NASA CR-66066

MATRIX SENSITIVITY ANALYSIS FOR LUNAR SATELLITE ORBITS

By C.B. Sheckells

Prepared under Contract No. NAS1-4605-3 by
TRW Systems
One Space Park, Redondo Beach, California

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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ABSTRACT

This report describes an investigation into the sensitivities of eight matrices associated with the Lunar Orbiter mission. The error in a 19 x 19 double precision covariance matrix is also determined.

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SYMBOLS

A	N x N matrix which is to be inverted
A^{-1}	N x N matrix which is the inverse of matrix A
B	N x N matrix which is the approximate inverse of matrix A
F	N x N perturbation matrix
$A + F$	N x N perturbed matrix
$(A + F)^{-1}$	N x N matrix which is the inverse of matrix A + F
E	N x N error matrix defined as $A^{-1} - B$
$\hat{E}$	N x N error matrix defined as $(A + F)^{-1} - B$
$E - \hat{E}$	N x N error matrix defined as $A^{-1} - (A + F)^{-1}$
$(\quad)_{ij}$	the matrix element in the ith row and jth column of matrix ( )
(i, j)	the matrix element in the ith row and jth column

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TRW Systems

1. SUMMARY

This report describes an investigation into the sensitivities of eight matrices associated with the Lunar Orbiter mission. The error in a 19 x 19 double precision covariance matrix is also determined. This 19 x 19 covariance matrix along with its corresponding normal matrix were provided by Langley Research Center (LRC) to TRW Systems. The eight matrices used in the sensitivity study were obtained by inverting matrices which were provided by LRC to TRW.

The error in the 19 x 19 covariance matrix is determined on the TRW Inversion Error Program. In general, the error in this matrix is in the 11th and 12th significant figure, or equivalently, this covariance matrix in general is correct to 10 or 11 significant figures.

Matrix sensitivity is studied on the TRW Inversion Error Program by applying four perturbations to each matrix: two random and two bias. It is found that nearly all of the eight matrices studied are quite sensitive to errors in the last two significant figures.

A description of the matrices supplied by LRC along with a description of the tracking situation is given at the beginning of the respective appendix in which the matrix is located. These descriptions were provided by LRC to TRW Systems.

2. INTRODUCTION

The TRW Inversion Error Program (INER) was used to determine the errors and sensitivities of the various matrices studied in this report. INER, which is described in appendix A, is a high precision matrix inversion program, which, in addition to inverting matrices, computes the error in taking the inverse of the matrix A + F to be the inverse of the matrix A, where F is a given perturbation matrix. A summary of the inputs and outputs of INER is given in appendix A.

Ten matrices were provided by LRC for this study, including one covariance matrix with its corresponding normal matrix, three covariance matrices without their corresponding normal matrices, and five normal matrices without their corresponding covariance matrices. These latter eight matrices were numbered 1 - 8 inclusive by LRC and can be found in appendixes C - J, respectively.

In order to identify the 120 matrices generated in this study, each matrix is assigned a two-part number. This number is located in the upper right-hand corner of the matrix to which it applies. The first part refers to the appendix in which the matrix is located, while the second part is the matrix number within that particular appendix. For example, matrix D-6 refers to the sixth matrix in appendix D. Appendixes B - J inclusive are used for the storage of matrices. In particular, appendix B contains the previously mentioned normal-covariance matrix pair provided by LRC and, in addition, contains all the matrices computed in this study which are related to this matrix pair. Similarly, appendixes C - J contain matrices 1 - 8 provided by LRC, and, in addition, contain all the matrices generated in this study which are related to these matrices. Just how they are related is described later in this report.

Although the two-part number described above is the main method of identification, there are also two other means of identification which should be mentioned before describing the results of the study. These additional means of identification are the INER input-output statement printed in the upper left-hand corner of each matrix and the descriptive title given each matrix. A summary of INER inputs and outputs is given in appendix A and should be referred to when interpreting the input-output statement.

