716548	-.00099112	.00123894	-.00056209
LONG 3	.00629663	.02275836	-.06098947	.03901584	-.04821523	-.03633482
ST ANG 1	-.01718276	.01917012	.00971227	-.01310171	.01681017	.00890717

SOLVE-FOR PARAMETERS

	STD DEV	MU PLN	A	RANGE
MU PLN	2.36123082E-02	1.00000000		
A	2.45076368E+00	-.65481902	1.00000000	
RANGE	4.76404683E-04	.30735612	-.23582601	1.00000000

DYNAMIC CONSIDER PARAMETERS

NODE	-.08159447	-.37773875	.01707658
OMEGA	-.08233578	-.38098916	.01748733

MEASUREMENT CONSIDER PARAMETERS

RADIUS 3	-.03613304	.00582212	.00616250
LAT 3	-.02833938	.00288369	.00035963
LONG 3	-.01961433	-.05060133	-.06363675
ST ANG 1	-.01601461	.02381825	-.00351159

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       ACTUAL DYNAMIC NOISE
               0.
               0.
               0.
               0.
               0.
               0.

       ACTUAL MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS
               5.00000000E-04           1.00000000E+00   0.
               3.00000000E-07           0.               1.00000000E+00

       ACTUAL MEASUREMENT NOISE
              -6.60826000E-04
              -7.18706400E-08


MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS
    4.5476140984E-03               1.0000000000E+00     1.2790594770E-01
    1.0265273602E-06               1.2790594770E-01     1.0000000000E+00

       MEASUREMENT
                  ESTIMATED                  ACTUAL                   RESIDUAL
             3.7863367393E+05       3.7863367154E+05       -2.3834649473E-03
             5.5775951838E-01       5.5775942694E-01       -9.1438966621E-08

       POSITION/VELOCITY  DEVIATIONS
           FROM MOST RECENT NOMINAL              FROM TARGETED NOMINAL          ACTUAL ORBIT ESTIMATION ERROR

               ESTIMATED         ACTUAL          ESTIMATED         ACTUAL         (ESTIMATED-ACTUAL)
          X   8.33991021E-03 -1.05050715E-01    8.33991021E-03 -1.05050715E-01          1.13390625E-01
          Y  -7.37682290E-03  4.49547025E-02   -7.37682290E-03  4.49547025E-02         -5.23315254E-02
          Z  -8.50655342E-02  1.90808746E-02   -8.50655342E-02  1.90808746E-02         -1.04146409E-01
         VX   1.85416481E-07  1.36282488E-08    1.85416481E-07  1.36282488E-08          1.71788232E-07
         VY  -4.23360696E-07 -9.19390084E-08   -4.23360696E-07 -9.19390084E-08         -3.31421687E-07
         VZ  -3.32550651E-06  1.90930652E-07   -3.32550651E-06  1.90930652E-07         -3.51643716E-06

       SOLVE-FOR PARAMETER DEVIATIONS (MOST RECENT NOMINAL=TARGETED NOMINAL FOR SOLVE-FOR PARAMETERS)
                                                 ESTIMATION ERROR
               ESTIMATED         ACTUAL         (ESTIMATED-ACTUAL)
    MU PLN   -8.29401641E-02  4.00000000E-02   -1.22940164E-01
    A        -3.68059688E-01  5.00000000E+00   -5.36805969E+00
    RANGE    -4.83363583E-03 -5.00000000E-03    1.66364170E-04
```

Case MP-1. NØMNAL Multiprobe Sample Case

INTERPLANETARY TRAJECTORY

TARGETING PROGRAM

INPUT DATA

```
TRAJECTORY PARAMETERS
     TM 86400.00  ALNGTH  149598500.00
     NBOD     3   BODIES  1  3  4
     IBARY    0   ICOORD  1
     NCPR   500   TMPR      50.000


          HELIOCENTRIC DATA


     POINT-TO-POINT CONDITIONS
LAUNCH DATE  1977  1  4  6 49  38.000                 FLIGHT TIME    133.00        ARRIVAL DATE  1977  5 17   6 49  38.000
 HELIOCENTRIC CONIC                                   DISTANCE
RL  147.10 LAL   0.00 LOL 103.81 VL   27.578 GAL   0.95 AZL   90.86 HCA 158.08 SMA 127.14 ECC0.15786 INC 0.8597 V1   30.287
RP  108.68 LAP -0.32 LOP -98.10 VP   37.394 GAP   3.60 AZP   89.20 TAL 174.90 TAP 332.98 RCA 107.07 APO 147.21 V2   34.867
 PLANETOCENTRIC CONIC
C3   7.746 VHL   2.783 DLA   1.06 RAL  24.61 RAD 6557.3 VEL 11.364 PTH  1.96 VHP  4.395 DPA-40.09 RAP 149.93 ECC 1.1275
LNCH AZMTH  LNCH TIME  L-I TIME  INJ LAT  INJ LONG  INJ RT ASC  INJ AZMTH  INJ TIME  PO CST TIM  INJ 2 LAT  INJ 2 LONG
   90.00     23  4 15.  2080.69   -15.15     30.94    -127.19      114.21   23 38 55.     1480.7

ZERO ITERATE PARAMETERS
     IZERO   1     ZDAT      -0.3762680914D 08    0.1422013254D 09    0.4339240126D 03
                             -0.2052307137D 02   -0.1468428602D 02   -0.1993798630D 01
                            LAUNCH PROFILE PARAMETERS
     RP    6560.0  A1   17.00  T1   500.0  LAT   28.32  THD   15.04  AZI    90.00
     FI     3.700  A2    8.00  T2   100.0  LON  279.46  RAT   15.04
```

GUIDANCE EVENT SCHEDULE

EVENT INDEX	EVENT TYPE	REF TIME	REF CODE	EVENT CALENDAR DATE	EVENT JULIAN DAY	EVENT TRAJ DAY	TARGET CALENDAR DATE	TARGET JULIAN DAY	TARGET TRAJ DAY	CONT
1	1	0.0	1	1977 1 5 6 28 33.331	28128.770	0.0	1977 5 17 6 49 38.000	28260.784	0.0	2.
2	4	122.00	1	1977 5 7 6 28 33.331	28250.770	0.0	0 0 0 0 0 0.0	-693991.500	0.0	2.
3	1	122.50	1	1977 5 7 18 28 33.331	28251.270	0.0	1977 5 17 6 49 38.000	28260.784	0.0	2.
4	5	123.00	1	1977 5 8 6 28 33.331	28251.770	0.0	0 0 0 0 0 0.0	-693991.500	0.0	2.
5	1	123.50	1	1977 5 8 18 28 33.331	28252.270	0.0	1977 5 17 5 49 38.000	28260.743	0.0	2.
6	-1	1.00	3	0 0 0 0 0 0.0	0.0	0.0	0 0 0 0 0 0.0	-693991.500	0.0	2.

IND	IMP	MOD	TAR KEY	TAR1	TAR2	TAR3	TOL1	TOL2	TOL3	DVX	DVY	DVZ	MAT	BADITS	BIT
1	3	1	13 14 1	0.0	68.20	28260.78	1.00	1.00	0.00	0.0	0.0	0.0	1	3 12	12
2	3	1	0 0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	3 12	12
3	3	1	13 14 1	-14.00	100.00	28260.78	1.00	1.00	0.00	0.0	0.0	0.0	1	3 12	12
4	3	1	11 11 0	30.30	-14.60	-34.40	1.00	1.00	1.00	0.0	0.0	0.0	1	3 12	12
5	3	1	13 14 15	20.00	30.00	28260.74	1.00	1.00	0.00	0.0	0.0	0.0	1	3 12	12
6	3	1	0 0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	3 12	12

```
GUIDANCE EVENT AT      0.0    DAYS
CALENDAR DATE   1977    1     5     6    28  33.331      JULIAN DATE    28128.76983

EVENT CODES         KUR  1       KTYP  1       KMXQ  3       MDL  1

CURRENT SPACECRAFT STATE
REFERENCE          X-COMP            Y-COMP             Z-COMP            RADIUS          X-DOT          Y-DOT          Z-DOT        VELOCITY
INERTIAL       -37626809.14      142201325.40             433.92       147095185.89   -20.52307137 -14.68428602   -1.99379863   25.31402669
SUN            -37626809.14      142201325.40             433.92       147095185.89   -20.52307137 -14.68428602   -1.99379863   25.31402669
VENUS         -108417521.47       60551662.29         2949985.23       124215800.85     6.04685081 -37.47566245   -3.84222030   38.15432266
EARTH              -3831.27          -5316.20             433.92            6567.25     8.76123194  -6.95710839   -1.99379863   11.36379228
     N-BODY TARGETING EVENT


     STATE    -0.3762680914D 08    0.1422013254D 09    0.4339240126D 03
              -0.2052307137D 02   -0.1468428602D 02   -0.1993798630D 01
     JULIAN DATE     0.2812876983D 05


     PARAMETER KEY DEFINITIONS
          1-TPS       4-TCA       7-RCA       10-XRF       13-DCP
          2-TSI       5-B.T       8-INC       11-YRF       14-RAP
          3-TCS       6-B.R       9-ASI       12-ZRF       15-TPR


     TARGETING SPECIFICATIONS
          KEY    TARGET VALUE       TOLERANCE
          13          0.0               1.000
          14         68.200             1.000
           1      28260.784             0.001


     TARGETING SCHEME
          LEVELS    0.100D-03  0.250D-04
          DVMAX    0.500000000D 00
          IBAST      3

 IND NOF PHS  KEYTAR         DTAR(1)        DTAR(2)        DTAR(3)    KAXTAR    ISTOP  DELT
   1   1   1  13 14  1          0.0          68.20       28260.78     5  6  1     2   145.216

ACCURACY       VX            VY            VZ             TAR -13-       TAR -14-       TAR - 1-      AUX - 5-      AUX - 6-       AUX - 1- INCR
0.10D-03 -20.5230714 -14.6842860  -1.9937986          -37.403        -92.562       28259.400    240548.938    345451.268      28259.400  541

         DAUX=    -0.11506D 05   -0.31738D 04    0.28261D 05     DTAR=     0.0              0.68200D 02    0.28261D 05

STATE=       -3831.       -5316.        434.    8.76123  -6.95711   -1.99380
 IOPT=  1 CON=     0.1000000000D-04    0.0                    0.0
DV=   0.7709778317D-05   -0.6122171376D-05   -0.1754518721D-05
0.10D-03 -20.5230637 -14.6842921  -1.9938004          -37.406        -92.570       28259.397    241131.544    346229.251      28259.397  541

         DAUX=    -0.11506D 05   -0.31738D 04    0.28261D 05     DTAR=     0.0              0.68200D 02    0.28261D 05

STATE=       -3831.       -5316.        434.    8.76123  -6.95711   -1.99380
 IOPT=  2 CON=     0.0                 0.1000000000D-05    0.0
DV=   0.6933354489D-05    0.8966197999D-05   -0.8195511393D-06
0.10D-03 -20.5230644 -14.6642770  -1.9937994          -37.405        -92.558       28259.400    240478.499    345399.457      28259.400  541

         DAUX=    -0.11506D 05   -0.31738D 04    0.28261D 05     DTAR=     0.0              0.68200D 02    0.28261D 05
```

```
STATE=      -3831.      -5316.        434.   8.76123  -6.95711  -1.99380
 IOPT=  3 CON=      0.0                0.0                     0.5000000000D-05
DV=    0.1037428787D-04   -0.2922984359D-05    0.5578731658D-04
0.10D-03 -20.5230610 -14.6842889  -1.9937428        -37.403      -32.563     28259.399    240571.612    345468.733    28259.399  541

          DAUX=    -0.11506D 05   -0.31738D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.76123  -6.95711  -1.99380
 IOPT=  4 CON=    -0.4622339990D-02    -0.9396496830D-03    -0.1079271603D-01
DV=    -0.3297415959D-01     0.1123364880D-02    -0.1186701303D 00

    SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR      VEL COR       DES AUX VAL      DES TAR VAL      TAR TOL
 0.58D 08 -0.70D 08  0.45D 07     -0.21D-07  0.30D-07  0.41D-03    -0.25D 06    -0.33D-01     -11505.672          0.0           1.000
 0.78D 08 -0.52D 08  0.35D 07     -0.31D-07  0.34D-08 -0.55D-02    -0.35D 06     0.11D-02      -3173.803         68.200         1.000
-0.28D 03  0.19D 03 -0.24D 02      0.32D-08 -0.33D-06 -0.91D-01     0.14D 01    -0.12D 00      28260.784      28260.784         0.001

ACCURACY      VX          VY          VZ             TAR -13-     TAR -14-     TAR - 1-      AUX - 5-     AUX - 6-      AUX - 1-  INCR
0.10D-03 -20.5560455 -14.6831627  -2.1124686          86.720      138.705     28260.746     1443.228   -23914.361    28260.746  529

          DAUX=    -0.11636D 05   -0.35031D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.72826  -6.95599  -2.11247
 IOPT=  1 CON=    0.1000000000D-04     0.0                     0.0
DV=    0.7683887139D-05    -0.6123673843D-05    -0.1859703500D-05
0.10D-03 -20.5560378 -14.6831688  -2.1124706          87.372      164.854     28260.742     1959.844   -23057.986    28260.742  529

          DAUX=    -0.11636D 05   -0.35031D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.72826  -6.95599  -2.11247
 IOPT=  2 CON=    0.0                0.1000000000D-05     0.0
DV=    0.6937936943D-05     0.8956261505D-05    -0.8253160065D-06
0.10D-03 -20.5560386 -14.6831537  -2.1124696          86.661      136.389     28260.746     1378.212   -23971.667    28260.746  529

          DAUX=    -0.11636D 05   -0.35031D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.72826  -6.95599  -2.11247
 IOPT=  3 CON=    0.0                0.0                     0.5000000000D-05
DV=    0.1085486935D-04    -0.3280348335D-05    0.5565230919D-04
0.10D-03 -20.5560347 -14.6831659  -2.1124131          86.743      139.495     28260.746     1464.540   -23891.891    28260.746  529

          DAUX=    -0.11636D 05   -0.35031D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.72826  -6.95599  -2.11247
 IOPT=  4 CON=    0.1059241819D-02     0.1054839769D-03    -0.1429773180D-01
DV=    -0.3033850246D-01     0.1038831217D-01    -0.1592178236D 00

    SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR      VEL COR       DES AUX VAL      DES TAR VAL      TAR TOL
 0.52D 08 -0.65D 08  0.43D 07     -0.22D-07  0.34D-07  0.19D-02    -0.13D 05    -0.30D-01     -11635.810          0.0           1.000
 0.86D 08 -0.57D 08  0.45D 07     -0.33D-07 -0.57D-08 -0.53D-02     0.20D 05     0.10D-01      -3503.145         68.200         1.000
-0.41D 03  0.27D 03 -0.31D 02      0.41D-08 -0.50D-06 -0.10D 00     0.38D-01    -0.16D 00      28260.784      28260.784         0.001

ACCURACY      VX          VY          VZ             TAR -13-     TAR -14-     TAR - 1-      AUX - 5-     AUX - 6-      AUX - 1-  INCR
0.10D-03 -20.5864340 -14.6727743  -2.2716860          40.989       14.332     28260.811   -14205.830    -6707.066    28260.811  531

          DAUX=    -0.11609D 05   -0.35226D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.69787  -6.94560  -2.27169
 IOPT=  1 CON=    0.1000000000D-04     0.0                     0.0
DV=    0.7656420707D-05    -0.6113958349D-05    -0.1999683791D-05
0.10D-03 -20.5864264 -14.6727805  -2.2716886          25.320       46.299     28260.804   -13693.286    -5845.980    28260.804  531

          DAUX=    -0.11609D 05   -0.35226D 04    0.28261D 05    DTAR=    0.0              0.68200D 02    0.28261D 05

STATE=      -3831.      -5316.        434.   8.69787  -6.94560  -2.27169
```

```
 IOPT=  2 CON=     0.0                          0.1000000000D-05    0.0
DV=    0.6936511071D-05     0.8958208298D-05    -0.8307356490D-06
0.10D-03 -20.5864271 -14.6727654  -2.2716874          41.005          14.546      28260.811     -14270.530      -6764.634      28260.811  531

          DAUX=   -0.11609D 05    -0.35226D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69787  -6.94560  -2.27169
 IOPT=  3 CON=     0.0                    0.0                    0.5000000000D-05
DV=    0.1149622482D-04    -0.3755096744D-05     0.5549870404D-04
0.10D-03 -20.5864225 -14.6727781  -2.2716311          39.255          20.881      28260.810     -14182.995      -6682.246      28260.810  531

          DAUX=   -0.11609D 05    -0.35226D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69787  -6.94560  -2.27169
 IOPT=  4 CON=     0.2097376730D-04    -0.2159240036D-04     0.2728330809D-04
DV=   -0.7099144304D-04    -0.2267393758D-03     0.3165829714D-03

     SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR      VEL COR       DES AUX VAL     DES TAR VAL       TAR TOL
 0.51D 08 -0.65D 08  0.46D 07     -0.23D-07  0.27D-07  0.18D-03     0.26D 04    -0.71D-04     -11609.204           0.0           1.000
 0.86D 08 -0.58D 08  0.50D 07     -0.30D-07  0.14D-07 -0.43D-03     0.32D 04    -0.23D-03      -3522.568          68.200         1.000
-0.75D 05  0.31D 03 -0.15D 03      0.51D-07 -0.10D-06 -0.82D-02    -0.27D-01     0.32D-03      28260.784       28260.784         0.001

ACCURACY       VX            VY           VZ            TAR -13-       TAR -14-       TAR - 1-       AUX - 5-       AUX - 6-       AUX - 1- INCR
0.10D-03 -20.5855050 -14.6730011  -2.2713700           0.035          68.200      28260.789     -11609.512      -3526.008      28260.789  531

          DAUX=   -0.11609D 05    -0.35196D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69780  -6.94582  -2.27137
 IOPT=  1 CON=     0.1000000000D-04     0.0                    0.0
DV=    0.7656344081D-05    -0.6114146651D-05    -0.1999401423D-05
0.10D-03 -20.5864974 -14.6730072  -2.2713720          -6.266          70.724      28260.785     -11096.012      -2665.104      28260.785  531