3. COVARIANCE MATRIX ERROR

The error in one of the covariance matrices provided by LRC is determined in this section. This error is determined by inverting the corresponding normal matrix provided by LRC and comparing the resulting inverse with the covariance matrix. This inverse is computed on INER to insure accuracy. Notice that it is necessary to know both the covariance matrix and the normal matrix before any covariance matrix errors can be determined. For this reason, the error in each covariance matrix provided by LRC cannot be determined. It is only possible to determine the error in the one covariance matrix provided with its corresponding normal matrix. This normal-covariance matrix pair is in appendix B.

The normal matrix (matrix B-1) and the covaraince matrix (matrix B-2) are both 19 x 19 double precision matrices. Referring to appendix B it is seen that these double precision matrices (16 significant figures) are given to 17 significant figures. This peculiarity of constructing 17 digit numbers from 16 digit numbers is a property of the INER double precision format and all double precision numbers appearing in this report should be rounded-off at the 16th significant figure. Thus the (1, 1) element of matrix B-1 is .2867125510364427D 01 and not .28671255103644272D 01.

Since INER computes the error in an approximate matrix inverse, given this inverse and the matrix to be inverted, the error in covariance matrix B-2 is easily determined on INER. Thus, normal matrix B-1 is input to INER as matrix A while covariance matrix B-2 is input as matrix B, and the error in the covariance matrix is output by INER as matrix E (matrix B-3). The correct covariance matrix is output by INER as matrix B + E (matrix (B-4). The extent of the error in covariance matrix B-2 is determined by comparing matrices B-2 and B-4. Thus, by direct comparison the (1, 1) elements of matrices B-2 and B-4 differ in the 12th significant figure, or equivalently, the (1, 1) element of the original covariance matrix B-2 is correct to 11 significant figures. By a similar comparison, it is seen that the (3, 1) elements of these matrices differ in the 11th significant figure, the (13, 2) elements differ in the 10th significant figure, and the (7, 4) elements differ

in the 13th significant figure. Thus, the (3, 1), (13, 2), and (7, 4) elements of the original covariance matrix B-2 are correct to 10, 9, and 12 significant figures, respectively. In general, corresponding elements of matrices B-2 and B-4 differ in the 11th and 12th significant figure and thus, the original covariance matrix B-2 in general is correct to 10 or 11 significant figures.

4. MATRIX SENSITIVITY

The sensitivities of eight matrices is studied in this section. These eight matrices were not provided by LRC but were obtained by inverting eight matrices provided by LRC. The results of this study are discussed in terms of each matrix. However, before describing these results a few general comments concerning all eight matrices are given.

The inversion of the eight single precision matrices provided by LRC is done in two steps. The first step consists of inverting all these matrices on an ordinary single precision program. The second step consists of inverting all eight matrices on INER, using the result of the single precision inversion as the approximate inverse; that is, the matrix obtained in the single precision inversion is used as the B matrix on INER.

Once the eight matrices used in the sensitivity study are obtained, they are perturbed to study their sensitivities to errors in the last two significant figures of each element. Since these matrices are symmetric, the errors are symmetric, and thus, the perturbations must be symmetric. Four perturbations are applied to each matrix: two random and two bias. The random perturbations are random in the sense that some elements are increased in magnitude while others are decreased in magnitude; however, symmetric elements are always perturbed the same. The random selection of whether a given element is increased or decreased in magnitude is made by observing the signs from a table of random numbers with zero mean. It is important to mention that the same random perturbation is applied to all matrices of the same dimensions so that a comparison of their relative sensitivity under the same perturbation can be made. Thus,

all 6 x 6 matrices are perturbed with the same random perturbation. The bias perturbations are bias in the sense that all elements are increased in magnitude.

The four types of perturbations applied to each single precision matrix are:

1) Type 1 - This perturbation is a random perturbation of the eighth digit.

2) Type 2 - This perturbation is a random perturbation of the seventh digit.

3) Type 3 - This perturbation is a bias perturbation of the eighth digit.

4) Type 4 - This perturbation is a bias perturbation of the seventh digit.

The two random perturbations, type 1 and type 2, are identical except that type 1 perturbs the eighth digit and type 2 perturbs the seventh digit. Thus, if type 1 perturbation increases the magnitude of a certain element, then type 2 perturbation also increases the magnitude of that element; however, the type 2 perturbation increases that element's magnitude more than the type 1 perturbation. The four types of perturbations given above are input to INER as matrices (matrix F). In this report all perturbed matrices A + F are formed in the second way, as described in appendix A, i.e:

$$(A + F)_{ij} = A_{ij} + A_{ij} F_{ij}$$

where $(\quad)_{ij}$ denotes the matrix element in the ith row and the jth column.

4.1 Covariance Matrix 1

Normal matrix 1 provided by LRC is given in appendix C as matrix C-1. The approximate covariance matrix C-2 is obtained by inverting matrix C-1 in ordinary single precision. Matrices C-1 and C-2 are then input to INER and the error in the approximate covariance matrix C-2 is computed to be

matrix C-3. The sum of matrices C-2 and C-3 gives the correct covariance matrix C-4. Notice that most of the corresponding elements of matrices C-2 and C-4 differ in the 4th digit; thus, the approximate covariance matrix C-2 in general is accurate to three significant figures. Matrices C-1 and C-4 are used in the sensitivity study of covariance matrix C-4 (also referred to as covariance matrix 1).

For the sensitivity study, covariance matrix C-4 is input to INER as matrix A (matrix C-5), and normal matrix C-1 is input as matrix B (matrix C-6). (Matrices C-4 and C-5 should be identical, but upon close examination it is seen that some corresponding elements differ in the eighth digit. This apparent input error is a property of the input format; actually, the two numbers are identical. These numbers are identical because the smaller of the two has a chain of 9's after it in INER, which when rounded-off give the larger number. Thus, this apparent input error should be ignored).

Type 1 perturbation matrix C-7 is combined with matrix C-5 to form the perturbed matrix. As previously mentioned at the end of section 4, these matrices are combined in the second way in INER, which is described in appendix A, to form the perturbed matrix. The difference between the inverses of the perturbed and unperturbed matrix is given as matrix C-8. The effect of the perturbation is determined by comparing the magnitudes of corresponding elements of matrices C-6 and C-8. For example, by comparing the (3, 1) elements of matrices C-6 and C-8, it is seen that the (3, 1) elements of the inverses of the perturbed and unperturbed covariance matrix C-5 differ in the 3rd digit. By comparing matrices C-6 and C-8, it is seen that in general the inverses of the perturbed and unperturbed covariance matrix C-5 differ in the 3rd digit. Thus, type 1 perturbation matrix C-7 in general produces a change in the 3rd digit of normal matrix C-6.

The effect of type 2 perturbation matrix C-9 on covariance matrix C-5 is determined by comparing matrices C-6 and C-10. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed covariance matrix C-5 differ in the 2nd digit. Thus, type 2 perturbation matrix C-9 in general produces a change in the 2nd digit of normal matrix C-6.

A comparison of matrices C-12 and C-6 shows that the effect of type 3 perturbation matrix C-11 on covariance matrix C-5 in general is to change the elements of normal matrix C-6 in the 5th digit. Similarly, a comparison of matrices C-14 and C-6 shows that the effect of type 4 perturbation matrix C-13 on covariance matrix C-5 in general is to change the elements of normal matrix C-6 in the 5th and 6th digit.

In summary, the effect of perturbation matrices C-7, C-9, C-11, and C-13 on covariance matrix C-5 in general is to change the elements of normal matrix C-6 in the 3rd, 2nd, 5th, and 5th digit, respectively.