          DAUX=   -0.11609D 05    -0.35196D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69780  -6.94582  -2.27137
 IOPT=  2 CON=     0.0                    0.1000000000D-05    0.0
DV=    0.6936713885D-05     0.8958074144D-05    -0.8307756078D-06
0.10D-03 -20.5864981 -14.6729921  -2.2713708           0.606          67.786      28260.790     -11674.171      -3583.391      28260.790  531

          DAUX=   -0.11609D 05    -0.35196D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69780  -6.94582  -2.27137
 IOPT=  3 CON=     0.0                    0.0                    0.5000000000D-05
DV=    0.1149502632D-04    -0.3754199030D-05     0.5549912035D-04
0.10D-03 -20.5864935 -14.6730048  -2.2713145          -0.168          63.341      28260.789     -11586.554      -3501.074      28260.789  531

          DAUX=   -0.11609D 05    -0.35196D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

STATE=        -3831.       -5316.         434.    8.69780  -6.94582  -2.27137
 IOPT=  4 CON=    -0.1123937576D-04     0.2595921074D-04     0.5055307029D-03
DV=    0.1339515980D-02    -0.1303167003D-03     0.5591434403D-02

     SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR      VEL COR       DES AUX VAL     DES TAR VAL       TAR TOL
 0.51D 08 -0.65D 08  0.46D 07     -0.18D-07  0.33D-07  0.23D-02     0.86D 00     0.13D-02     -11608.654           0.0           1.000
 0.86D 08 -0.57D 08  0.50D 07     -0.43D-07 -0.85D-09 -0.55D-02     0.64D 01    -0.13D-03      -3519.576          68.200         1.000
-0.41D 03  0.33D 03 -0.36D 02     -0.18D-06 -0.38D-06 -0.10D 00    -0.49D-02     0.56D-02      28260.784       28260.784         0.001

ACCURACY       VX            VY           VZ            TAR -13-       TAR -14-       TAR - 1-       AUX - 5-       AUX - 6-       AUX - 1- INCR
0.10D-03 -20.5851655 -14.6731314  -2.2657780           0.164          68.125      28260.785     -11622.245      -3539.915      28260.785  531

          DAUX=   -0.11609D 05    -0.35185D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05

ACCURACY       VX            VY           VZ            TAR -13-       TAR -14-       TAR - 1-       AUX - 5-       AUX - 6-       AUX - 1- INCR
0.25D-04 -20.5851655 -14.6731314  -2.2657780          34.081          32.813      28260.938     -46707.473     -31537.026      28260.938 1015

          DAUX=   -0.11609D 05    -0.35520D 04     0.28261D 05      DTAR=     0.0                 0.68200D 02     0.28261D 05
```

```
STATE=      -3831.      -5316.        434.   8.69914  -6.94595  -2.26578
 IOPT=  4 CON=   -0.5043402732D-04    -0.6700749937D-03    -0.1227971156D-02
DV=    -0.7512669084D-02    -0.5047120948D-02    -0.1306281998D-01

     SENSITIVITY MATRIX                 TARGETING MATRIX          AUX ERROR      VEL COR     DES AUX VAL    DES TAR VAL       TAR TOL
 0.51D 08 -0.65D 08  0.46D 07    -0.18D-07  0.33D-07  0.23D-02     0.35D 05    -0.75D-02    -11609.109          0.0          1.000
 0.86D 08 -0.57D 08  0.50D 07    -0.43D-07 -0.65D-09 -0.55D-02     0.28D 05    -0.50D-02     -3551.979         68.200         1.000
-0.41D 03  0.33D 03 -0.36D 02    -0.18D-06 -0.38D-06 -0.10D 00    -0.15D 00    -0.13D-01     28260.784      28260.784         0.001

ACCURACY      VX           VY            VZ           TAR -13-       TAR -14-       TAR - 1-       AUX - 5-       AUX - 6-       AUX - 1- INCR
0.25D-04 -20.5926782 -14.6781785   -2.2788414          0.158         67.209      28260.799     -11735.312      -3443.218      28260.799 1022

        DAUX=   -0.11608D 05    -0.35265D 04     0.28261D 05      DTAR=      0.0              0.68200D 02     0.28261D 05

STATE=      -3831.      -5316.        434.   8.69163  -6.95100  -2.27884
 IOPT=  4 CON=   -0.3915362774D-04     0.7520311375D-04     0.1524570876D-02
DV=     0.3996836831D-02    -0.4466391610D-03     0.1686766590D-01

     SENSITIVITY MATRIX                 TARGETING MATRIX          AUX ERROR      VEL COR     DES AUX VAL    DES TAR VAL       TAR TOL
 0.51D 08 -0.65D 08  0.46D 07    -0.18D-07  0.33D-07  0.23D-02     0.13D 03     0.40D-02    -11608.309          0.0          1.000
 0.86D 08 -0.57D 08  0.50D 07    -0.43D-07 -0.85D-09 -0.55D-02    -0.83D 02    -0.45D-03     -3526.458         68.200         1.000
-0.41D 03  0.33D 03 -0.36D 02    -0.18D-06 -0.38D-06 -0.10D 00    -0.15D-01     0.17D-01     28260.784      28260.784         0.001

ACCURACY      VX           VY            VZ           TAR -13-       TAR -14-       TAR - 1-       AUX - 5-       AUX - 6-       AUX - 1- INCR
0.25D-04 -20.5886813 -14.6786252   -2.2619737          0.251         68.085      28260.785     -11629.910      -3556.020      28260.785 1021

        DAUX=   -0.11610D 05    -0.35233D 04     0.28261D 05      DTAR=      0.0              0.68200D 02     0.28261D 05


   EXECUTION EVENT

   DELTA V =     -0.06560997      0.00566086     -0.26817509      0.27614234

   DOMINANT BODY ELEMENTS       SMA              ECC           OMEGA         INC          NODE          TA
   PLANET ECLIPTIC
      BEFORE IMPULSE    -0.5146125190 05    0.1127475D 01    155.91574     10.93505     74.26438      3.70000
      AFTER IMPULSE     -0.5201721590 05    0.1126100D 01    157.99784     12.24832     71.98035      3.85551
   PLANET EQUATORIAL
      BEFORE IMPULSE    -0.5146125190 05    0.1127475D 01   -150.25672     28.31700     22.63881      3.70000
      AFTER IMPULSE     -0.5201721590 05    0.1126100D 01   -151.77571     29.48676     24.19617      3.85551
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                                              X - COMP.              Y - COMP.              Z - COMP.          RESULTANT

TRAJECTORY TIME =    0.13200782284D 03           TOTAL TIME INCREMENTS =      600

SPACECRAFT INERTIAL TRAJECTORY
   POSITION. . . . . . . . . . . . .   -0.15353386239D 08  -0.10759326976D 09  -0.61014185885D 06   0.10868491358D 09
   VELOCITY. . . . . . . . . . . . .    0.41344115157D 02  -0.19970309470D 01   0.27058444609D 01   0.41480665195D 02

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CALENDAR DATE = MAY      17,  6 HR, 39 MIN, 49.225 SEC, 1977
JULIAN DATE =     2443280.77765307

EPHEMERIS DATA
   POSITION OF SUN       . . . . . . .   0.0                 0.0                 0.0                 0.0
   VELOCITY OF SUN       . . . . . . .   0.0                 0.0                 0.0                 0.0
   POSITION OF VENUS     . . . . . . .  -0.15343030597D 08  -0.10759438796D 09  -0.60756456663D 06   0.10868454456D 09
   VELOCITY OF VENUS     . . . . . . .   0.34433843076D 02  -0.50807861120D 01  -0.20562174701D 01   0.34867348147D 02
   POSITION OF EARTH     . . . . . . .  -0.84051222850D 08  -0.12581111648D 09   0.0                 0.15130447810D 09
   VELOCITY OF EARTH     . . . . . . .   0.24283689127D 02  -0.16656317191D 02   0.0                 0.29447078972D 02

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SPACECRAFT RELATIVE TRAJECTORIES
   POSITION REL. TO SUN        . . .  -0.15353386239D 08  -0.10759326976D 09  -0.61014185885D 06   0.10868491358D 09
   VELOCITY REL. TO SUN        . . .   0.41344115157D 02  -0.19970309470D 01   0.27058444609D 01   0.41480665195D 02

   POSITION REL. TO VENUS      . . .  -0.10349642125D 05   0.11181961287D 04  -0.25772922180D 04   0.10724173155D 05
   VELOCITY REL. TO VENUS      . . .   0.69102720811D 01   0.30837551650D 01   0.47620619310D 01   0.89408411230D 01

   POSITION REL. TO EARTH      . . .   0.68697836611D 08   0.18217846717D 08  -0.61014185885D 06   0.71074995372D 08
   VELOCITY REL. TO EARTH      . . .   0.17060426030D 02   0.14659286244D 02   0.27058444609D 01   0.22655560107D 02
```

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
VIRTUAL MASS DATA				
VIRTUAL MASS POSITION	-0.15343030575D 08	-0.10759434573D 09	-0.60756432816D 06	0.10868450191D 09
VIRTUAL MASS VELOCITY	0.34421210063D 02	-0.51692835499D 01	-0.20567164084D 01	0.34867911853D 02
SPACECRAFT POS. REL. TO V.M.	-0.10355663814D 05	0.10759665531D 04	-0.25775306832D 04	0.10725723354D 05
SPACECRAFT VEL. REL. TO V.M.	0.69229050940D 01	0.31722526029D 01	0.47625608693D 01	0.89817474664D 01
KEPLER (ANG. MOM.) VECTOR	0.13304562106D 05	0.31477394160D 05	-0.40313370383D 05	0.52848893532D 05
ECCENTRICITY VECTOR	0.11056055264D 00	0.95329653831D 00	0.78083897049D 00	0.12372176137D 01

V.M. MAGN. = 0.32498342253D 06
V.M. MAGN. RATE = -0.15819387478D 01

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
V.M. RELATIVE POSITIONS				
POSITION REL. TO SUN . . .	-0.15343030575D 08	-0.10759434573D 09	-0.60756432816D 06	0.10868450191D 09
POSITION REL. TO VENUS . . .	0.60216889924D 01	0.42229575597D 02	0.23846518842D 00	0.42657410365D 02
POSITION REL. TO EARTH . . .	0.68708192275D 08	0.18215770750D 08	-0.60756432816D 06	0.71084706911D 08

NAVIGATION PARAMETERS
FLIGHT PATH ANGLE . . . . -0.53653476283D 01
INCLINATION TO PLANE OF SKY 0.63211305864D 02
GEOCENTRIC DECLINATION. 0.53991655721D 01
TARGET PLANET ANGLE (ZAE) 0.15469016563D 03
ANTENNA AXIS - EARTH ANGLE. . . . . -0.49186047987D 00
ANTENNA AXIS - LIMB OF SUN ANGLE. . 0.11260513123D 03
OCCULTATION RATIO FOR SUN IS 0.14336367676D 03
OCCULTATION RATIO FOR VENUS IS 0.75763523288D 00

SPACECRAFT PASSING IN FRONT OF VENUS
INTERPOLATED INFORMATION AT IMPACT
SPACECRAFT IMPACTED VENUS AT DATE. . . . 2443230.78459923

POSITION. . . .	-0.55109222046D 04	0.28139327337D 04	0.38925444767D 03	0.62000000000D 04
VELOCITY. . . .	0.96658980228D 01	0.22481490288D 01	0.50278702539D 01	0.11142274178D 02
DECLINATION . .	0.299			
RT. ASCENSION .	71.073			

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     GUIDANCE EVENT AT   122.500 DAYS
     CALENDAR DATE   1977    5    7   18   28  33.331      JULIAN DATE    28251.26983

     EVENT CODES        KUR  3      KTYP  1      KMXQ  3      MDL  1

     CURRENT SPACECRAFT STATE
     REFERENCE        X-COMP          Y-COMP            Z-COMP           RADIUS         X-DOT          Y-DOT          Z-DOT        VELOCITY
INERTIAL        -45143096.69     -101567706.88      -1098803.77      111153522.80    34.77555111  -11.60696386    0.51188536   36.66500500
SUN             -45143096.69     -101567706.88      -1098803.77      111153522.80    34.77555111  -11.60696386    0.51188536   36.66500500
VENUS            -2374115.37       -1835286.21      -2181372.21        3710157.41     2.82999075    2.34789039    2.54769537    4.47349848
EARTH            57684769.71        8992796.52      -1098803.77       58391869.45    13.44870713    8.78862863    0.51188536   16.07388389
        N-BODY TARGETING EVENT


        STATE     -0.4514309669D 08   -0.1015677069D 09   -0.1098803769D 07
                   0.3477555111D 02   -0.1160696386D 02    0.5118853568D 00
        JULIAN DATE      0.2825126983D 05


        PARAMETER KEY DEFINITIONS
             1-TPS       4-TCA       7-RCA       10-XRF       13-DCP
             2-TSI       5-B.T       8-INC       11-YRF       14-RAP
             3-TCS       6-B.R       9-ASI       12-ZRF       15-TPR


        TARGETING SPECIFICATIONS
             KEY    TARGET VALUE       TOLERANCE
              13         -14.000           1.000
              14         100.000           1.000
               1       28260.734           0.001


        TARGETING SCHEME
             LEVELS    0.100D-03  0.250D-04
             DVMAX    0.500000000D 00
             IBAST       3

     IND NOF PHS  KEYTAR          DTAR(1)        DTAR(2)        DTAR(3)   KAXTAR    ISTOP   DELT
       3   1   1  13 14  1          -14.00         100.00       28260.78    5  6  1     2     10.466

ACCURACY      VX            VY              VZ             TAR -13-      TAR -14-      TAR - 1-      AUX - 5-      AUX - 6-       AUX - 1- INCR
0.10D-03  34.7755511 -11.6069639    0.5118854           0.339        66.415     28260.785    -11837.808     -3377.699     28260.785  105

         DAUX=    -0.64809D 04   -0.37477D 04    0.28261D 05     DTAR=   -0.14000D 02    0.10000D 03    0.28261D 05

STATE=    57684770.     8992797.    -1098804.   13.44871    8.78863    0.51189
 IOPT=  1 CON=     0.1000000000D-04     0.0                        0.0
DV=    0.8306806194D-05    0.5467644717D-05    0.3184577917D-06
0.10D-03  34.7755595 -11.6069584    0.5118857           0.313        66.414     28260.785    -11837.380     -3372.852     28260.785  105

         DAUX=    -0.64809D 04   -0.37477D 04    0.28261D 05     DTAR=   -0.14000D 02    0.10000D 03    0.28261D 05

STATE=    57684770.     8992797.    -1098804.   13.44871    8.78853.   0.51189
 IOPT=  2 CON=     0.0                   0.1000000000D-05    0.0
DV=   -0.8783769700D-05    0.1333322782D-04    0.1854769325D-05
0.10D-03  34.7755423 -11.6069505    0.5118372           0.404        66.318     28260.785    -11851.246     -3378.262     28260.785  105

         DAUX=    -0.64809D 04   -0.37477D 04    0.28261D 05     DTAR=   -0.14000D 02    0.10000D 03    0.28261D 05
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STATE=   57684770.     8992797.    -1098804.  13.44871    8.78863   0.51189
 IOPT=  3 CON=      0.0                0.0                    0.5000000000D-05
DV=      0.2947406599D-05    -0.9157987546D-05     0.7979152613D-04
0.10D-03  34.7755541 -11.6069730    0.5119651          0.572          66.522     28260.784    -11830.206     -3432.609     28260.784   105

         DAUX=    -0.64809D 04    -0.37477D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.44871    8.78863   0.51189
 IOPT=  4 CON=    -0.2856739360D-02    -0.4157469164D-03    -0.7106167858D-04
DV=      0.1217914085D-02    -0.6974878466D-02    -0.1995820690D-02

     SENSITIVITY MATRIX                   TARGETING MATRIX              AUX ERROR      VEL COR      DES AUX VAL      DES TAR VAL        TAR TOL
 0.43D 05 -0.13D 08  0.15D 07     -0.50D-05  0.50D-06 -0.39D 00      0.54D 04     0.12D-02      -6480.871         -14.000          1.000
 0.48D 06 -0.56D 06 -0.11D 06     -0.78D-07 -0.62D-08 -0.32D-02     -0.37D 03    -0.70D-02      -3747.733         100.000          1.000
-0.20D 01  0.17D 02 -0.16D 02     -0.18D-07 -0.69D-07 -0.17D-01     -0.65D-04    -0.20D-02      28260.784       28260.784          0.001

ACCURACY       VX            VY            VZ            TAR -13-       TAR -14-      TAR - 1-      AUX - 5-      AUX - 6-      AUX - 1-  INCR
0.10D-03  34.7767690 -11.6139387    0.5098895         -14.057         99.932     28260.787     -6476.608     -3743.224     28260.787   105

         DAUX=    -0.64669D 04    -0.37575D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.44993    8.78165   0.50989
 IOPT=  1 CON=      0.1000000000D-04    0.0                   0.0
DV=      0.8369051285D-05     0.5464276597D-05     0.3172725248D-06
0.10D-03  34.7767774 -11.6139333    0.5098899         -14.083         99.930     28260.787     -6476.193     -3738.371     28260.787   105

         DAUX=    -0.64669D 04    -0.37575D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.44993    8.78165   0.50989
 IOPT=  2 CON=      0.0                0.1000000000D-05      0.0
DV=     -0.8776709743D-05     0.1333479616D-04     0.1852158487D-05
0.10D-03  34.7767602 -11.6139254    0.5098914         -14.029         99.857     28260.787     -6490.060     -3743.811     28260.787   105

         DAUX=    -0.64669D 04    -0.37575D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.44993    8.78165   0.50989
 IOPT=  3 CON=      0.0                0.0                    0.5000000000D-05
DV=      0.2944802790D-05    -0.9142818884D-05     0.7977897494D-04
0.10D-03  34.7767720 -11.6139479    0.5099693         -13.784        100.023     28260.787     -6469.006     -3798.148     28260.787   105

         DAUX=    -0.64669D 04    -0.37575D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.44993    8.78165   0.50989
 IOPT=  4 CON=      0.1026578799D-02     0.7674580635D-05     0.4624655379D-04
DV=      0.8190131558D-03     0.5787177803D-03     0.7847331392D-03

     SENSITIVITY MATRIX                   TARGETING MATRIX              AUX ERROR      VEL COR      DES AUX VAL      DES TAR VAL        TAR TOL
 0.42D 05 -0.13D 08  0.15D 07     -0.16D-06  0.52D-06 -0.39D 00      0.97D 01     0.82D-03      -6466.895         -14.000          1.000
 0.49D 06 -0.59D 06 -0.11D 08     -0.75D-07 -0.60D-08 -0.31D-02     -0.14D 02     0.58D-03      -3757.514         100.000          1.000
-0.19D 01  0.48D 01 -0.15D 02     -0.31D-08 -0.68D-07 -0.17D-01     -0.27D-02     0.78D-03      28260.784       28260.784          0.001

ACCURACY       VX            VY            VZ            TAR -13-       TAR -14-      TAR - 1-      AUX - 5-      AUX - 6-      AUX - 1-  INCR
0.10D-03  34.7775880 -11.6133600    0.5106743         -13.994         99.994     28260.784     -6466.894     -3757.562     28260.784   105

         DAUX=    -0.64658D 04    -0.37568D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

ACCURACY       VX            VY            VZ            TAR -13-       TAR -14-      TAR - 1-      AUX - 5-      AUX - 6-      AUX - 1-  INCR
0.25D-04  34.7775880 -11.6133600    0.5106743         -13.467        101.294     28260.785     -6259.793     -3932.395     28260.785   188

         DAUX=    -0.64634D 04    -0.37617D 04      0.28261D 05      DTAR=    -0.14000D 02     0.10000D 03     0.28261D 05

STATE=   57684770.     8992797.    -1098804.  13.45074    8.78223   0.51067
 IOPT=  4 CON=      0.3100076900D-03     0.1578695527D-04    -0.2586924167D-05
DV=      0.1192914594D-03     0.3848436967D-03    -0.3756934786D-05
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   SENSITIVITY MATRIX                     TARGETING MATRIX              AUX ERROR     VEL COR      DES AUX VAL    DES TAR VAL      TAR TOL
 0.42D 05 -0.13D 08  0.15D 07     -0.16D-06  0.52D-06 -0.39D 00     -0.20D 03     0.12D-03      -6463.362        -14.000        1.000
 0.49D 06 -0.59D 06 -0.11D 08     -0.75D-07 -0.60D-08 -0.31D-02      0.17D 03     0.38D-03      -3761.693        100.000        1.000
-0.19D 01  0.48D 01 -0.15D 02     -0.31D-03 -0.68D-07 -0.17D-01     -0.49D-03    -0.38D-05      28260.784      28260.784        0.001

ACCURACY     VX          VY          VZ          TAR -13-     TAR -14-     TAR - 1-     AUX - 5-     AUX - 6-     AUX - 1-  INCR
0.25D-04  34.7777073 -11.6129752  0.5106705     -13.996      100.003     28260.784    -6463.399    -3761.797    28260.784  188

      DAUX=   -0.64638D 04   -0.37609D 04    0.28261D 05    DTAR=   -0.14000D 02    0.10000D 03    0.28261D 05


   EXECUTION EVENT

   DELTA V =     0.00215622    -0.00601132    -0.00121484    0.00650085

   DOMINANT BODY ELEMENTS        SMA              ECC            OMEGA        INC        NODE          TA
   PLANET ECLIPTIC
      BEFORE IMPULSE     0.1271670380 09   0.1579276D 00     5.38506     0.93906    -76.86909    -42.98306
      AFTER IMPULSE      0.1272022229D 09   0.1580368D 00     5.71355     0.93752    -76.79810    -42.88253
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    GUIDANCE EVENT AT    123.000 DAYS
    CALENDAR DATE   1977    5    3    6   28  33.331     JULIAN DATE    28251.76983

    EVENT CODES        KUR  4     KTYP  5     KMXQ  3     MDL  1

    CURRENT SPACECRAFT STATE
    REFERENCE       X-COMP          Y-COMP           Z-COMP           RADIUS        X-DOT        Y-DOT         Z-DOT      VELOCITY
INERTIAL       -43636664.23    -102060214.85      -1076631.10     111002725.44   34.96409556 -11.18650277   0.51585470  36.71364771
SUN            -43636664.23    -102060214.85      -1076631.10     111002725.44   34.96409556 -11.18650277   0.51585470  36.71364771
VENUS           -2251864.10      -1734612.95      -2071649.72       3517315.25    2.82979709   2.31966668   2.55632534   4.46356408
EARTH           58266155.36       9377426.04      -1076631.10      59025758.06   13.46677047   9.02423020   0.51585470  16.21902413

        MINIPROBE TARGETING EVENT

        PLANETOCENTRIC STATE OF SPACECRAFT AT IMPACT BASED ON STATE AT RELEASE
                -6096.14          -440.68          -1040.63          6200.00    8.79491659   4.14451540   5.44043184  11.14117877

        EQUIVALENT CONIC PLANETOCENTRIC STATE OF SPACECRAFT AT RELEASE
             -2258096.68      -1685092.32      -2093986.35       3510458.03    2.83517615   2.12520723   2.63976012   4.41849103

                                                   GAUSS LEAST SQUARES ROUTINE
                                                           N = 4
                                                           M = 6
                                                       DELTA = 0.100D-04
                                                          C1 = 0.100D 05
                                                          C2 = 0.100D 01
                                                         EPS = 0.100D 01
                                                          S0 = 0.500D 00
                                                       ITLIM = 20

                                                     GAUSS ITERATION POINT

                                                         X 0 1=-0.6505776830D-01
                                                         X 0 2= 0.8105177361D 00
                                                         X 0 3= 0.6402983955D 00
                                                         X 0 4= 0.6432358423D 00
                                                           Y 0= 0.2089388767D 07

                                                    JACOBIAN MATRIX ROUTINE

                                              NOMINAL AND PERTURBED FUNCTION VALUES
INCRE-
MENTED       PHI(1) OR                PHI(2) OR                PHI(3) OR                PHI(4) OR                PHI(5) OR
VARI-         PHI(6)                   PHI(7)                   PHI(8)                   PHI(9)                   PHI(10)
ABLE
 0     -0.2421661730812130D 02  0.4319756519321910D 03  0.8138207550123760D 03 -0.5711349261702440D 02 -0.7580636159431660D 01
       -0.1112051550032470D 04
 1     -0.2421251113096940D 02  0.4318217310076160D 03  0.8138745277357440D 03 -0.5703888335275220D 02 -0.7613749482565140D 01
       -0.1112093225647990D 04
 2     -0.2413718048280420D 02  0.4318444603472640D 03  0.8137764469614020D 03 -0.5711938081520380D 02 -0.7497803008428950D 01
       -0.1112128378875010D 04
 3     -0.2421660984232240D 02  0.4318756387563090D 03  0.8138207921678010D 03 -0.5711550012245790D 02 -0.7552941877028450D 01
       -0.1112077310422520D 04
 4     -0.2421425471971620D 02  0.4318450723620040D 03  0.8138529153759710D 03 -0.5707506398633360D 02 -0.7597670329379410D 01
       -0.1112073036593120D 04
```