4.2 Covariance Matrix 2

Normal matrix 2 provided by LRC is given in appendix D as matrix D-1. The approximate covariance matrix D-2 is obtained by inverting matrix D-1 in ordinary single precision. Matrices D-1 and D-2 are then input to INER, and the error in the approximate covariance matrix D-2 is computed to be matrix D-3. The correct covariance matrix D-4 is the sum of matrices D-2 and D-3. Most of the corresponding elements of matrices D-2 and D-4 differ in the 2nd digit; thus, the approximate covariance matrix D-2 in general is accurate to one significant figure. Matrices D-1 and D-4 are used in the sensitivity study of covariance matrix D-4 (also referred to as covariance matrix 2).

For the sensitivity study, covariance matrix D-4 is input to INER as matrix A (matrix D-5), and normal matrix D-1 is input as matrix B (matrix D-6). The effect of type 1 perturbation matrix D-7 on covariance matrix D-5 is determined by comparing matrices D-6 and D-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed covariance matrix D-5 differ in the 1st digit. Similarly, a comparison of matrices D-10 and D-6 shows that the effect of type 2 perturbation matrix D-9 on covariance matrix D-5 in general is to change the elements of normal matrix D-6 in the 1st digit.

A comparison of matrices D-12 and D-6 shows that the effect of type 3 perturbation matrix D-11 on covariance matrix D-5 in general is to change the

elements of normal matrix D-6 in the 2nd digit. Similarly, a comparison of matrices D-14 and D-6 shows that the effect of type 4 perturbation matrix D-13 on covariance matrix D-5 in general is to change the elements of normal matrix D-6 in the 3rd digit.

A comparison of matrices D-8 and D-10 shows that perturbation matrices D-7 and D-9 change the elements of normal matrix D-6 in the same direction. However, a comparison of matrices D-12 and D-14 shows that perturbation matrices D-11 and D-13 change the elements of normal matrix D-6 in the opposite direction.

In summary, the effect of perturbation matrices D-7, D-9, D-11, and D-13 on covariance matrix D-5 in general is to change the elements of normal matrix D-6 in the 1st, 1st, 2nd, and 3rd digit, respectively.

4.3 Normal Matrix 3

Covariance matrix 3 provided by LRC is given in appendix E as matrix E-1. The approximate normal matrix E-2 is obtained by inverting matrix E-1 in ordinary single precision. Matrices E-1 and E-2 are then input to INER, and the error in the approximate normal matrix E-2 is computed to be matrix E-3. The correct normal matrix E-4 is the sum of matrices E-2 and E-3. Most of the corresponding elements of matrices E-2 and E-4 differ in the 4th digit; thus, the approximate normal matrix E-2 in general is accurate to three significant figures. Matrices E-1 and E-4 are used in the sensitivity study of normal matrix E-4 (also referred to as normal matrix 3).

For the sensitivity study, normal matrix E-4 is input to INER as matrix A (matrix E-5), and covariance matrix E-1 is input as matrix B (matrix E-6). The effect of type 1 perturbation matrix E-7 on normal matrix E-5 is determined by comparing matrices E-6 and E-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed normal matrix E-5 differ in the 2nd digit. Similarly, a comparison of matrices E-10 and E-6 shows that the effect of type 2 perturbation matrix E-9 on normal matrix E-5 in general is to change the elements of covariance matrix E-6 in the 1st digit.

A comparison of matrices E-12 and E-6 shows that the effect of type 3 perturbation matrix E-11 on normal matrix E-5 in general is to change the elements of covariance matrix E-6 in the 4th digit. Similarly, a comparison of matrices E-14 and E-6 shows that the effect of type 4 perturbation matrix E-13 on normal matrix E-5 in general is to change the elements of covariance matrix E-6 in the 4th digit.

In summary, the effect of perturbation matrices E-7, E-9, E-11, and E-13 on normal matrix E-5 in general is to change the elements of covariance matrix E-6 in the 2nd, 1st, 4th, and 4th digit, respectively.

4.4 Normal Matrix 4

Covariance matrix 4provided by LRC is given in appendix F as matrix F-1. The approximate normal matrix F-2 is obtained by inverting matrix F-1 in ordinary single precision. Matrices F-1 and F-2 are then input to INER, and the error in the approximate normal matrix F-2 is computed to be matrix F-3. The correct normal matrix F-4 is the sum of matrices F-2 and F-3. Most of the corresponding elements of matrices F-2 and F-4 differ in the 4th digit; thus, the approximate normal matrix F-2 in general is accurate to three significant figures. Matrices F-1 and F-4 are used in the sensitivity study of normal matrix F-4 (also referred to as normal matrix 4).

For the sensitivity study, normal matrix F-4 is input to INER as matrix A (matrix F-5), and covariance matrix F-1 is input as matrix B (matrix F-6). The effect of type 1 perturbation matrix F-7 on normal matrix F-5 is determined by comparing matrices F-6 and F-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed normal matrix F-5 differ in the 2nd digit. Similarly, a comparison of matrices F-10 and F-6 shows that the effect of type 2 perturbation matrix F-9 on normal matrix F-5 in general is to change the elements of covariance matrix F-6 by two orders of magnitude.

A comparison of matrices F-12 and F-6 shows that the effect of type 3 perturbation matrix F-11 on normal matrix F-5 in general is to change the

elements of covariance matrix F-6 in the 3rd digit. Similarly, a comparison of matrices F-14 and F-6 shows that the effect of type 4 perturbation matrix F-13 on normal matrix F-5 in general is to change the elements of covariance matrix F-6 in the 3rd digit.

In summary, the effect of perturbation matrices F-7, F-11, and F-13 on normal matrix F-5 in general is to change the elements of covariance matrix F-6 in the 2nd, 3rd, and 3rd digit, respectively. The effect of perturbation matrix F-9 on normal matrix F-5 in general is to change the elements of covariance matrix F-6 by two orders of magnitude.

4.5 Normal Matrix 5

Covariance matrix 5 provided by LRC is given in appendix G as matrix G-1. The approximate normal matrix G-2 is obtained by inverting matrix G-1 in ordinary single precision. Matrices G-1 and G-2 are then input to INER, and the error in the approximate normal matrix G-2 is computed to be matrix G-3. The correct normal matrix G-4 is the sum of matrices G-2 and G-3. Most of the corresponding elements of matrices G-2 and G-4 differ in the 2nd digit; thus, the approximate normal matrix G-2 in general is accurate to one significant figure. Matrices G-1 and G-4 are used in the sensitivity study of normal matrix G-4 (also referred to as normal matrix 5).

For the sensitivity study, normal matrix G-4 is input to INER as matrix A (matrix G-5), and covariance matrix G-1 is input matrix B (matrix G-6). The effect of type 1 perturbation matrix G-7 on normal matrix G-5 is determined by comparing matrices G-6 and G-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed normal matrix G-5 differ in the 1st digit. Similarly, a comparison of matrices G-10 and G-6 shows that the effect of type 2 perturbation matrix G-9 on normal matrix G-5 in general is to change the elements of covariance matrix G-6 in the 1st digit.

A comparison of matrices G-12 and G-6 shows that the effect of type 3 perturbation matrix G-11 on normal matrix G-5 in general is to change the

elements of covariance matrix G-6 in the 2nd digit. Similarly, a comparison of matrices G-14 and G-6 shows that the effect of type 4 perturbation matrix G-13 on normal matrix G-5 in general is to change the elements of covariance matrix G-6 in the 3rd digit.

A comparison of matrices G-8 and G-10 shows that perturbation matrices G-7 and G-9 change the elements of covariance matrix G-6 in the opposite direction. However, a comparison of matrices G-12 and G-14 shows that perturbation matrices G-11 and G-13 change the elements of covariance matrix G-6 in the same direction.

In summary, the effect of perturbation matrices G-7, G-9, G-11, and G-13 on normal matrix G-5 in general is to change the elements of covariance matrix G-6 in the 1st, 1st, 2nd, and 3rd digit, respectively.