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.4106177152D 03	0.7343682532D 04	0.7465798831D 00	0.2362588405D 03	
PHI(2)	-0.5792086458D 04	-0.3519158493D 04	-0.1317588249D 01	-0.3457957019D 04	
PHI(3)	0.5377272337D 04	-0.4430305097D 04	0.3715542516D 01	0.3216036359D 04	
PHI(4)	0.7460926427D 04	-0.5868193179D 03	-0.2007505434D 03	0.3842863069D 04	
PHI(5)	-0.3211332313D 04	0.8283315100D 04	0.2769428240D 04	-0.1703416995D 04	
PHI(6)	-0.4167561552D 04	-0.7682384254D 04	-0.2576039005D 04	-0.2148856065D 04	

PROJECTION MATRIX

-0.4077901242D-04	0.5817972314D-03	-0.5334193770D-03	0.6445209356D-03	-0.2865026405D-03
-0.3593173030D-03				
0.8355734697D-04	-0.3833786605D-04	-0.4540002474D-04	-0.9702540681D-06	0.6127254776D-06
0.7125787688D-06				
-0.2495674665D-03	0.1155122795D-03	0.1348241508D-03	-0.1062561984D-04	0.1910067558D-03
-0.1819556968D-03				
0.7947441633D-04	-0.1129206094D-02	0.1035869522D-02	-0.1078798658D-02	0.4793919896D-03
0.6015464470D-03				

GAUSS ITERATION POINT

X 1 1=-0.2481443180D 00
X 1 2= 0.8667878048D 00
X 1 3= 0.2731415921D 00
X 1 4= 0.9008002580D 00
GRAD 0= 0.1630581097D 08
Y 1= 0.1525000459D 07

JACOBIAN MATRIX ROUTINE

NOMINAL AND PERTURNED FUNCTION VALUES

INCRE-MENTED VARI-ABLE	PHI(1) OR PHI(6)	PHI(2) OR PHI(7)	PHI(3) OR PHI(8)	PHI(4) OR PHI(9)	PHI(5) OR PHI(10)
0	0.1184322905921853D 03	0.1019212651967000D 04	0.8114090020194250D 02	-0.1772221854465910D 03	-0.6362974746239060D 03
	-0.3596019672837990D 03				
1	0.1184450281347370D 03	0.1019149631681580D 04	0.8119199414746070D 02	-0.1771555633451640D 03	-0.6363255848959550D 03
	-0.3596407005009810D 03				
2	0.1185091807379930D 03	0.1019186492129900D 04	0.8109091942858330D 02	-0.1772290686048820D 03	-0.6362272350747360D 03
	-0.3596651095972400D 03				
3	0.1184374859163450D 03	0.1019196311431710D 04	0.8115298126145540D 02	-0.1772315924434770D 03	-0.6362605326780070D 03
	-0.3596295428951800D 03				
4	0.1184205369550720D 03	0.1019200104776480D 04	0.8116603259583360D 02	-0.1771829270495160D 03	-0.6363110412721340D 03
	-0.3595278205818750D 03				

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.1173221288D 04	0.7593481614D 04	0.4189594492D 03	-0.1275857113D 04	
PHI(2)	-0.6302028512D 04	-0.2615983710D 04	-0.1634053529D 04	-0.1254719051D 04	
PHI(3)	0.5119394552D 04	-0.4988177335D 04	0.1218105951D 04	0.2523249385D 04	
PHI(4)	0.6622101430D 04	-0.5331582910D 03	-0.9406936886D 03	0.3925839708D 04	
PHI(5)	-0.2811027205D 04	0.7023954917D 04	0.3694194590D 04	-0.1356664823D 04	
PHI(6)	-0.2873321713D 04	-0.6314231344D 04	-0.2757561133D 04	-0.2585329808D 04	

PROJECTION MATRIX

0.8710729529D-04	-0.1441520656D-03	0.5733791788D-04	-0.2416906915D-04	-0.4612558954D-04
0.7043640458D-04				
0.5238400862D-04	0.2096371900D-04	-0.7368820965D-04	0.4217574239D-04	0.4022741970D-05
-0.4601201015D-04				
-0.9208557283D-04	-0.5393009420D-04	0.1567597107D-03	-0.1193460023D-03	0.1485843395D-03
-0.2970167721D-04				
-0.1607056952D-03	0.2327964223D-03	-0.7304247471D-04	0.1894336412D-03	0.2958236933D-04
[illegible]				

GAUSS ITERATION POINT

X 2 1=-0.1244953791D 00
X 2 2= 0.8386845551D 00
X 2 3= 0.3992586838D 00
X 2 4= 0.6619084526D 00
GRAD 1= 0.1270770463D 08
Y 2= 0.1076873683D 07

JACOBIAN MATRIX ROUTINE

NOMINAL AND PERTURNED FUNCTION VALUES

INCRE-MENTED VARI-ABLE	PHI(1) OR PHI(6)	PHI(2) OR PHI(7)	PHI(3) OR PHI(8)	PHI(4) OR PHI(9)	PHI(5) OR PHI(10)
0	0.166725146552114D 03	0.650229038029805D 03	0.403740035002525D 03	-0.354275979252919D 03	-0.378599811949994D 03
	-0.440934806633777D 03				
1	0.166732891681209D 03	0.650167631294085D 03	0.403793624066224D 03	-0.354207375659003D 03	-0.378627355153910D 03
	-0.440976052532568D 03				
2	0.166804190893278D 03	0.650197616174340D 03	0.403692338010630D 03	-0.354285205758506D 03	-0.378524164256249D 03
	-0.441001031151260D 03				
3	0.166725306624340D 03	0.650227958164662D 03	0.403740987474651D 03	-0.354280536942461D 03	-0.378565969891176D 03
	-0.440964145304120D 03				
4	0.166726979598082D 03	0.650205598033414D 03	0.403761542330681D 03	-0.354236409642231D 03	-0.378615562256682D 03
	-0.440958718194316D 03				

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.7745129095D 03	0.7904434116D 04	0.1500722260D 02	0.1833045968D 03	
PHI(2)	-0.6140673572D 04	-0.3142185546D 04	-0.1079865143D 03	-0.2343999639D 04	
PHI(3)	0.5358906370D 04	-0.4769699189D 04	0.9524721363D 02	0.2150732816D 04	
PHI(4)	0.6860359392D 04	-0.9226505587D 03	-0.4557689543D 03	0.3956961069D 04	
PHI(5)	-0.2754320392D 04	0.7564769374D 04	0.3384205882D 04	-0.1575030669D 04	
PHI(6)	-0.4124589879D 04	-0.6622451748D 04	-0.2933867034D 04	-0.2391156054D 04	

PROJECTION MATRIX

0.4907198573D-04	-0.2838983605D-03	0.2373624109D-03	-0.1954744838D-03	0.6803427974D-04
0.1272668513D-03				
0.8186622407D-04	-0.2601765577D-04	-0.5606269565D-04	0.7481163050D-05	-0.2586587685D-05
-0.4561568634D-05				
-0.1832069341D-03	0.5640370015D-04	0.1274292715D-03	-0.3966033903D-04	0.1728708119D-03
-0.1342187004D-03				
-0.8720038372D-04	0.4923093057D-03	-0.4104420718D-03	0.5044448106D-03	-0.1829886964D-03
-0.3213621343D-03				

GAUSS ITERATION POINT

X 3 1=-0.3128842758D-01
X 3 2= 0.8642473472D 00
X 3 3= 0.3338967242D 00
X 3 4= 0.4897784822D 00
GRAD 2= 0.5260204579D 07
Y 3= 0.9773079595D 06

JACOBIAN MATRIX ROUTINE

NOMINAL AND PERTURNED FUNCTION VALUES

INCRE-MENTED VARI-ABLE	PHI(1) OR PHI(6)	PHI(2) OR PHI(7)	PHI(3) OR PHI(8)	PHI(4) OR PHI(9)	PHI(5) OR PHI(10)
0	0.324191793943808D 03	0.378472896759957D 03	0.518975454991964D 03	-0.412211569704345D 03	-0.379351164107829D 03
	[illegible]				

	-0.3818458... 03				
1	0.324197312568522D 03	0.378411254151668D 03	0.519031503807679D 03	-0.412143291941499D 03	-0.379378031272894D 03
	-0.381885385806754D 03				
2	0.324270348287572D 03	0.378439263905332D 03	0.518930516085949D 03	-0.412221191455840D 03	-0.379277762058817D 03
	-0.381907383200259D 03				
3	0.324191487772103D 03	0.378481545129230D 03	0.518967038873090D 03	-0.412212769889548D 03	-0.379317364273320D 03
	-0.381875461672438D 03				
4	0.324202845191419D 03	0.378448273200267D 03	0.518988903350699D 03	-0.412171045113065D 03	-0.379368530917821D 03
	-0.381867014024314D 03				

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.5518624714D 03	0.7855434376D 04	-0.3061717043D 02	0.1105124761D 04	
PHI(2)	-0.6164260827D 04	-0.3363285462D 04	0.8749369274D 03	-0.2462355969D 04	
PHI(3)	0.5604881571D 04	-0.4493890602D 04	-0.8416113875D 03	0.1344835873D 04	
PHI(4)	0.6827776285D 04	-0.9621751496D 03	-0.1200185204D 03	0.4052459128D 04	
PHI(5)	-0.2686716507D 04	0.7340204901D 04	0.3379983451D 04	-0.1736680999D 04	
PHI(6)	-0.4155968521D 04	-0.6356707871D 04	-0.3264555039D 04	-0.2319790277D 04	

PROJECTION MATRIX

-0.4238767040D-04	-0.1455879811D-03	0.1892121318D-03	-0.9707785882D-04	0.9872159246D-04
0.8026533279D-05				
0.7522118543D-04	-0.6466071613D-04	-0.1041779764D-04	-0.3607554519D-04	0.2570912645D-04
0.1266844038D-04				
-0.1530317550D-03	0.1450576970D-03	0.7898705414D-05	0.7171126035D-04	0.9734200925D-04
-0.1698970271D-03				
0.8471569934D-04	0.2339363084D-03	-0.3214411596D-03	0.3210074101D-03	-0.2228567504D-03
-0.9776666461D-04				

GAUSS ITERATION POINT

X 4 1=-0.6393713503D-01
X 4 2= 0.8686351384D 00
X 4 3= 0.3261216089D 00
X 4 4= 0.5510462718D 00
GRAD 3= 0.2321908288D 07
Y 4= 0.9559053662D 06