4.6 Covariance Matrix 6

Normal matrix 6 provided by LRC is given in appendix H as matrix H-1. The approximate covariance matrix H-2 is obtained by inverting matrix H-1 in ordinary single precision. Matrices H-1 and H-2 are then input to INER, and the error in the approximate covariance matrix H-2 is computed to be matrix H-3. The correct covariance matrix H-4 is the sum of matrices H-2 and H-3. Most of the corresponding elements of matrices H-2 and H-4 differ in the 2nd digit; thus, the approximate covariance matrix H-2 in general is accurate to one significant figure. Matrices H-1 and H-4 are used in the sensitivity study of covariance matrix H-4 (also referred to as covariance matrix 6).

For the sensitivity study, covariance matrix H-4 is input to INER as matrix A (matrix H-5), and normal matrix H-1 is input as matrix B (matrix H-6). The effect of type 1 perturbation matrix H-7 on covariance matrix H-5 is determined by comparing matrices H-6 and H-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed covariance matrix H-5 differ in the 1st digit. Similarly, a comparison of matrices H-10 and H-6 shows that the effect of type 2 perturbation matrix H-9 on covariance matrix H-5 in general is to change the elements of normal matrix H-6 in the 1st digit.

A comparison of matrices H-12 and H-6 shows that the effect of type 3 perturbation matrix H-11 on covariance matrix H-5 in general is to change the elements of normal matrix H-6 in the 2nd digit. Similarly, a comparison of matrices H-14 and H-6 shows that the effect of type 4 perturbation matrix H-13 on covariance matrix H-5 in general is to change the elements of normal matrix H-6 in the 3rd digit.

A comparison of matrices H-8 and H-10 shows that perturbation matrices H-7 and H-9 change the elements of normal matrix H-6 in the opposite direction. However, a comparison of matrices H-12 and H-14 shows that perturbation matrices H-11 and H-13 change the elements of normal matrix H-6 in the same direction.

In summary, the effect of perturbation matrices H-7, H-9, H-11, and H-13 on covariance matrix H-5 in general is to change the elements of normal matrix H-6 in the 1st, 1st, 2nd, and 3rd digit, respectively.

4.7 Covariance Matrix 7

Normal matrix 7 provided by LRC is given in appendix I as matrix I-1. The approximate covariance matrix I-2 is obtained by inverting matrix I-1 in ordinary single precision. Matrices I-1 and I-2 are then input to INER, and the error in the approximate covariance matrix I-2 is computed to be matrix I-3. The correct covariance matrix I-4 is the sum of matrices I-2 and I-3. Most of the corresponding elements of matrices I-2 and I-4 differ in the 4th digit; thus, the approximate covariance matrix I-2 in general is accurate to three significant figures. Matrices I-1 and I-4 are used in the sensitivity study of covariance matrix I-4 (also referred to as covariance matrix 7).

For the sensitivity study, covariance matrix I-4 is input to INER as matrix A (matrix I-5), and normal matrix I-1 is input as matrix B (matrix I-6). The effect of type 1 perturbation matrix I-7 on covariance matrix I-5 is determined by comparing matrices I-6 and I-8. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed covariance matrix I-5 differ in the 4th digit. Similarly, a comparison of matrices I-10 and I-6 shows that the effect of type 2 perturbation matrix I-9 on covariance

matrix I-5 in general is to change the elements of normal matrix I-6 in the 3rd digit.

A comparison of matrices I-12 and I-6 shows that the effect of type 3 perturbation matrix I-11 on covariance matrix I-5 in general is to change the elements of normal matrix I-6 in the 5th digit. Similarly, a comparison of matrices I-14 and I-6 shows that the effect of type 4 perturbation matrix I-13 on covariance matrix I-5 in general is to change the elements of normal matrix I-6 in the 5th digit.

In summary, the effect of perturbation matrices I-7, I-9, I-11, and I-13 on covariance matrix I-5 in general is to change the elements of normal matrix I-6 in the 4th, 3rd, 5th, and 5th digit, respectively.

4.8 Covariance Matrix 8

Normal matrix 8 provided by LRC is given in appendix J as matrix J-1. The approximate covariance matrix J-2 is obtained by inverting matrix J-1 in ordinary single precision. Matrices J-1 and J-2 are then input to INER, and the error in the approximate covariance matrix J-2 is computed to be matrix J-3. The corrected covariance matrix J-4 is the sum of matrices J-2 and J-3. Notice that nearly every element of the error matrix J-3 is the negative of the corresponding element in matrix J-2. This large error means that matrix J-2 is a very poor inverse of J-1, which implies that matrix J-1 cannot be inverted in single precision. Notice that the corrected covariance matrix J-4 is not symmetric. This nonsymmetry is explained by the fact that matrix J-4 is the sum of a double precision matrix J-3 and a single precision matrix J-2 in which the single precision number is canceling the most significant part of the double precision number and leaving the least significant part. (Recall that although the error matrix, in this case matrix J-3, is output by INER in the same precision as the inputs, it is always computed in double precision. Thus, when the sum of matrices J-3 and J-2 is computed internally by INER, matrix J-3 is treated as a double precision matrix. The fact that the error matrix is always computed in double precision is mentioned in appendix A). The fact that matrix J-4 is not symmetric immediately implies that it too is

a poor inverse of the symmetric matrix J-1. In order to get the inverse of matrix J-1 it is necessary to invert it in high precision on INER.

Matrix J-1 is inverted on INER by assuming its approximate inverse is the zero matrix. Thus, matrix J-1 is input to INER as matrix A (matrix J-5) and the zero matrix is input as matrix B (matrix J-6). The error matrix J-7 and the corrected inverse matrix J-8 output by INER are, of course, identical and the inverse of matrix J-5. Matrices J-8 and J-5 are used in the sensitivity study of covariance matrix J-8 (also referred to as covariance matrix 8).

For the sensitivity study, covariance matrix J-8 is input to INER as matrix A (matrix J-9) and normal matrix J-5 is input as matrix B (matrix J-10). The effect of type 1 perturbation matrix J-11 on covariance matrix J-9 is determined by comparing matrices J-12 and J-10. This comparison shows that in general corresponding elements of the inverses of the perturbed and unperturbed covariance matrix J-9 differ in the 1st digit. Similarly, a comparison of matrices J-14 and J-10 shows that the effect of type 2 perturbation matrix J-13 on covariance matrix J-9 in general is to change the elements of normal matrix J-10 in the 1st digit.

A comparison of matrices J-16 and J-10 shows that the effect of type 3 perturbation matrix J-15 on covariance matrix J-9 in general is to change the elements of normal matrix J-10 in the 1st digit. Similarly, a comparison of matrices J-18 and J-10 shows that the effect of type 4 perturbation matrix J-17 on covariance matrix J-9 in general is to change the elements of normal matrix J-10 in the 2nd digit.

A comparison of matrices J-12 and J-14 shows that perturbation matrices J-11 and J-13 neither change the elements of normal matrix J-10 in the same direction nor change them in the opposite direction. For example, the (1, 1) element of matrix J-10 is decreased by both perturbation matrices J-11 and J-13; however, the (6, 1) element of matrix J-10 is decreased by perturbation matrix J-11 and increased by perturbation matrix J-13. Similarly, a comparison of matrices J-16 and J-18 shows that perturbation matrices J-15 and J-17 neither change the elements of normal matrix J-10 in the same direction nor change them in the opposite direction.

In summary, the effect of perturbation matrices J-11, J-13, J-15, and J-17 on covariance matrix J-9 in general is to change the elements of normal matrix J-10 in the 1st, 1st, 1st, and 2nd digit, respectively.

The effects of the four perturbations on each matrix studied along with the accuracy of its single precision inverse are tabulated below for reference.

Table I. Summary of Sensitivity Study

The significant figure which the perturbation effects is tabulated below.