JACOBIAN MATRIX ROUTINE

NOMINAL AND PERTURNED FUNCTION VALUES

INCRE-MENTED VARI-ABLE	PHI(1) OR PHI(6)	PHI(2) OR PHI(7)	PHI(3) OR PHI(8)	PHI(4) OR PHI(9)	PHI(5) OR PHI(10)
0	0.396824211201535D 03	0.416728369705531D 03	0.407537590553921D 03	-0.388149629654122D 03	-0.391710601319796D 03
	-0.393178279629490D 03				
1	0.396830592279264D 03	0.416665657082052D 03	0.407593842506018D 03	-0.388081364492246D 03	-0.391737672860624D 03
	-0.393219642466864D 03				
2	0.396903195508627D 03	0.416695344400518D 03	0.407491592784753D 03	-0.388158922214368D 03	-0.391637707986308D 03
	-0.393241656938016D 03				
3	0.396823835752722D 03	0.416733763498707D 03	0.407532602762751D 03	-0.388152118010394D 03	-0.391675693807302D 03
	-0.393210746264544D 03				
4	0.396831811179154D 03	0.416705760128870D 03	0.407552473878536D 03	-0.388108676903900D 03	-0.391727743611900D 03
	-0.393202148137156D 03				

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.6381077728D 03	0.7898430709D 04	-0.3754498138D 02	0.7599977618D 03	
PHI(2)	-0.6271262348D 04	-0.3302530501D 04	0.5393793176D 03	-0.2260957666D 04	
PHI(3)	0.5625195210D 04	-0.4599776917D 04	-0.4987791171D 03	0.1488332461D 04	
PHI(4)	0.6826516188D 04	-0.9292560247D 03	-0.2486356272D 03	0.4095275022D 04	
PHI(5)	-0.2707154083D 04	0.7289343349D 04	0.3490751249D 04	-0.1714229210D 04	
PHI(6)	-0.4136283737D 04	-0.6337730853D 04	-0.3246663505D 04	-0.2386850767D 04	

PROJECTION MATRIX

PROJECTION MATRIX

-0.1691013801D-04	-0.1640189897D-03	0.1822079534D-03	-0.1047272520D-03	0.7300855572D-04
0.3147831446D-04				
0.8136869181D-04	-0.5428584147D-04	-0.2705217304D-04	-0.2353426503D-04	0.1342903303D-04
0.1043871604D-04				
-0.1645851893D-03	0.1178980217D-03	0.4681822823D-04	0.3637740475D-04	0.1249166325D-03
-0.1621911144D-03				
0.3660940376D-04	0.2679486614D-03	-0.3074520246D-03	0.3340896393D-03	-0.1925608519D-03
-0.1413184085D-03				

GAUSS ITERATION POINT

X 5 1=-0.6280703625D-01
X 5 2= 0.8702230539D 00
X 5 3= 0.3225023806D 00
X 5 4= 0.5488405365D 00
GRAD 4= 0.2491562586D 06
Y 5= 0.9556665884D 06

JACOBIAN MATRIX ROUTINE

NOMINAL AND PERTURNED FUNCTION VALUES

INCRE-MENTED VARI-ABLE	PHI(1) OR PHI(6)	PHI(2) OR PHI(7)	PHI(3) OR PHI(8)	PHI(4) OR PHI(9)	PHI(5) OR PHI(10)
0	0.408530670577018D 03	0.407385523349859D 03	0.405175757266134D 03	-0.390058699646451D 03	-0.392065543525286D 03
	-0.390867933049676D 03				
1	0.408537011569692D 03	0.407322729310585D 03	0.405232130277161D 03	-0.389990449631534D 03	-0.392092590659882D 03
	-0.390909304813472D 03				
2	0.408609645673935D 03	0.407352450899827D 03	0.405129816566659D 03	-0.390067996836060D 03	-0.391992786767870D 03
	-0.390931167628288D 03				
3	0.408530291587174D 03	0.407391060154922D 03	0.405170630126398D 03	-0.390061151050960D 03	-0.392030556387159D 03
	-0.390900515922642D 03				
4	0.408538396459507D 03	0.407363025418843D 03	0.405190401970609D 03	-0.390017676766835D 03	-0.392082741649575D 03
	-0.390891814946152D 03				

JACOBIAN MATRIX

	X1	X2	X3	X4	X5
PHI(1)	0.6340992674D 03	0.7897509692D 04	-0.3789698442D 02	0.7725882488D 03	
PHI(2)	-0.6279403927D 04	-0.3307245003D 04	0.5536805063D 03	-0.2249793102D 04	
PHI(3)	0.5637301103D 04	-0.4594059947D 04	-0.5127139735D 03	0.1464470448D 04	
PHI(4)	0.6825001492D 04	-0.9257189609D 03	-0.2451404509D 03	0.4102287962D 04	
PHI(5)	-0.2704713460D 04	0.7275675742D 04	0.3498713813D 04	-0.1719812429D 04	
PHI(6)	-0.4137176380D 04	-0.6323457861D 04	-0.3258287297D 04	-0.2388189648D 04	

PROJECTION MATRIX

-0.1749351824D-04	-0.1607419134D-03	0.1794770053D-03	-0.1016233748D-03	0.7189304557D-04
0.2949038460D-04				
0.8124806996D-04	-0.5446048881D-04	-0.2675521369D-04	-0.2379575591D-04	0.1366017665D-04
0.1046921350D-04				
-0.1634818346D-03	0.1178444561D-03	0.4575755698D-04	0.3688256345D-04	0.1240172547D-03
-0.1617912021D-03				
0.3770912134D-04	0.2618237088D-03	-0.3023546578D-03	0.3282509906D-03	-0.1904608046D-03
-0.1375803907D-03				

GAUSS ITERATION POINT

X 6 1=-0.6282165033D-01
X 6 2= 0.8702241321D 00
X 6 3= 0.3225079585D 00
X 6 4= 0.5488670654D 00
GRAD 5= 0.1495317261D 04
Y 6= 0.9556665831D 06

ADEQUATE CONVERGENCE OCCURRED ON PREVIOUS STEP

ITERATION HISTORY

ITER	X(1)	X(2)	X(3)	X(4)	X(5)	GRADYM	Y
0	-0.55057758D-01	0.81051774D 00	0.64029840D 00	0.64323584D 00	0.26928933D-77	0.16305811D 08	0.20893888D 07
1	-0.24614432D 00	0.85678780D 00	0.27314159D 00	0.90080026D 00	0.26251602D-77	0.12707705D 08	0.16250005D 07
2	-0.12449538D 00	0.83868456D 00	0.39925869D 00	0.66190845D 00	0.11304653D-67	0.52602046D 07	0.10768739D 07
3	-0.31288428D-01	0.86424735D 00	0.33389672D 00	0.48977848D 00	0.51537386D-84	0.23219083D 07	0.97730796D 06
4	-0.63937135D-01	0.85863514D 00	0.32612161D 00	0.35104627D 00	0.26545915D-77	0.24915626D 06	0.95590537D 06
5	-0.62507038D-01	0.87022305D 00	0.32250238D 00	0.54884054D 00	0.51656770D-78	0.14953173D 04	0.95566659D 06
6	-0.62821650D-01	0.87022413D 00	0.32250796D 00	0.54835707D 00	0.61210451D-87	0.0	0.95566658D 06

MINIMUM-MISS RELEASE CONTROLS FOR CONIC PROPAGATION

ROLL RELEASE ANGLE - -3.599 DEG
TANGENTIAL VELOCITY AT RELEASE - 0.0087022 KM/SEC
ECLIPTIC DECLINATION OF SPIN AXIS - 18.474 DEG
ECLIPTIC RIGHT ASCENSION OF SPIN AXIS - 31.448 DEG

CONIC MODEL PROBE IMPACT DATA

PROBE NUMBER	DECLINATION DEG	RIGHT ASCENSION DEG	DATE DAY	VELOCITY KM/SEC	FLIGHT PATH ANGLE DEG	ANGLE OF ATTACK DEG
0	-12.875	102.437	28260.78449	11.1412	-62.200	
1	-12.279	139.718	28260.78397	11.1410	-71.445	11.958
2	-34.649	70.944	28260.79087	11.1402	-54.030	23.977
3	31.622	73.562	28260.78746	11.1423	-27.537	15.933

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MINIPROBE 1 MINIMUM MISS APPROACH TRAJECTORY

	X - COMP.	Y - COMP.	Z - COMP.	RESULTANT
VIRTUAL MASS DATA				
VIRTUAL MASS POSITION	-0.15313225926D 08	-0.10759877463D 09	-0.60934451780D 06	0.10868469299D 09
VIRTUAL MASS VELOCITY	0.34432546003D 02	-0.50898931650D 01	-0.20562689832D 01	0.34867398510D 02
SPACECRAFT POS. REL. TO V.M.	-0.43350625959D 04	0.22021850014D 04	0.35766477459D 04	0.60365551455D 04
SPACECRAFT VEL. REL. TO V.M.	0.10590736561D 02	0.27970935891D 01	0.26702543149D 01	0.11274648179D 02
KEPLER (ANG. MOM.) VECTOR	-0.41253483985D 04	0.49453942205D 05	-0.35450191782D 05	0.60987105165D 05
ECCENTRICITY VECTOR	0.57116790577D-02	0.75807311079D 00	0.10568740683D 01	0.13006528521D 01
V.M. MAGN. = 0.32451820005D 06				
V.M. MAGN. RATE = -0.60005597950D 00				

****

V.M. RELATIVE POSITIONS				
POSITION REL. TO VENUS . . .	-0.15313225926D 08	-0.10759877463D 09	-0.60934451780D 06	0.10868469299D 09
POSITION REL. TO VENUS . . .	0.10730137387D 01	0.75399079286D 01	0.42699921381D-01	0.76159958862D 01
POSITION REL. TO EARTH . . .	0.68716973211D 08	0.18226759479D 08	-0.60934451780D 06	0.71095769699D 08

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NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-0.51907937686D 01
INCLINATION TO PLANE OF SKY	0.70069369061D 02
GEOCENTRIC DECLINATION.	0.54046898870D 01
TARGET PLANET ANGLE (ZAE)	0.12722945581D 03
ANTENNA AXIS - EARTH ANGLE.	-0.48821675581D 00
ANTENNA AXIS - LIMB OF SUN ANGLE. .	0.11259178906D 03
OCCULTATION RATIO FOR SUN IS	0.14337536750D 03
OCCULTATION RATIO FOR VENUS IS	0.79474513750D 00

SPACECRAFT PASSING IN FRONT OF VENUS

N-BODY MODEL PROBE IMPACT DATA

PROBE NUMBER	DECLINATION DEG	RIGHT ASCENSION DEG	DATE DAY	VELOCITY KM/SEC	FLIGHT PATH ANGLE DEG	ANGLE OF ATTACK DEG
0	-12.895	102.437	28260.78449	11.1412	-62.200	
1	-11.932	139.798	28260.78422	11.1408	-71.199	11.889
2	-34.451	70.785	28260.79070	11.1404	-53.892	23.984
3	30.922	74.054	28260.78731	11.1425	-28.052	15.761

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

     GUIDANCE EVENT AT    123.500 DAYS
     CALENDAR DATE   1977     5     3   16    28  33.331      JULIAN DATE    28252.26983

     EVENT CODES         KUR  5      KTYP  1      KMXQ  3      MDL  1

     CURRENT SPACECRAFT STATE
     REFERENCE        X-COMP           Y-COMP            Z-COMP            RADIUS         X-DOT         Y-DOT         Z-DOT        VELOCITY
INERTIAL         -42122298.19     -102534216.25       -1054234.53      110854250.79   35.14497381 -10.75621092   0.52103817  36.75781194
SUN              -42122298.19     -102534216.25       -1054234.53      110854250.79   35.14497381 -10.75621092   0.52103817  36.75781194
VENUS             -2129697.06       -1634871.15       -1961010.54        3324751.95    2.82821043   2.29877132   2.56577298   4.45716443
EARTH             58848144.14        9772545.72       -1054234.53       59663373.43   13.47877344   9.26827361   0.52103817  16.36611469
          N-BODY TARGETING EVENT


          STATE     -0.4212229819D 08   -0.1025342163D 09   -0.1054234532D 07
                     0.3514497381D 02   -0.1075621092D 02    0.5210381740D 00
          JULIAN DATE       0.2825226983D 05


          PARAMETER KEY DEFINITIONS
               1-TPS       4-TCA       7-RCA       10-XRF       13-DCP
               2-TSI       5-B.T       8-INC       11-YRF       14-RAP
               3-TCS       6-B.P       9-ASI       12-ZRF       15-TPR


          TARGETING SPECIFICATIONS
               KEY    TARGET VALUE        TOLERANCE
                13        20.000              1.000
                14        30.000              1.000
                15     28260.743              0.001


          TARGETING SCHEME
               LEVELS    0.100D-03  0.250D-04
               DVMAX    0.50000000D 00
               IBAST        3

     IND NUF PHS  KEYTAR          DTAR(1)         DTAR(2)         DTAR(3)    KAXTAR    ISTUP   DELT
       5  2   1   13 14  1          20.00           30.00        28260.74    5  6  1      2      9.320

ACCURACY       VX            VY            VZ              TAR -13-      TAR -14-      TAR - 1-      AUX - 5-      AUX - 6-       AUX - 1- INCR
0.10D-03   35.1449738 -10.7562109    0.5210382          -14.611         98.413      28260.784     -6722.441     -3546.397      28260.784  102

          DAUX=    -0.15119D 05    -0.24699D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=    58848144.     9772546.    -1054235.   13.47877    9.26827    0.52104
 IOPT=   1 CON=     0.1000000000D-04     0.0                          0.0
DV=      0.8235780878D-05     0.5663087294D-05     0.3183640002D-06
0.10D-03   35.1449820 -10.7562053    0.5210385          -14.633         98.410      28260.784     -6722.224     -3542.051      28260.784  102

          DAUX=    -0.15119D 05    -0.24699D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=    58848144.     9772546.    -1054235.   13.47877    9.26827    0.52104
 IOPT=   2 CON=     0.0                          0.1000000000D-05     0.0
DV=     -0.9264514937D-05     0.1337303738D-04     0.1783351926D-05
0.10D-03   35.1449645 -10.7561975    0.5210400          -14.583         98.344      28260.784     -6734.741     -3547.070      28260.784  102
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         DAUX=  -0.15119D 05  -0.24699D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.47877   9.26827   0.52104
 IOPT=  3 CON=    0.0                    0.0                     0.5000000000D-05
DV=    0.2920723492D-05   -0.8818507715D-05    0.8130157467D-04
0.10D-03  35.1449767 -10.7562197   0.5211195      -14.364       93.498      28260.784    -6715.836     -3596.570     28260.784  102

         DAUX=  -0.15119D 05  -0.24699D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.47877   9.26827   0.52104
 IOPT=  4 CON=    0.2049606662D-01    0.7967448711D-03    0.7271553471D-03
DV=    0.9906913664D-02    0.2098589212D-01    0.1391345306D-01

    SENSITIVITY MATRIX                  TARGETING MATRIX            AUX ERROR     VEL COR     DES AUX VAL     DES TAR VAL       TAR TOL
 0.22D 05 -0.12D 08  0.13D 07    -0.23D-06  0.59D-06 -0.44D 00    -0.84D 04     0.99D-02     -15118.509          20.000         1.000
 0.43D 06 -0.67D 06 -0.10D 08    -0.82D-07 -0.69D-08 -0.28D-02     0.11D 04     0.21D-01      -2469.944          30.000         1.000
-0.17D 01  0.56D 01 -0.14D 02    -0.44D-08 -0.74D-07 -0.19D-01    -0.41D-01     0.14D-01      28260.743       28260.743         0.001

ACCURACY      VX          VY           VZ          TAR -13-     TAR -14-     TAR - 1-     AUX - 5-      AUX - 6-      AUX - 1- INCR
0.10D-03  35.1548807 -10.7352250   0.5349516       20.462       29.507      28260.750   -15077.273     -2475.947     28260.750  102

         DAUX=  -0.15060D 05  -0.24364D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.48868   9.28926   0.53495
 IOPT=  1 CON=    0.1000000000D-04    0.0                     0.0
DV=    0.9231525438D-05    0.5668810730D-05    0.3264565407D-06
0.10D-03  35.1548890 -10.7352194   0.5349520       20.436       29.521      28260.750   -15077.037     -2471.633     28260.750  102

         DAUX=  -0.15060D 05  -0.24364D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58843144.    9772546.   -1054235.  13.48863   9.28926   0.53495
 IOPT=  2 CON=    0.0                    0.1000000000D-05    0.0
DV=   -0.9285970786D-05    0.1337964281D-04    0.1810225941D-05
0.10D-03  35.1548714 -10.7352116   0.5349534       20.654       29.195      28260.750   -15089.511     -2476.593     28260.750  102

         DAUX=  -0.15060D 05  -0.24364D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.48868   9.28926   0.53495
 IOPT=  3 CON=    0.0                    0.0                     0.5000000000D-05
DV=    0.2946809559D-05   -0.3966309508D-05    0.8138763378D-04
0.10D-03  35.1548837 -10.7352340   0.5350330       20.631       29.565      28260.750   -15070.613     -2525.961     28260.750  102

         DAUX=  -0.15060D 05  -0.24364D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.48868   9.28926   0.53495
 IOPT=  4 CON=    0.3225416183D-02    0.1941437680D-04    0.1338344033D-03
DV=    0.2553495826D-02    0.1348017080D-02    0.2320178344D-02

    SENSITIVITY MATRIX                  TARGETING MATRIX            AUX ERROR     VEL COR     DES AUX VAL     DES TAR VAL       TAR TOL
 0.24D 05 -0.12D 08  0.13D 07    -0.19D-05  0.43D-06 -0.44D 00     0.17D 02     0.26D-02     -15060.457          20.000         1.000
 0.43D 06 -0.65D 06 -0.10D 08    -0.93D-07 -0.80D-08 -0.29D-02     0.40D 02     0.18D-02      -2436.392          30.000         1.000
-0.19D 01  0.51D 02 -0.15D 02    -0.75D-07 -0.81D-07 -0.19D-01    -0.73D-02     0.23D-02      28260.743       28260.743         0.001

ACCURACY      VX          VY           VZ          TAR -13-     TAR -14-     TAR - 1-     AUX - 5-      AUX - 6-      AUX - 1- INCR
0.10D-03  35.1574342 -10.7333770   0.5372718       20.155       29.742      28260.743   -15060.433     -2436.807     28260.743  102

         DAUX=  -0.15050D 05  -0.24348D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

ACCURACY      VX          VY           VZ          TAR -13-     TAR -14-     TAR - 1-     AUX - 5-      AUX - 6-      AUX - 1- INCR
0.25D-04  35.1574342 -10.7333770   0.5372718       17.823       34.907      28260.743   -14807.469     -2649.700     28260.743  184

         DAUX=  -0.15054D 05  -0.24365D 04   0.28261D 05     DTAR=   0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.    9772546.   -1054235.  13.49123   9.29111   0.53727
 IOPT=  4 CON=    0.4695676793D-03    0.2076266411D-04   -0.2376096271D-05
DV=    0.1922704371D-03    0.5483068461D-03    0.1439755228D-04
```

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     SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
 0.24D 05 -0.12D 08  0.13D 07     -0.19D-05  0.43D-06 -0.44D 00      -0.25D 03     0.19D-03    -15053.652        20.000        1.000
 0.43D 06 -0.65D 06 -0.10D 05     -0.93D-07 -0.80D-08 -0.29D-02       0.21D 03     0.55D-03     -2436.790        30.000        1.000
-0.19D 01  0.51D 02 -0.15D 02     -0.75D-07 -0.81D-07 -0.19D-01       0.19D-03     0.14D-04     28260.743     28260.743        0.001

ACCURACY     VX          VY            VZ          TAR -13-      TAR -14-     TAR - 1-     AUX - 5-      AUX - 6-     AUX - 1-  INCR
0.25D-04  35.1576265 -10.7328287   0.5372462       20.015        29.978     28260.743   -15053.580    -2437.108    28260.743   184

          DAUX=   -0.15053D 05   -0.24363D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

   IND NOF PHS  KEYTAR         DTAR(1)       DTAR(2)        DTAR(3)    KAXTAR   ISTOP   DELT
    5  2  2  13 14 15           20.00         30.00       28260.74    5  6 15     2      9.320

ACCURACY     VX          VY            VZ          TAR -13-      TAR -14-     TAR -15-     AUX - 5-      AUX - 6-     AUX -15-  INCR
0.10D-03  35.1574342 -10.7333770   0.5372718       17.214        36.655     28250.742   -14691.353    -2770.076    28260.742   353

          DAUX=   -0.15041D 05   -0.24403D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.     9772546.    -1054235.   13.49123    9.29111    0.53727
 IOPT=  1 CON=     0.1000000000D-05     0.0                       0.0
DV=     0.4231467501D-06     0.5563822652D-05     0.3278079163D-07
0.10D-03  35.1574350 -10.7333764   0.5372718       17.212        36.655     28260.742   -14691.330    -2769.645    28260.742   353

          DAUX=   -0.15041D 05   -0.24403D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.     9772546.    -1054235.   13.49123    9.29111    0.53727
 IOPT=  2 CON=     0.0                    0.1000000000D-05     0.0
DV=    -0.9287895568D-05     0.1333158630D-04     0.1815185541D-05
0.10D-03  35.1574249 -10.7333636   0.5372735       17.356        36.439     28250.742   -14703.578    -2770.732    28260.742   355

          DAUX=   -0.15041D 05   -0.24403D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.     9772546.    -1054235.   13.49123    9.29111    0.53727
 IOPT=  3 CON=     0.0                    0.0                       0.5000000000D-05
DV=     0.2951518801D-05    -0.3795255421D-05     0.8140072581D-04
0.10D-03  35.1574372 -10.7333860   0.5373532       17.396        36.718     28260.742   -14684.606    -2820.017    28260.742   354

          DAUX=   -0.15041D 05   -0.24403D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

ACCURACY     VX          VY            VZ          TAR -13-      TAR -14-     TAR -15-     AUX - 5-      AUX - 6-     AUX -15-  INCR
0.25D-04  35.1576265 -10.7328287   0.5372962       16.930        37.177     28260.742   -14663.685    -2784.735    28260.742   667

          DAUX=   -0.15045D 05   -0.24424D 04    0.28261D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

STATE=   58848144.     9772546.    -1054235.   13.49143    9.29166    0.53729
 IOPT=  4 CON=     0.1552523244D-03     0.2343619075D-04    -0.2815098631D-04
DV=    -0.1222727757D-03     0.5361761241D-03    -0.4006321214D-03

     SENSITIVITY MATRIX                  TARGETING MATRIX              AUX ERROR     VEL COR     DES AUX VAL    DES TAR VAL     TAR TOL
 0.23D 05 -0.12D 08  0.13D 07     -0.14D-05  0.47D-06 -0.44D 00      -0.38D 03    -0.13D-03    -15045.111        20.000        1.000
 0.43D 06 -0.66D 06 -0.10D 08     -0.90D-07 -0.79D-08 -0.29D-02       0.34D 03     0.54D-03     -2442.418        30.000        1.000
-0.19D 01  0.38D 02 -0.15D 02     -0.55D-07 -0.79D-07 -0.19D-01       0.12D-02    -0.40D-03     28260.743     28260.743        0.001

ACCURACY     VX          VY            VZ          TAR -13-      TAR -14-     TAR -15-     AUX - 5-      AUX - 6-     AUX -15-  INCR
0.25D-04  35.1574982 -10.7322925   0.5368856       19.999        30.004     28260.743   -15045.194    -2442.473    28260.743   685

          DAUX=   -0.15045D 05   -0.24421D 04    0.28251D 05     DTAR=    0.20000D 02    0.30000D 02    0.28261D 05

   EXECUTION EVENT

   DELTA V =      0.01252441      0.02391839      0.01564740      0.03130639

   DOMINANT BODY ELEMENTS       SMA            ECC            OMEGA          INC           NODE           TA
   PLANET ECLIPTIC
   [illegible]
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Case MP-2. ERRAN Multiprobe Sample Case

ERROR ANALYSIS MODE- MINI PROBE EVENT AT TRAJECTORY TIME 20.000 DAYS
PROBLEM. . 88

STATE VECTOR AT TIME 20.000 DAYS

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X-0.5552560846519D 08
Y-0.9777457375327D 03
Z-0.9454968415265D 06
VX 0.3333252560197D 02
VY-0.1428036274302D 02
VZ 0.2733456257884D 00
```

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-0.6403926040 10D 01
ANGLE BETWEEN RELATIVE VELOCITY AND PLANE OF THE SKY.	0.6753312398 5D 02
GEOCENTRIC DECLINATION.	0.1751459798 3D 01
EARTH/SPACECRAFT/TARG PLANET ANGLE	0.1336240672 6D 03
ANTENNA AXIS - EARTH ANGLE.	-0.1006974764 1D 01
ANTENNA AXIS - LIMB OF SUN ANGLE. .	0.1259754754 2D 02
OCCULTATION RATIO FOR SUN IS	0.1298083505 4D 03
OCCULTATION RATIO FOR VENUS IS	0.5987740254 2D 03

STATE TRANSITION MATRIX PARTITIONS OVER(19.988, 20.000) --TRANSPOSES SHOWN

	X(20.000)	Y(20.000)	Z(20.000)	VX(20.000)	VY(20.000)	VZ(20.000)
X(19.988)	0.9999999866D 00	0.6453987043D-07	0.6279115949D-09	-0.2594070423D-10	0.1246852230D-09	0.1211100767D-11
Y(19.988)	0.6453987943D-07	0.1000000064D 01	0.1105113768D-08	0.1246852230D-09	0.1226961210D-09	0.2131792185D-11
Z(19.988)	0.6279117322D-09	0.1105113699D-08	0.9999999498D 00	0.1211100767D-11	0.2131792185D-11	-0.9675540702D-10
VX(19.988)	0.1036799995D 04	0.2227311126D-04	0.2169962700D-06	0.9999999865D 00	0.6463376940D-07	0.6277579411D-09
VY(19.988)	0.2241463500D-04	0.1036800022D 04	0.3824645591D-06	0.6463376074D-07	0.1000000064D 01	0.1105128514D-08
VZ(19.988)	0.2175659366D-06	0.3810575375D-06	0.1036799983D 04	0.6277579056D-09	0.1105128600D-08	0.9999999498D 00

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

IGNORE PARAMETERS

--NONE

DIAGONAL OF DYNAMIC NOISE MATRIX

0.0 0.0 0.0 0.0 0.0 0.0

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT EVENT TIME 20.000 DAYS
PROPAGATED FORWARD FROM TIME 19.988 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	0.28121000D 02	1.00000000					
Y	0.81575095D 01	-0.95263943	1.00000000				
Z	0.66232336D 02	-0.23935204	-0.22817476	1.00000000			
VX	0.10661273D-04	0.07195652	-0.47345120	0.68737575	1.00000000		
VY	0.34261378D-04	0.21904708	0.20872130	-0.74201216	-0.95450206	1.00000000	
VZ	0.38310449D-03	0.05400557	-0.46585009	0.71475231	0.99855464	-0.95526463	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	0.02990948	0.00136874	-0.04841615	-0.09946192	0.10948997	-0.09792381
LAT 1	-0.02990948	-0.00136874	0.04841615	0.09946193	-0.10948997	0.09792382
LONG 1	-0.03515895	0.04779950	-0.14996280	0.26094840	-0.27386526	0.24033135
RADIUS 2	0.01184649	-0.05714122	0.09795704	0.03734599	0.00173056	0.05503754
LAT 2	-0.01184649	0.05714122	-0.09795704	-0.03734599	-0.00173056	-0.05503754
LONG 2	-0.04255415	0.38828769	-0.67113884	-0.46829006	0.44429927	-0.48187171
RADIUS 3	0.03203697	-0.22430626	0.32870609	0.36993365	-0.33009738	0.37917599
LAT 3	0.03203697	-0.22430629	0.32870614	0.36993370	-0.33009743	0.37917604
LONG 3	-0.01282504	0.07193221	-0.20107957	0.22879949	-0.23046802	0.21129907

NO SOLVE-FOR PARAMETERS

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	0.77466506682590 03	1	0.27832805590 02
2	0.16429218868340 01	2	0.12817651450 01
3	0.44677498967120 04	3	0.66841229020 02

POSITION EIGENVECTORS

1	0.9493505896270D 00	-0.2651894194053D 00	0.1319107767930D 00
2	0.2793445743778D 00	0.9582340527025D 00	0.6127078428625D-01
3	-0.1438751776386D 00	-0.2131889538997D-01	0.9893661799146D 00

FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE 3 SIGMA LEVEL
THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION

0.487D-01 X**2 + 0.559D 00 Y**2 + 0.253D-02 Z**2 + 0.325D 00 XY + 0.211D-01 XZ + 0.714D-01 YZ = 9

XY HYPERELLIPSOID. . . . . . 0.487D-01 X**2 + 0.325D 00 XY + 0.559D 00 Y**2 = 9
XZ HYPERELLIPSOID. . . . . . 0.487D-01 X**2 + 0.211D-01 XZ + 0.253D-02 Z**2 = 9
YZ HYPERELLIPSOID. . . . . . 0.559D 00 Y**2 + 0.714D-01 YZ + 0.253D-02 Z**2 = 9

VELOCITY EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	0.3276191555114D-12	1	0.5723802543D-06
2	0.1019309098499D-09	2	0.1009608389D-04
3	0.1479543091803D-06	3	0.3846482928D-03

VELOCITY EIGENVECTORS

1	0.9996166624382D 00	0.2197786519606D-02	-0.2759162850522D-01

```
 2      [illegible]              [illegible]              [illegible]
 3      0.2757855691717D-01      -0.8514621060478D-01      0.9959839456077D 00

             FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE.3 SIGMA LEVEL
                   THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
0.305D 13 X**2 +  0.975D 10 Y**2 +  0.240D 10 Z**2 +  0.134D 11 XY + -0.168D 12 XZ +  0.129D 10 YZ =   9
       XY HYPERELLIPSOID. . . . . .  0.305D 13 X**2 +  0.134D 11 XY +  0.975D 10 Y**2 =   9
       XZ HYPERELLIPSOID. . . . . .  0.305D 13 X**2 + -0.168D 12 XZ +  0.240D 10 Z**2 =   9
       YZ HYPERELLIPSOID. . . . . .  0.975D 10 Y**2 +  0.129D 10 YZ +  0.240D 10 Z**2 =   9
```

PROBLEM 88

TARGETED NOMINAL TRAJECTORY ENCOUNTERED SPHERE OF INFLUENCE AT TRAJECTORY TIME 32.77735 DAYS

	X	Y	Z	RESULTANT
POSITION RELATIVE TO TARGET PLANET	-0.4571314251D 04	-0.3271904069D 04	-0.2614905311D 04	0.6200000000D 04
VELOCITY RELATIVE TO TARGET PLANET	0.7511614278D 01	0.5945402583D 01	0.5688712165D 01	0.1114152624D 02

B = 0.1711249847D 04   B DOT T = -0.7065916322D 03   B DOT R = -0.1558558406D 04

-0.4571314251D 04   -0.3271904069D 04   -0.2614905311D 04   0.7511614278D 01   0.5945402583D 01   0.5688712165D 01

0.2826C50119D C5

UCNTRL= 0.1601057023D 01   0.5908384306D 00   0.3912024515D 00   0.6592120675D 00

KKWIT= 0

-0.5552561bD 08	-0.9777458 7D 08	-0.94949696D 06	0.33332527D 02	-0.14280361D 02	0.27334619D 00
-0.55525616D 08	-0.97774587D 08	-0.94949696D 06	0.33334198D 02	-0.14278840D 02	0.26788667D 00

EXECUTION ERROR COVARIANCE MATRIX

0.1556649068D-07	-0.3979359281D-09	-0.2241875133D-08
-0.3979359281D-09	0.1564320064D-07	-0.2040113746D-08
-0.2241875133D-08	-0.2040113746D-08	0.2127685147D-07

PROBLEM 88

TARGETED NOMINAL TRAJECTORY ENCOUNTERED SPHERE OF INFLUENCE AT TRAJECTORY TIME 32.78123 DAYS

	X	Y	Z	RESULTANT
POSITION RELATIVE TO TARGET PLANET	-0.2745748636D 04	-0.1637574717D 04	-0.5312175964D 04	0.6200000000D 04
VELOCITY RELATIVE TO TARGET PLANET	0.6642699166D 01	0.5147885384D 01	0.7314317814D 01	0.1114115888D 02

B = 0.4971608179D 04 B DOT T = -0.8842291815D 03 B DOT R = 0.4892343675D 04

PROBE RELEASE EVENT

-0.2745748636D 04	-0.1637574717D 04	-0.5312175954D 04	0.6642699166D 01	0.5147885384D 01	0.7314317814D 01
0.2826050507D 05	0.3278123250D 02	0.4120000000D-02			

STATE TRANSITION MATRIX PARTITIONS OVER(20.000, 32.781) --TRANSPOSES SHOWN

	X(32.781)	Y(32.781)	Z(32.781)	VX(32.781)	VY(32.781)	VZ(32.781)
X(20.000)	0.1221482323D 01	0.5426950980D 00	0.7926932934D 00	0.2948404597D-03	0.3720136422D-03	0.1052832863D-02
Y(20.000)	0.6393701613D 00	0.1081821791D 01	0.7136679531D 00	0.5097218146D-03	-0.1368741432D-04	0.9173152384D-03
Z(20.000)	0.6447052662D 00	0.4864597974D 00	0.1314354474D 01	0.6817301850D-03	0.4409112293D-03	0.8614286693D-03
VX(20.000)	0.1341945003D 07	0.5537923812D 06	0.8494632962D 06	0.3034244253D 03	0.4173144219D 03	0.1135267350D 04
VY(20.000)	0.6050713070D 06	0.1105460753D 07	0.7016291611D 06	0.5160433758D 03	-0.3449095230D 02	0.9041636113D 03
VZ(20.000)	0.7306833251D 06	0.5507138835D 06	0.1504164162D 07	0.7795373384D 03	0.5047527684D 03	0.9810874805D 03

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

IGNORE PARAMETERS

--NONE

DIAGONAL OF DYNAMIC NOISE MATRIX

0.0	0.0	0.0	0.0	0.0	0.0

CONTROL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT ENTRY TIME 32.781 DAYS
PROPAGATED FORWARD FROM TIME 20.000 DAYS

	STD DEV	X	Y	Z	VX	VY	VZ
X	0.3633665570D 03	1.00000000					
Y	0.2581157300D 03	0.92383489	1.00000000				
Z	0.6690196880D 03	0.94306506	0.89949472	1.00000000			
VX	0.3409135600D 00	0.92938566	0.91528292	0.99705434	1.00000000		
VY	0.2370637100D 00	0.93965721	0.83391985	0.93667849	0.97175160	1.00000000	
VZ	0.4506288800D 00	0.98613421	0.95230178	0.97885849	0.97511635	0.95866380	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-0.07595023	-0.07047941	-0.08704927	-0.08672604	-0.08693396	-0.08096300
LAT 1	0.07595024	0.07047942	0.08704927	0.08672605	0.08693396	0.08096301

LONG 1	0.15953538	0.14306419	0.18043009	0.17869655	0.18225412	0.16813432
RADIUS 2	0.05577962	0.05706960	0.06061731	0.06122813	0.05820295	0.05925948
LAT 2	-0.05577962	-0.05706960	-0.06061732	-0.06122813	-0.05820295	-0.05925948
LONG 2	-0.44163523	-0.41241646	-0.49080366	-0.48876914	-0.48880784	-0.46528137
RADIUS 3	0.32627705	0.30521578	0.36163257	0.36017005	0.35989366	0.34350409
LAT 3	0.32627710	0.30521582	0.36163262	0.36017010	0.35989371	0.34350414
LONG 3	0.13483042	0.12073093	0.15085044	0.14927400	0.15243017	0.14143509

NO SOLVE-FOR PARAMETERS

TIME= 28260.50507369 1977 5 17 0******************

STATE AT PROBE SPHERE
-0.27456407D 04
-0.16368563D 04
-0.53121722D 04
0.66228342D 01
0.51509710D 01
0.73155062D 01

STATE AT PROBE SPHERE IN SUB-SOLAR COORDINATES
0.29798107D 04
0.32598870D 02
-0.54366056D 04
-0.80840739D 01
-0.82465318D 00
0.76078093D 01

COMMUNICATION ANGLE= 60.7548380836 DEGREES

A MATRIX=

0.4806332834D 00	0.5258086338D-02	-0.8769059239D 00
0.0	0.0	0.0
-0.1379321457D-03	-0.3526772897D-04	-0.7581226106D-04
0.2672028745D-07	0.2923176219D-09	0.3446201591D-03

H= 0.1499959281D 03

V= 0.1113153474D 02

GAMMA= -0.7157877763D 02

PHI-S= -0.1180873530D 03

OMEGS= -0.1687436936D 03

I-S= 0.5577341826D 02

P (LTR) COVARIANCE MATRIX

0.1804359202D 06	-0.1182994264D 02	0.6562934477D 02	-0.9700942999D 02
-0.1182994264D 02	0.5830975593D-02	-0.7565007940D-02	0.8596823137D-02
0.6562934477D 02	-0.7565007940D-02	0.2597634951D-01	-0.3672636535D-01
-0.9700942999D 02	0.8596823137D-02	-0.3672636535D-01	0.5316109199D-01

MEASUREMENT NO 10 AT TRAJECTORY TIME 21.017 PROBLEM. . 88

RANGE-RATE WAS MEASURED FROM STATION 1 AT TRAJECTORY TIME 21.01670 DAYS

INITIAL TRAJECTORY TIME 20.988
FINAL TRAJECTORY TIME 21.017

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	-52661454.83	-98959957.70	-926281.56	112103345.41	33.767976596	-13.490695561	0.276033027	36.364148613
GEO-	54791701.20	6989978.66	-926281.56	55233618.28	13.338027107	7.828391671	0.276033027	15.468124563
PLANETO-	-2946452.73	-2562113.73	-2456161.27	4612888.32	2.884864786	2.717240297	2.281825487	4.573026047
FINAL								
INERTIAL	-52577705.78	-98993361.62	-925596.79	112093538.97	33.780293615	-13.467551381	0.276269559	36.367011175
GEO-	54814775.62	7009409.02	-925596.79	55268871.62	13.340055089	7.841384898	0.276269559	15.476456693
PLANETO-	-2939301.64	-2555377.03	-2450502.25	4601565.73	2.884373146	2.715524055	2.282455838	4.572010935

ELEVATION AND AZIMUTH RELATIVE TO TRACKING STATION 1

ELEVATION ANGLE= -52.234 DEGREES

AZIMUTH ANGLE= 9.289 DEGREES

****

NAVIGATION PARAMETERS
FLIGHT PATH ANGLE . . . . -0.624082410860 01
ANGLE BETWEEN RELATIVE VELOCITY
AND PLANE OF THE SKY. 0.667562538710 02
GEOCENTRIC DECLINATION. 0.201084737590 01
EARTH/SPACECRAFT/TARG PLANET ANGLE 0.134029078550 03
ANTENNA AXIS - EARTH ANGLE. . . . . -0.959586605890 00
ANTENNA AXIS - LIMB OF SUN ANGLE. . 0.124902776690 03
OCCULTATION RATIO FOR SUN IS 0.131155964460 03
OCCULTATION RATIO FOR VENUS IS 0.546875385670 03

STATE TRANSITION MATRIX PARTITIONS OVER(20.988, 21.017) --TRANSPOSES SHOWN

	X(21.017)	Y(21.017)	Z(21.017)	VX(21.017)	VY(21.017)	VZ(21.017)
X(20.988)	0.9999999019D 00	0.3601978421D-06	0.3370301638D-08	-0.7919236578D-10	0.2904801086D-09	0.2717478211D-11
Y(20.988)	0.3601978510D-06	0.1000000388D 01	0.6337450132D-08	0.2904801085D-09	0.3127668169D-09	0.5111536969D-11
Z(20.988)	0.3370301675D-08	0.6337450047D-08	0.9999997104D 00	0.2717478210D-11	0.5111536970D-11	-0.2335743157D-09
VX(20.988)	0.2479679919D 04	0.2976300017D-03	0.2784832532D-05	0.9999999017D 00	0.3600998385D-06	0.3368174712D-08
VY(20.988)	0.2977516343D-03	0.2479680320D 04	0.5238765421D-05	0.3600998335D-06	0.1000000388D 01	0.6337525426D-08
VZ(20.988)	0.2785335095D-05	0.5237570372D-05	0.2479679761D 04	0.3368174692D-08	0.6337525477D-08	0.9999997104D 00

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

```
            --NONE

DIAGONAL OF DYNAMIC NOISE MATRIX
            0.0          0.0          0.0          0.0          0.0          0.0


OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN
                                  RANGE-RATE(1)
             X                 -0.1455022164D-07
             Y                  0.1154665847D-06
             Z                  0.5650770711D-08
            VX                  0.9917851658D 00
            VY                  0.1268047078D 00
            VZ                 -0.1681519960D-01

     SOLVE-FOR PARAMETERS

            --NONE

     DYNAMIC CONSIDER PARAMETERS

            --NONE

     MEASUREMENT CONSIDER PARAMETERS
     RADIUS 1                  -0.5900412079D-05
     LAT   1                    0.2632307169D-01
     LONG 1                    -0.3765766586D 00
     RADIUS 2                   0.0
     LAT   2                    0.0
     LONG 2                     0.0
     RADIUS 3                   0.0
     LAT   3                    0.0
     LONG 3                     0.0

     IGNORE PARAMETERS

            --NONE


MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS
    0.1146734494D-04              0.1000000000D 01


MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS
    0.1185664809D-04              0.1000000000D 01


GAIN MATRIX PARTITIONS
            K-MATRIX
                                 -0.1004721019D 05
                                  0.1098307738D 06
                                 -0.1734163558D 06
                                 -0.1100953646D 00
                                  0.1164295981D 01
                                 -0.8403002245D 00
```

[illegible]

NOT DEFINED

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 21.017 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	0.28233030D 02	1.00000000					
Y	0.14050372D 02	-0.49828259	1.00000000				
Z	0.94104231D 02	-0.15361561	-0.38692692	1.00000000			
VX	0.19263375D-04	0.09236836	-0.87187459	0.49892373	1.00000000		
VY	0.12500895D-03	0.00583613	0.81453069	-0.25261913	-0.92411803	1.00000000	
VZ	0.40863379D-03	0.08652042	-0.47319499	0.85185467	0.59492044	-0.28170907	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	0.02651368	0.02333785	-0.06906796	-0.05456300	0.02887815	-0.09169253
LAT 1	-0.02651368	-0.02333785	0.06906796	0.05456300	-0.02887815	0.09169253
LONG 1	-0.02619812	-0.03216064	-0.01968586	0.14741862	-0.07675842	0.22530500
RADIUS 2	0.01285566	-0.03158729	0.08854154	0.01763847	0.00200385	0.05139194
LAT 2	-0.01285566	0.03158729	-0.08854155	-0.01763847	-0.00200385	-0.05139195
LONG 2	-0.05820949	0.32327132	-0.64418390	-0.26336040	0.12540017	-0.45032737
RADIUS 3	0.04424729	-0.20139288	0.36668499	0.20537551	-0.09115745	0.35472662
LAT 3	0.04424730	-0.20139291	0.36668504	0.20537554	-0.09115746	0.35472667
LONG 3	-0.00503811	-0.00882824	-0.05615514	0.12928824	-0.06483490	0.19804027

NO SOLVE-FOR PARAMETERS

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 21.017 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	0.28232778D 02	1.00000000					
Y	0.13989895D 02	-0.50004831	1.00000000				
Z	0.94081765D 02	-0.15374587	-0.38665804	1.00000000			
VX	0.19219096D-04	0.09229541	-0.87133880	0.49870823	1.00000000		
VY	0.12424439D-03	0.00634091	0.81274356	-0.25180609	-0.92440041	1.00000000	
VZ	0.40851231D-03	0.08644402	-0.47311169	0.85177844	0.59481190	-0.28081707	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	0.02652041	0.02329549	-0.06905082	-0.05458418	0.02888487	-0.09168226
LAT 1	-0.02652041	-0.02329550	0.06905082	0.05458419	-0.02888487	0.09168226
LONG 1	-0.02627640	-0.03057773	-0.02009485	0.14650181	-0.07517536	0.22492083
RADIUS 2	0.01286092	-0.03183748	0.08858937	0.01776203	0.00188054	0.05143700
LAT 2	-0.01286092	0.03183748	-0.08858937	-0.01776203	-0.00188054	-0.05143700
LONG 2	-0.05814027	0.32313042	-0.64397653	-0.26284465	0.12433556	-0.45005821
RADIUS 3	0.04422127	-0.20168072	0.36663572	0.20542345	-0.09102278	0.35467942
LAT 3	0.04422128	-0.20168075	0.36663577	0.20542348	-0.09102279	0.35467946
LONG 3	-0.00502822	-0.00908540	-0.06611951	0.12974591	-0.06549528	0.19815654

NO SOLVE-FOR PARAMETERS

MEASUREMENT NO 220 AT TRAJECTORY TIME 24.176 PROBLEM. . 1

RANGE-RATE WAS MEASURED FROM STATION 3 AT TRAJECTORY TIME 24.17600 DAYS

INITIAL TRAJECTORY TIME 24.175
FINAL TRAJECTORY TIME 24.176

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	-38958171.62	-103380455.01	-923582.48	110481268.18	35.515372603	-9.873343707	.508811515	36.865749637
GEO-	60091138.22	10671212.83	-923582.48	61038288.64	13.510272102	9.767615516	.508811515	16.679108319
PLANETO-	-1824401.01	-1373236.22	-1650130.39	2817294.28	2.846551856	2.255438411	2.561001874	4.443938624
FINAL								
INERTIAL	-38955103.08	-103381308.03	-923538.52	110480984.01	35.515706129	-9.872462948	.508821439	36.865835210
GEO-	60092305.43	10672056.84	-923538.52	61039584.64	13.510276121	9.768116854	.508821439	16.679405475
PLANETO-	-1824155.14	-1373041.32	-1649909.11	2816910.46	2.846552565	2.255404879	2.561018310	4.443931532

ELEVATION AND AZIMUTH RELATIVE TO TRACKING STATION 3

ELEVATION ANGLE= 15.111 DEGREES

AZIMUTH ANGLE= 74.815 DEGREES

****

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-5.11829885182E+00
ANGLE BETWEEN RELATIVE VELOCITY AND PLANE OF THE SKY.	6.40737633388E+01
GEOCENTRIC DECLINATION.	3.19151028433E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE	1.35551680106E+02
ANTENNA AXIS - EARTH ANGLE.	-8.66927234348E-01
ANTENNA AXIS - LIMB OF SUN ANGLE. .	1.20354143230E+02
OCCULTATION RATIO FOR SUN IS	1.36094015805E+02
OCCULTATION RATIO FOR VENUS IS	3.26059959803E+02

STATE TRANSITION MATRIX PARTITIONS OVER(24.175, 24.176) --TRANSPOSES SHOWN

	X(24.176)	Y(24.176)	Z(24.176)	VX(24.176)	VY(24.176)	VZ(24.176)
X(24.175)	9.9999999977E-01	3.6354700283E-10	3.2512881276E-12	-5.3313183684E-12	8.4165352329E-12	7.5189719217E-14
Y(24.175)	3.6363226774E-10	1.0000000006E+00	8.6207152528E-12	8.4165351567E-12	1.3832426287E-11	1.9953414737E-13
Z(24.175)	3.2516211945E-12	8.6194384963E-12	9.9999999963E-01	7.5189718973E-14	1.9953414853E-13	-8.5011078253E-12
VX(24.175)	8.6399999750E+01	-4.2499003428E-07	-2.9872708751E-09	9.9999999977E-01	3.6349371169E-10	3.2469027467E-12
VY(24.175)	5.0622010409E-07	8.6399999681E+01	7.1391035306E-09	3.6364647816E-10	1.0000000006E+00	8.6214924089E-12
VZ(24.175)	-7.6170181273E-12	-7.0302377253E-09	8.6399999857E+01	3.2474578582E-12	8.6191886961E-12	9.9999999963E-01

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

IGNORE PARAMETERS

--NONE

DIAGONAL OF DYNAMIC NOISE MATRIX

0.	0.	0.	0.	0.	0.

OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN

	RANGE-RATE(3)
X	-2.0257502890E-08
Y	1.1514321030E-07
Z	1.3222517621E-08
VX	9.8446423343E-01
VY	1.7493436523E-01
VZ	-1.5104336122E-02

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	0.
LAT 1	0.
LONG 1	0.
RADIUS 2	0.
LAT 2	0.
LONG 2	0.
RADIUS 3	-5.5328831784E-05
LAT 3	-2.5039047378E-01
LONG 3	1.3603722578E-01

IGNORE PARAMETERS

--NONE

MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

7.4899933244E-08	1.0000000000E+00

MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

1.4443774317E-07	1.0000000000E+00

GAIN MATRIX PARTITIONS

K-MATRIX

2.0083791577E+07
-1.3005072467E+06
-1.0566656621E+07

```
-2.9336976997E-01
 6.6472917229E+00
 6.5863356101E+00
```

S-MATRIX

NOT DEFINED

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 24.176 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.46146976E+01	1.00000000					
Y	3.62196806E+00	-.42312252	1.00000000				
Z	4.76776056E+01	-.27374452	-.65250750	1.00000000			
VX	3.61491599E-07	-.05026704	.06111130	-.47502032	1.00000000		
VY	4.60467740E-06	.98183298	-.55620398	-.09059102	-.15872713	1.00000000	
VZ	1.71158726E-05	.47217954	-.99070816	.55712483	.05736418	.58760305	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 1	-.01611785	-.08773217	.10048892	-.01368931	.00269910	.08451658
LAT 1	.01611785	.08773218	-.10048893	.01368931	-.00269910	-.08451658
LONG 1	-.01463801	.42895595	-.54314945	.34705615	-.12435435	-.37814808
RADIUS 2	-.08798337	-.07089869	.13484899	-.02366019	-.06765887	.05838135
LAT 2	.08798337	.07089869	-.13484899	.02366019	.06765887	-.05838135
LONG 2	.07538852	.31394190	-.50652723	.36115425	-.02359048	-.25727783
RADIUS 3	-.08528006	-.07181736	.13702548	-.03053287	-.06411690	.05881325
LAT 3	-.08528007	-.07181737	.13702550	-.03053287	-.06411690	.05881326
LONG 3	.18054800	.31115914	-.56063832	.32985039	.07935567	-.24815920

NO SOLVE-FOR PARAMETERS

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 24.176 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.43239104E+01	1.00000000					
Y	3.61709385E+00	-.42177685	1.00000000				
Z	4.76531711E+01	-.27295875	-.65538508	1.00000000			
VX	3.58999510E-07	-.02773973	.05548879	-.48234338	1.00000000		
VY	4.50346799E-06	.98110225	-.55839864	-.08584625	-.13825686	1.00000000	
VZ	1.70894147E-05	.47123745	-.99068819	.56005638	.06442234	.58987087	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.02624093	-.08533844	.10208964	-.00807507	-.00755257	.08195480
LAT 1	.02624093	.08533844	-.10208964	.00807507	.00755257	-.08195481
LONG 1	.03846289	.41584112	-.55187271	.31834366	-.07093576	-.36405583
RADIUS 2	-.09464608	-.06974373	.13568935	-.02098225	-.07431309	.05713130
LAT 2	.09464608	.06974373	-.13568935	.02098225	.07431309	-.05713130
LONG 2	.12554349	.30189617	-.51447679	.33532176	.02706744	-.24431056
RADIUS 3	.05012036	-.10707882	.11540874	-.11066845	.07880365	.09659814
LAT 3	.05012037	-.10707883	.11540876	-.11066846	.07880366	.09659816
LONG 3	.11864786	.32839138	-.55055680	.37035322	.01211697	-.26656558

NO SOLVE-FOR PARAMETERS

****

ACTUAL ESTIMATION ERROR STATISTICS

DIAGONAL OF ACTUAL DYNAMIC NOISE COVARIANCE MATRIX

0. 0. 0. 0. 0. 0.

ACTUAL MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

7.48999332E-08 1.00000000

ACTUAL MEASUREMENT RESIDUAL MEAN

0.

ACTUAL MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

3.69582298E-07 1.00000000

ACTUAL ESTIMATION ERROR MEANS AT TIME 24.176 DAYS BEFORE THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 24.176 DAYS JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.74775447E+01	1.00000000					
Y	7.40345394E+00	.11275733	1.00000000				
Z	1.37387932E+02	-.44304398	-.91846819	1.00000000			
VX	7.13053460E-07	.27240779	.74921874	-.87894007	1.00000000		
VY	5.14429027E-06	.88905360	-.33777598	.01501090	-.15182258	1.00000000	

VZ	3.09898647E-05	-.04122083	-.99393882	.87231278	-.67910898	.39296043	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.04043318	-.12876278	.10461773	-.02081991	.00724792	.14003691
LAT 1	.04043318	.12876279	-.10461773	.02081991	-.00724792	-.14003692
LONG 1	-.03672084	.62957029	-.56546599	.52783374	-.33393045	-.62655984
RADIUS 2	-.22071467	-.10405661	.14038954	-.03598451	-.18168527	.09673302
LAT 2	.22071467	.10405661	-.14038954	.03598451	.18168526	-.09673302
LONG 2	.18911930	.46076634	-.52733898	.54927530	-.06334784	-.42628784
RADIUS 3	-.21393320	-.10540494	.14265548	-.04643709	-.17217397	.09744865
LAT 3	-.21393323	-.10540495	.14265550	-.04643709	-.17217399	.09744866
LONG 3	.45292190	.45668215	-.58367336	.50166564	.21309486	-.41117905

IGNORE PARAMETERS

--NONE

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

ACTUAL ESTIMATION ERROR MEANS AT TIME 24.176 DAYS AFTER THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 24.176 DAYS JUST AFTER THE MEASUREMENT

X	1.66293717E+01	1.00000000					
Y	7.38112669E+00	.14726346	1.00000000				
Z	1.37420739E+02	-.46594921	-.92180166	1.00000000			
VX	7.09836871E-07	.31877021	.74584799	-.38227411	1.00000000		
VY	4.81177237E-06	.87663981	-.32933908	.01573509	-.12648026	1.00000000	
VZ	3.08592427E-05	-.07675283	-.99399382	.87666161	-.67451462	.38339331	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.06780882	-.12545936	.10620438	-.01225188	-.02120595	.13615625
LAT 1	.06780882	.12545937	-.10620439	.01225188	.02120596	-.13615626
LONG 1	.09939144	.61134427	-.57411612	.48300630	-.19917210	-.60482704
RADIUS 2	-.24457361	-.10253296	.14115833	-.03183527	-.20865488	.09491552
LAT 2	.24457360	.10253296	-.14115832	.03183527	.20865488	-.09491552
LONG 2	.32441519	.44382927	-.53521286	.50876621	.07599944	-.40588723
RADIUS 3	.12951534	-.15742074	.12006032	-.16791148	.22126341	.16048409
LAT 3	.12951535	-.15742076	.12006034	-.16791150	.22126343	.16048411
LONG 3	.30659630	.48278093	-.57274711	.56191764	.03402179	-.44286079

IGNORE PARAMETERS

--NONE

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

MEASUREMENT NO 270 AT TRAJECTORY TIME 29.988 PROBLEM. . 1

RANGE-RATE WAS MEASURED FROM STATION 2 AT TRAJECTORY TIME 29.98800 DAYS

INITIAL TRAJECTORY TIME 29.787
FINAL TRAJECTORY TIME 29.988

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	-21341924.34	-106933342.58	-660445.36	109044273.94	37.039264915	-4.700711425	.597110416	37.341135149
GEO-	66605798.75	16112618.09	-660445.06	68530176.39	13.290487840	12.729538332	.597110416	18.412896405
PLANETO-	-436176.99	-309189.73	-387125.51	660086.97	2.909571667	2.177460684	2.660718350	4.504038683
FINAL								
INERTIAL	-20698278.66	-107013268.46	-649993.63	108998536.04	37.086377342	-4.503554977	.606887453	37.363748529
GEO-	66836488.33	16334692.88	-649993.63	68806691.94	13.279151288	12.844627035	.606887453	18.484821205
PLANETO-	-385578.53	-271327.87	-340840.79	581774.92	2.919655615	2.182940490	2.669972137	4.518668975

ELEVATION AND AZIMUTH RELATIVE TO TRACKING STATION 2

ELEVATION ANGLE= 16.050 DEGREES

AZIMUTH ANGLE= -97.340 DEGREES

****

NAVIGATION PARAMETERS

FLIGHT PATH ANGLE	-4.02834733771E+00
ANGLE BETWEEN RELATIVE VELOCITY AND PLANE OF THE SKY.	5.95943954955E+01
GEOCENTRIC DECLINATION.	4.92067297440E+00
EARTH/SPACECRAFT/TARG PLANET ANGLE	1.38501133122E+02
ANTENNA AXIS - EARTH ANGLE.	-5.41261969105E-01
ANTENNA AXIS - LIMB OF SUN ANGLE. .	1.14313224038E+02
OCCULTATION RATIO FOR SUN IS	1.41899209286E+02
OCCULTATION RATIO FOR VENUS IS	6.37193703629E+01

STATE TRANSITION MATRIX PARTITIONS OVER(29.787, 29.988) --TRANSPOSES SHOWN

	X(29.988)	Y(29.988)	Z(29.988)	VX(29.988)	VY(29.988)	VZ(29.988)
X(29.787)	1.0000604023E+00	1.7934475105E-04	2.2480163966E-04	7.4592456620E-09	2.2039874038E-08	2.7642516311E-08
Y(29.787)	1.7934481240E-04	9.9993360066E-01	1.5896486626E-04	2.2039890634E-08	-8.1842910749E-09	1.9521596834E-08
Z(29.787)	2.2480168147E-04	1.5896484144E-04	1.0000060358E+00	2.7642527620E-08	1.9521590122E-08	7.3480315303E-10
VX(29.787)	1.7366773759E+04	1.1052124061E+00	1.3860535641E+00	1.0000691054E+00	2.0339553305E-04	2.5523302717E-04
VY(29.787)	1.1052127389E+00	1.7365989702E+04	9.7902253928E-01	2.0339560799E-04	9.9992424437E-01	1.8004339462E-04
VZ(29.787)	1.3860537909E+00	9.7902240464E-01	1.7366436843E+04	2.5523307823E-04	1.8004336430E-04	1.0000066965E+00

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

```
    IGNORE PARAMETERS

                  --NONE

DIAGONAL OF DYNAMIC NOISE MATRIX
                    0.              0.              0.              0.              0.              0.



OBSERVATION MATRIX PARTITIONS -- TRANSPOSES SHOWN
                                       RANGE-RATE(2)
                X                   -3.1698716550E-08
                Y                    1.3019642002E-07
                Z                    1.1207815248E-08
               VX                    9.7138597318E-01
               VY                    2.3731736921E-01
               VZ                   -9.4740369306E-03

         SOLVE-FOR PARAMETERS

                  --NONE

         DYNAMIC CONSIDER PARAMETERS

                  --NONE

         MEASUREMENT CONSIDER PARAMETERS
         RADIUS 1                    0.
         LAT  1                      0.
         LONG 1                      0.
         RADIUS 2                    5.2790506088E-05
         LAT  2                     -2.8721918833E-01
         LONG 2                      1.0253774519E-01
         RADIUS 3                    0.
         LAT  3                      0.
         LONG 3                      0.

         IGNORE PARAMETERS

                  --NONE


MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS
    7.0710678119E-08              1.0000000000E+00


MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS
    1.5318793244E-06              1.0000000000E+00


GAIN MATRIX PARTITIONS
                  K-MATRIX
                               -1.7738864826E+06
                               -1.6916165677E+06
                                3.2860420602E+07
```

7.6590452252E-01
4.2454433046E-01
5.2354494762E+00

S-MATRIX

NOT DEFINED

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 29.988 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	8.97033548E+00	1.00000000					
Y	2.81321888E+00	.27638167	1.00000000				
Z	5.07267636E+01	-.37543757	-.93284389	1.00000000			
VX	1.23872799E-06	-.53108238	-.94499756	.97232826	1.00000000		
VY	3.00399169E-06	.86263910	-.19208367	.14137159	-.04751599	1.00000000	
VZ	1.27548831E-05	.38600572	-.76996484	.59707086	.53098806	.71130659	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.10826519	-.12374062	.12587596	.13950569	-.05114286	.04557781
LAT 1	.10826519	.12374063	-.12587597	-.13950570	.05114286	-.04557781
LONG 1	.26865637	.41896148	-.47326453	-.47312335	.02948248	-.19835496
RADIUS 2	-.06339173	-.17374763	.21950942	.19701022	.05822205	.10493212
LAT 2	.06339174	.17374763	-.21950943	-.19701022	-.05822205	-.10493212
LONG 2	.15510458	.48432977	-.55149924	-.51309341	-.14072132	-.32450602
RADIUS 3	-.08807186	-.16317381	.16106655	.16784953	-.01017349	.09479705
LAT 3	-.08807187	-.16317383	.16106657	.16784956	-.01017349	.09479706
LONG 3	.19480460	.45435175	-.53469482	-.50206047	-.09057348	-.26864081

NO SOLVE-FOR PARAMETERS

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 29.988 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	8.54884580E+00	1.00000000					
Y	1.09503103E+00	-.00716305	1.00000000				
Z	6.26659963E+00	-.63558398	-.39024799	1.00000000			
VX	3.97337130E-07	-.79871514	-.58096338	.81824727	1.00000000		
VY	2.93274787E-06	.99764736	.01930922	-.60913423	-.80653957	1.00000000	
VZ	9.91793381E-06	.77793474	-.63029153	-.28000920	-.25888905	.75767188	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.07564612	-.03531464	.05972779	.08231444	-.07886544	-.03794687
LAT 1	.07564612	.03531464	-.05972779	-.08231445	.07886545	.03794687
LONG 1	.13326554	-.03023587	-.07477515	-.09422237	.13389317	.12303624
RADIUS 2	.02668316	.24749347	-.57838685	-.25160015	-.00538366	-.10215305
LAT 2	-.02668316	-.24749348	.57838686	.25160016	.00538366	.10215306
LONG 2	-.00229460	.01553126	-.29337515	-.06639125	-.02899719	.00254697
RADIUS 3	-.04259088	-.04827840	.04471424	.06044519	-.04517921	-.00483655
LAT 3	-.04259088	-.04827841	.04471425	.06044520	-.04517922	-.00483655
LONG 3	.03235055	-.11368973	.01985928	.03314559	.02726087	.09223100

NO SOLVE-FOR PARAMETERS

****

ACTUAL ESTIMATION ERROR STATISTICS

DIAGONAL OF ACTUAL DYNAMIC NOISE COVARIANCE MATRIX

0. 0. 0. 0. 0. 0.

ACTUAL MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

7.07106781E-08 1.00000000

ACTUAL MEASUREMENT RESIDUAL MEAN

0.

ACTUAL MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

4.39958236E-06 1.00000000

ACTUAL ESTIMATION ERROR MEANS AT TIME 29.988 DAYS BEFORE THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 29.988 DAYS JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	1.34896426E+01	1.00000000					
Y	7.17746652E+00	.72878617	1.00000000				
Z	1.45542539E+02	-.75186776	-.98897175	1.00000000			
VX	3.41605733E-06	-.79719975	-.99131587	.99563020	1.00000000		
VY	3.39845892E-06	.37158926	-.34117213	.33139369	.25749002	1.00000000	

VZ	2.17623984E-05	-.39797029	-.91505165	.87455006	.85783594	.64603283	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.21598238	-.14550097	.13161677	.15176233	-.13561975	.08013910
LAT 1	.21598239	.14550098	-.13161678	-.15176234	.13561976	-.08013910
LONG 1	.53595295	.49263781	-.49484872	-.51469088	.07818114	-.34876595
RADIUS 2	-.12646259	-.20430192	.22952055	.21431905	.15439222	.18450127
LAT 2	.12646259	.20430192	-.22952055	-.21431905	-.15439222	-.18450127
LONG 2	.30942406	.56950132	-.57665140	-.55817253	-.37316234	-.57057627
RADIUS 3	-.17569794	-.19186867	.16841231	.18259640	-.02697789	.16668089
LAT 3	-.17569796	-.19186869	.16841232	.18259642	-.02697789	.16668090
LONG 3	.38862317	.53425155	-.55908060	-.54617029	-.24018118	-.47234895

IGNORE PARAMETERS

--NONE

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

ACTUAL ESTIMATION ERROR MEANS AT TIME 29.988 DAYS AFTER THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 29.988 DAYS JUST AFTER THE MEASUREMENT

X	9.42886914E+00	1.00000000					
Y	1.39859258E+00	.01529614	1.00000000				
Z	1.32301281E+01	-.37775769	-.59558899	1.00000000			
VX	5.18814628E-07	-.70374242	-.68436812	.82012936	1.00000000		
VY	3.24252329E-06	.99221961	-.00878271	-.27665692	-.65651767	1.00000000	
VZ	1.12400918E-05	.74860319	-.64476314	.04508553	-.10152978	.74944936	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.20575754	-.08294901	.08487222	.18912295	-.21399302	-.10044967
LAT 1	.20575756	.08294902	-.08487223	-.18912296	.21399303	.10044968
LONG 1	.36248248	-.07101973	-.10625429	-.21648222	.36330498	.32569096
RADIUS 2	.07257822	.58132657	-.82187832	-.57806816	-.01460800	-.27041073
LAT 2	-.07257822	-.58132656	.82187831	.57806816	.01460800	.27041072
LONG 2	-.00624131	.03648071	-.41688133	-.15253834	-.07868079	.00674211
RADIUS 3	-.11584726	-.11339903	.06353822	.13887688	-.12258900	-.01280289
LAT 3	-.11584727	-.11339905	.06353823	.13887690	-.12258902	-.01280289
LONG 3	.08799354	-.26704084	.02821972	.07615422	.07396947	.24414595

IGNORE PARAMETERS

--NONE

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

MEASUREMENT NO 90 AT TRAJECTORY TIME 9.988 PROBLEM. 3

RANGE-RATE WAS MEASURED FROM STATION 2 AT TRAJECTORY TIME 9.98800 DAYS

INITIAL TRAJECTORY TIME 9.787
FINAL TRAJECTORY TIME 9.988

STATE	X-COMP	Y-COMP	Z-COMP	RADIUS	X-DOT	Y-DOT	Z-DOT	VELOCITY
INITIAL								
INERTIAL	-79242985.63	-83929194.38	-1466297.05	115437041.15	28.678394790	-20.805364142	.360554701	35.432238209
GEO-	43948238.50	2559993.22	-1466297.05	44047148.14	12.047772691	3.683173041	.360554701	12.603356306
PLANETO-	-5521607.71	-4686583.08	-4618515.07	8589696.98	3.285543259	3.212731367	2.158069275	5.076780509
FINAL								
INERTIAL	-78743915.33	-84289414.14	-1460016.09	115357883.06	26.796916795	-20.679173262	.362790866	35.454509458
GEO-	44157760.15	2624560.09	-1460016.09	44259775.69	12.083139022	3.750770472	.362790866	12.657098600
PLANETO-	-5464690.28	-4630936.57	-4580967.96	8502569.08	3.270627180	3.194681705	2.165999752	5.059105481

ELEVATION AND AZIMUTH RELATIVE TO TRACKING STATION 2

ELEVATION ANGLE= 20.432 DEGREES

AZIMUTH ANGLE= -109.064 DEGREES

****

NAVIGATION PARAMETERS
FLIGHT PATH ANGLE . . . . -7.37609551809E+00
ANGLE BETWEEN RELATIVE VELOCITY
AND PLANE OF THE SKY. . . . . 7.57148522276E+01
GEOCENTRIC DECLINATION. . . . . . . -3.82401770232E-01
EARTH/SPACECRAFT/TARG PLANET ANGLE 1.30976814990E+02
ANTENNA AXIS - EARTH ANGLE. . . . . -1.89038325862E+00
ANTENNA AXIS - LIMB OF SUN ANGLE. . 1.36101781523E+02
OCCULTATION RATIO FOR SUN IS 1.14012611653E+02
OCCULTATION RATIO FOR VENUS IS 1.06107077116E+03

STATE TRANSITION MATRIX PARTITIONS OVER(9.787, 9.988) --TRANSPOSES SHOWN

	X(9.988)	Y(9.988)	Z(9.988)	VX(9.988)	VY(9.988)	VZ(9.988)
X(9.787)	1.0000053170E+00	1.9488707785E-05	3.3950890482E-07	6.0859031038E-10	2.2449421953E-09	3.9052861536E-11
Y(9.787)	1.9488707439E-05	1.0000076956E+00	3.6085831451E-07	2.2449420402E-09	8.9053650646E-10	4.1582009336E-11
Z(9.787)	3.3950890371E-07	3.6085831973E-07	9.9998698757E-01	3.9052861020E-11	4.1582011660E-11	-1.4990877523E-09
VX(9.787)	1.7366430592E+04	1.1283900607E-01	1.9630162606E-03	1.0000052519E+00	1.9497771080E-05	3.3869725541E-07
VY(9.787)	1.1284475728E-01	1.7366444760E+04	2.0901532641E-03	1.9497770231E-05	1.0000077697E+00	3.6126994270E-07
VZ(9.787)	1.3630353745E-03	2.0900670906E-03	1.7366324648E+04	3.3869725258E-07	3.6126995542E-07	9.9998697862E-01

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

```
     IGNORE PARAMETERS
     R-RATE          0.                0.                0.                0.                0.                0.

DIAGONAL OF DYNAMIC NOISE MATRIX
                    0.                0.                0.                0.                0.                0.


OBSERVATION MATRIX PARTITICNS -- TRANSPOSES SHOWN
                                       RANGE-RATE(2)
               X                   -3.2284191314E-09
               Y                    6.4968923827E-08
               Z                    1.8870683451E-08
               VX                   9.9770100109E-01
               VY                   5.9172713404E-02
               VZ                  -3.3034866600E-02

         SOLVE-FOR PARAMETERS

                   --NONE

         DYNAMIC CONSIDER PARAMETERS

                   --NONE

         MEASUREMENT CONSIDER PARAMETERS
         RADIUS 1               0.
         LAT  1                 0.
         LONG 1                 0.
         RADIUS 2               4.9107016916E-05
         LAT  2                -2.6705610773E-01
         LONG 2                 1.6426974225E-01
         RADIUS 3               0.
         LAT  3                 0.
         LONG 3                 0.

         IGNORE PARAMETERS
         R-RATE                 0.


MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS
    7.0710678119E-08              1.0000000000E+00


MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS
    1.5865031983E-07              1.0000000000E+00


GAIN MATRIX PARTITIONS
                   K-MATRIX
                                  3.5138388194E+07
                                 -4.0882831586E+06
                                 -4.7641061439E+07
                                 -3.6634926272E-01
                                  9.7779391890E+00
```

-3.5571318406E+01

S-MATRIX

NOT DEFINED

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.988 DAYS, JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	5.22048478E+01	1.00000000					
Y	2.23917237E+01	-.92529159	1.00000000				
Z	6.53577335E+01	-.87828462	.74321683	1.00000000			
VX	2.67760311E-06	.80906098	-.95502149	-.70772817	1.00000000		
VY	1.30030615E-05	.98438639	-.95753720	-.82606636	.85248598	1.00000000	
VZ	3.77434556E-05	.24880185	-.59683286	-.06353862	.73927712	.36105325	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	.06024531	-.10482750	-.04906756	.13627821	.06950898	.15000394
LAT 1	-.06024531	.10482751	.04906757	-.13627822	-.06950898	-.15000395
LONG 1	-.05406132	.13109235	-.22261458	-.04570975	-.08429456	-.18996475
RADIUS 2	.11866759	-.04559357	-.13012626	.00029754	.12342147	-.13182679
LAT 2	-.11866759	.04559357	.13012627	-.00029754	-.12342148	.13182679
LONG 2	-.05176670	.16103301	-.20980604	-.10357916	-.11738425	-.27886160
RADIUS 3	.05942579	-.05159161	-.06336369	.04855385	.06447743	.00941319
LAT 3	.05942579	-.05159161	-.06336369	.04855386	.06447744	.00941319
LONG 3	-.12628539	.20714642	-.15397025	-.12122490	-.18861991	-.23718568

NO SOLVE-FOR PARAMETERS

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.988 DAYS, JUST AFTER THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	5.19063451E+01	1.00000000					
Y	2.23823278E+01	-.92789113	1.00000000				
Z	6.49192259E+01	-.87679802	.74517726	1.00000000			
VX	2.67697223E-06	.81623731	-.95627674	-.71520435	1.00000000		
VY	1.29101966E-05	.98426400	-.96134778	-.82363878	.86142926	1.00000000	
VZ	3.73191702E-05	.26931853	-.60825384	-.08230094	.74457502	.38595515	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	.05562340	-.10353094	-.04401308	.13731472	.06445036	.15870486
LAT 1	-.05562341	.10353095	.04401308	-.13731472	-.06445036	-.15870487
LONG 1	-.03754812	.12660791	-.24235631	-.04912164	-.06607808	-.21581302
RADIUS 2	.04480777	-.02549971	-.05019818	.01536690	.04091127	-.02836909
LAT 2	-.04480777	.02549971	.05019818	-.01536690	-.04091127	.02836909
LONG 2	-.09701237	.17322848	-.16249765	-.09451700	-.16851649	-.21874468
RADIUS 3	.05681310	-.05081610	-.06058896	.04916256	.06163581	.01368009
LAT 3	.05681311	-.05081611	-.06058897	.04916256	.06163582	.01368009
LONG 3	-.09959152	.19983488	-.18473486	-.12679666	-.15929903	-.27849014

NO SOLVE-FOR PARAMETERS

****

ACTUAL ESTIMATION ERROR STATISTICS

DIAGONAL OF ACTUAL DYNAMIC NOISE COVARIANCE MATRIX

0. 0. 0. 0. 0. 0.

ACTUAL MEASUREMENT NOISE CORRELATION MATRIX AND STANDARD DEVIATIONS

7.07106781E-08 1.00000000

ACTUAL MEASUREMENT RESIDUAL MEAN

0.

ACTUAL MEASUREMENT RESIDUAL CORRELATION MATRIX AND STANDARD DEVIATIONS

1.40430325E-06 1.00000000

ACTUAL ESTIMATION ERROR MEANS AT TIME 9.988 DAYS BEFORE THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.988 DAYS JUST BEFORE THE MEASUREMENT

	STD DEV	X	Y	Z	VX	VY	VZ
X	2.15438200E+02	1.00000000					
Y	2.12579382E+02	-.98841725	1.00000000				
Z	6.01735425E+02	.94134184	-.98005086	1.00000000			
VX	1.83715121E-05	.98841140	-.99847980	.97226523	1.00000000		
VY	7.67717723E-05	.99658092	-.99715249	.96452503	.99607252	1.00000000	
VZ	5.49034131E-04	.97204716	-.99640630	.99125767	.99438851	.98742483	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	.01459860	-.01104184	-.00532949	.01986222	.01177294	.01031205
LAT 1	-.01459861	.01104184	.00532949	-.01986222	-.01177294	-.01031205
LONG 1	-.01310010	.01380841	-.02417937	-.00666208	-.01427722	-.01305916
RADIUS 2	.02875545	-.00480253	-.01413372	.00004337	.02090426	-.00906246
LAT 2	-.02875546	.00480253	.01413372	-.00004337	-.02090426	.00906246
LONG 2	-.01254407	.01696217	-.02278817	-.01509641	-.01988172	-.01917039
RADIUS 3	.01440002	-.00543432	-.00688227	.00707661	.01092073	.00064711
LAT 3	.01440002	-.00543432	-.00688227	.00707661	.01092073	.00064711
LONG 3	-.03060139	.02181945	-.01672354	-.01766823	-.03194711	-.01630537

IGNORE PARAMETERS

R-RATE	-.97019725	.99443697	-.99408392	-.98932182	-.98555217	-.99763433

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

ACTUAL ESTIMATION ERROR MEANS AT TIME 9.988 DAYS AFTER THE MEASUREMENT

X	0.
Y	0.
Z	0.
VX	0.
VY	0.
VZ	0.

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 9.988 DAYS JUST AFTER THE MEASUREMENT

X	1.68197870E+02	1.00000000					
Y	2.06906538E+02	-.97658631	1.00000000				
Z	6.67812594E+02	.92038397	-.98158716	1.00000000			
VX	1.88772830E-05	.97730043	-.99875474	.97534617	1.00000000		
VY	6.33487597E-05	.99313142	-.99446216	.95805975	.99401524	1.00000000	
VZ	5.98532948E-04	.95452427	-.99630022	.99282837	.99455149	.98201340	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	.01716554	-.01119957	-.00427859	.01947249	.01313470	.00989542
LAT 1	-.01716554	.01119957	.00427859	-.01947249	-.01313470	-.00989542
LONG 1	-.01158746	.01369594	-.02355988	-.00696590	-.01346642	-.01345617
RADIUS 2	.01382781	-.00275846	-.00487985	.00217917	.00833753	-.00176884
LAT 2	-.01382781	.00275846	.00487985	-.00217917	-.00833753	.00176884
LONG 2	-.02993830	.01873917	-.01579668	-.01340338	-.03434291	-.01363896
RADIUS 3	.01753269	-.00549708	-.00588996	.00697170	.01256110	.00085297
LAT 3	.01753269	-.00549708	-.00588996	.00697170	.01256111	.00085297
LONG 3	-.03073423	.02161734	-.01795840	-.01798093	-.03246443	-.01736416

IGNORE PARAMETERS

R-RATE	-.95119223	.99413177	-.99526379	-.98989402	-.97901369	-.99805435

SOLVE-FOR PARAMETERS

NO SOLVE-FOR PARAMETERS

```
ERROR ANALYSIS MODE-EIGENVECTOR        EVENT AT TRAJECTORY TIME       30.383 DAYS
                                                                              PROBLEM. .         3
****************************************************************************************************

STATE VECTOR AT TIME        30.383 DAYS
        X-1.9430929740297E+07
        Y-1.0716025337564E+08
        Z-6.2884364202965E+05
        VX 3.7185349709934E+01
        VY-4.1078272575873E+00
        VZ 6.3522294272467E-01

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

NAVIGATION PARAMETERS
    FLIGHT PATH ANGLE . . . . . . . . . .  -3.97885335456E+00
    ANGLE BETWEEN RELATIVE VELOCITY
    AND PLANE OF THE SKY. . . . . . . .     5.93107536965E+01
    GEOCENTRIC DECLINATION. . . . . . .     5.04389624543E+00
    EARTH/SPACECRAFT/TARG PLANET ANGLE      1.39013518124E+02
    ANTENNA AXIS - EARTH ANGLE. . . . .    -5.19530748457E-01
    ANTENNA AXIS - LIMB OF SUN ANGLE. .     1.13909827248E+02
    OCCULTATION RATIO FOR SUN        IS      1.42237629072E+02
    OCCULTATION RATIO FOR VENUS      IS      4.62881622171E+01
```

STATE TRANSITION MATRIX PARTITIONS OVER(30.350,   30.383)   --TRANSPOSES SHOWN

	X(30.383)	Y(30.383)	Z(30.383)	VX(30.383)	VY(30.383)	VZ(30.383)
X(30.350)	1.0000054273E+00	1.4759206127E-05	1.8707540262E-05	3.8700259841E-09	1.0509756753E-08	1.3323679079E-08
Y(30.350)	1.4759206126E-05	9.9999419981E-01	1.2899553809E-05	1.0509756958E-08	-4.1339906124E-09	9.1834446051E-09
Z(30.350)	1.8707540261E-05	1.2899553809E-05	1.0000003732E+00	1.3323679225E-08	9.1834445261E-09	2.6433365909E-10
VX(30.350)	2.8512052422E+03	1.4236966052E-02	1.8048758742E-02	1.0000056067E+00	1.5206131719E-05	1.9280831098E-05
VY(30.350)	1.4236954457E-02	2.8511943999E+03	1.2440365485E-02	1.5206131852E-05	9.9999401322E-01	1.3284212642E-05
VZ(30.350)	1.8048758517E-02	1.2440369945E-02	2.8512003580E+03	1.9280831194E-05	1.3284212590E-05	1.0000003803E+00

```
SOLVE-FOR PARAMETERS

        --NONE

DYNAMIC CONSIDER PARAMETERS

        --NONE

IGNORE PARAMETERS
R-RATE          0.          0.          0.          0.          0.          0.

   DIAGONAL OF DYNAMIC NOISE MATRIX
               0.          0.          0.          0.          0.          0.

CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT EVENT TIME     30.383 DAYS
     PROPAGATED FORWARD FROM TIME    30.350 DAYS
```

	STD DEV	X	Y	Z	VX	VY	VZ
X	8.47563043E+00	1.00000000					
Y	1.00258513E+00	.08615729	1.00000000				
Z	3.97752821E+00	-.90643312	-.32176668	1.00000000			
VX	5.20511028E-07	-.86294945	-.46917205	.98596067	1.00000000		
VY	3.34494638E-06	.99862325	.09511349	-.89271462	-.85249734	1.00000000	
VZ	1.03540104E-05	.83124226	-.48016101	-.62381696	-.50192084	.82491204	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

	X	Y	Z	VX	VY	VZ
RADIUS 1	-.04030920	-.02033327	.02925570	.03185305	-.04299656	-.02443815
LAT 1	.04030920	.02033327	-.02925570	-.03185305	.04299656	.02443815
LONG 1	.04920679	-.06820672	-.12886456	-.10975569	.03368862	.08140362
RADIUS 2	.01071217	-.05391594	-.01756166	-.00802865	.00671655	.03880755
LAT 2	-.01071217	.05391595	.01756166	.00802865	-.00671655	-.03880755
LONG 2	-.00964838	-.16278537	.04484538	.06396939	-.01460557	.07563521
RADIUS 3	-.06516720	-.00574458	.17600892	.16248258	-.04958435	-.05810813
LAT 3	-.06516721	-.00574458	.17600895	.16248260	-.04958435	-.05810814
LONG 3	.05431069	.07311107	-.34148941	-.32552798	.01859408	.01633974

NO SOLVE-FOR PARAMETERS

POSITION EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	8.5296542717864E+01	1	9.2356127419E+00
2	5.6219086296823E-01	2	7.4979388032E-01
3	2.8034852386458E+00	3	1.6743611434E+00

POSITION EIGENVECTORS			
1	9.1518490033522E-01	1.4080508967309E-02	-4.0278820422853E-01
2	1.6407891218292E-01	8.9980539679412E-01	4.0426273446489E-01
3	3.6812322498762E-01	-4.3606420074043E-01	8.2117799779178E-01

FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION

1.060E-01 X**2 + 1.508E+00 Y**2 + 5.331E-01 Z**2 + 4.110E-01 XY + 4.430E-01 XZ + 1.038E+00 YZ = 9

XY HYPERELLIPSOID. . . . . . 1.060E-01 X**2 + 4.110E-01 XY + 1.508E+00 Y**2 = 9

XZ HYPERELLIPSOID. . . . . . 1.060E-01 X**2 + 4.430E-01 XZ + 5.331E-01 Z**2 = 9

YZ HYPERELLIPSOID. . . . . . 1.508E+00 Y**2 + 1.038E+00 YZ + 5.331E-01 Z**2 = 9

VELOCITY EIGENVALUES		SQUARE ROOTS OF EIGENVALUES	
1	3.7881676026622E-14	1	1.9463215569E-07
2	3.4854667941197E-12	2	1.8669404902E-06
3	1.1514178118116E-10	3	1.0730413840E-05

```
VELOCITY EIGENVECTORS
   1      9.7698769016582E-01      2.1094560812185E-01     -3.1575365057773E-02
   2     -2.1168983005613E-01      9.4081758220625E-01     -2.6466902512827E-01
   3     -2.6124109845766E-02      2.6526256318155E-01      9.6382223644150E-01

          FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                 THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
2.521E+13 X**2 +  1.429E+12 Y**2 +  5.448E+10 Z**2 +  1.077E+13 XY + -1.597E+12 XZ + -4.901E+11 YZ =   9
         XY HYPERELLIPSOID. . . . . .  2.521E+13 X**2 +  1.077E+13 XY +  1.429E+12 Y**2 =   9
         XZ HYPERELLIPSOID. . . . . .  2.521E+13 X**2 + -1.597E+12 XZ +  5.448E+10 Z**2 =   9
         YZ HYPERELLIPSOID. . . . . .  1.429E+12 Y**2 + -4.901E+11 YZ +  5.448E+10 Z**2 =   9

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

   DIAGONAL OF ACTUAL DYNAMIC NOISE MATRIX
         0.             0.             0.             0.             0.             0.

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

  ACTUAL ESTIMATION ERROR MEANS AT TIME   30.383 DAYS
         X    0.
         Y    0.
         Z    0.
        VX    0.
        VY    0.
        VZ    0.
```

ACTUAL CORRELATION MATRIX PARTITIONS AND STANDARD DEVIATIONS AT TIME 30.383 DAYS

X	8.61706933E+00	1.00000000					
Y	1.39148166E+00	-.06406290	1.00000000				
Z	2.10759655E+01	-.34545665	.63723467	1.00000000			
VX	2.58732187E-06	-.34750930	.61126449	.99938636	1.00000000		
VY	3.70817871E-06	.80813112	.36114423	.27191179	.26811250	1.00000000	
VZ	1.32001899E-05	.75323201	-.70149129	-.70148184	-.68680538	.31592283	1.00000000

SOLVE-FOR PARAMETERS

--NONE

DYNAMIC CONSIDER PARAMETERS

--NONE

MEASUREMENT CONSIDER PARAMETERS

RADIUS 1	-.03964757	-.01465045	.00552124	.00640812	-.03878486	-.01916888
LAT 1	.03964757	.01465045	-.00552124	-.00640812	.03878486	.01916888
LONG 1	.04839912	-.04914405	-.02431976	-.02208038	.03038868	.06385165
RADIUS 2	.01053634	-.03884731	-.00331430	-.00161518	.00605864	.03044000
LAT 2	-.01053634	.03884731	.00331430	.00161518	-.00605864	-.03044000
LONG 2	-.00949002	-.11728950	.00846337	.01286920	-.01317489	.05932701
RADIUS 3	-.06409756	-.00413906	.03321701	.03268784	-.04472734	-.04557906
LAT 3	-.06409757	-.00413906	.03321701	.03268785	-.04472735	-.04557906

```
LONG 3                          .05341925     .05267771    -.06444705    -.06548892     .01677271     .01281662

            IGNORE PARAMETERS
R-RATE                          .18044156    -.69344875    -.98203027    -.97955480    -.43164169     .62028326


               SOLVE-FOR PARAMETERS

      NO SOLVE-FOR PARAMETERS

                POSITION EIGENVALUES              SQUARE ROOTS OF EIGENVALUES
                   1        6.3986243921820E+01          1     7.9991401989E+00
                   2        1.0931790556329E+00          2     1.0455520339E+00
                   3        4.5530700341289E+02          3     2.1337924065E+01


                POSITION EIGENVECTORS
                   1        9.8629295225138E-01      3.6270145376657E-02      1.6096797474522E-01
                   2       -2.9172136311304E-02      9.9850417355688E-01     -4.6242857313282E-02
                   3       -1.6240442974949E-01      4.0913224559035E-02      9.8587570679771E-01

                        FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                                THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
1.604E-02 X**2 +  9.121E-01 Y**2 +  4.496E-03 Z**2 + -5.220E-02 XY +  6.727E-03 XZ + -8.412E-02 YZ =   9
         XY HYPERELLIPSOID. . . . . .  1.604E-02 X**2 + -5.220E-02 XY +  9.121E-01 Y**2 =   9
         XZ HYPERELLIPSOID. . . . . .  1.604E-02 X**2 +  6.727E-03 XZ +  4.496E-03 Z**2 =   9
         YZ HYPERELLIPSOID. . . . . .  9.121E-01 Y**2 + -8.412E-02 YZ +  4.496E-03 Z**2 =   9

                VELOCITY EIGENVALUES              SQUARE ROOTS OF EIGENVALUES
                   1        1.5002101783548E-12          1     1.2248306733E-06
                   2        1.4364118292235E-11          2     3.7900024132E-06
                   3        1.7882550916426E-10          3     1.3372565542E-05


                VELOCITY EIGENVECTORS
                   1        9.0712382333057E-01     -3.9004255457208E-01      1.5809229825948E-01
                   2        3.9924789727018E-01      9.1635021923619E-01     -3.0056484010737E-02
                   3       -1.3314460436463E-01      9.0382970346405E-02      9.8696678414216E-01

                        FOR THE NORMAL DISTRIBUTION X = N(0,Q) AND THE,3 SIGMA LEVEL
                                THE HYPERELLIPSOID HAS THE FOLLOWING EQUATION
5.597E+11 X**2 +  1.599E+11 Y**2 +  2.217E+10 Z**2 + -4.209E+11 XY +  1.880E+11 XZ + -8.504E+10 YZ =   9
         XY HYPERELLIPSOID. . . . . .  5.597E+11 X**2 + -4.209E+11 XY +  1.599E+11 Y**2 =   9
         XZ HYPERELLIPSOID. . . . . .  5.597E+11 X**2 +  1.880E+11 XZ +  2.217E+10 Z**2 =   9
         YZ HYPERELLIPSOID. . . . . .  1.599E+11 Y**2 + -8.504E+10 YZ +  2.217E+10 Z**2 =   9
```