Matrix	Perturbation Type				Accurate significant figures in the single precision inverse
	Type 1	Type 2	Type 3	Type 4	
Normal Matrix 1	3rd	2nd	5th	5th	3
Normal Matrix 2	1st	1st	2nd	3rd	1
Covariance Matrix 3	2nd	1st	4th	4th	3
Covariance Matrix 4	2nd	2 orders of magnitude	3rd	3rd	3
Covariance Matrix 5	1st	1st	2nd	3rd	1
Normal Matrix 6	1st	1st	2nd	3rd	1
Normal Matrix 7	4th	3rd	5th	5th	3
Normal Matrix 8	1st	1st	1st	2nd	0

5. NEW TECHNOLOGY

This section is included to comply with the requirements of the "New Technology" clause of the Master Agreement under which this report was prepared. The most significant new technology resulting from this contract is the development of a high precision matrix inversion program by TRW Systems.

APPENDIX A

INER Program Description

1. INTRODUCTION

The TRW Inversion Error Program (INER) is a matrix inversion program which uses a high precision matrix multiplication subroutine. Because of this high precision subroutine, INER is more accurate than ordinary single and double precision matrix inversion programs.

The high precision matrix multiplication subroutine differs from ordinary single and double precision matrix multiplication subroutines in the method used to compute products and sums. The entire product, which results from multiplying two numbers, is saved in high precision multiplication, as compared to ordinary single and double precision multiplication where part of the product is lost because of truncation. Sums are calculated in high precision by first summing numbers of the same magnitude and then summing numbers of different magnitudes, as opposed to just summing numbers without regard to magnitude as is done in ordinary single and double precision.

2. CALCULATION OF A^{-1}

Let A and B be two Nth order matrices, $N \leq 40$, where B is the approximate inverse of A. A and B can be either single or double precision. In order to determine the correct inverse of A, A^{-1}, it is necessary to compute the error matrix E defined by

$$E = A^{-1} - B \qquad \text{(A-1)}$$

Once the matrix E is known it is simply added to B to obtain A^{-1}.

To compute E, calculate in high precision the Nth order double precision residual matrix

$$R = AB - I \tag{A-2}$$

where I is the identity matrix. From equation (A-1) one has

$$R = - AE \tag{A-3}$$

In order to solve equation (A-3) for E, it is necessary to precondition the matrix A obtaining the double precision conditioned matrix

$$G = MA \tag{A-4}$$

and the double precision matrix M.

The preconditioning of A consists of a normalization and an orthogonalization. The normalization consists of dividing each row by its maximum magnitude element. The orthogonalization consists of the usual Gram-Schmidt orthogonalization procedure in which a set of N orthogonal row vectors is formed from a set of N row vectors.

Once the matrix M has been calculated the Nth order double precision matrix MR is computed with the high precision matrix multiplication subroutine. From equations (A-3) and (A-4) one has

$$MAE = - MR$$

$$GE = - MR \tag{A-5}$$

The matrix E is solved for in equation (A-5). Both matrices G and MR are double precision and the matrix E is solved for in double precision.

3. CALCULATION OF $A^{-1} - (A + F)^{-1}$

In addition to computing A^{-1} as described above, INER also has the capability to compute the error in taking the inverse of A + F to be the inverse of A, where F is a given perturbation matrix. This error is defined as the difference $A^{-1} - (A + F)^{-1}$. INER computes this difference by inverting the matrices A and A + F and then computing the difference $A^{-1} - (A + F)^{-1}$.

The inversion of matrix A is described above. Recall that the matrix E of equation (A-1) is solved for in equation (A-5) and A^{-1} is given by

$$A^{-1} = B + E \tag{A-6}$$

The matrix A + F is inverted by repeating the procedure used to invert matrix A with A + F in place of A and B unchanged. Thus the error matrix

$$\hat{E} = (A + F)^{-1} - B \tag{A-7}$$

associated with A + F is the solution of equation (A-5) in which, of course, matrices G and MR have been formed from A + F. Thus one has

$$(A + F)^{-1} = B + \hat{E} \tag{A-8}$$

From equations (A-6) and (A-8) the difference $A^{-1} - (A + F)^{-1})$ is

$$A^{-1} - (A + F)^{-1} = B + E - B - \hat{E} = E - \hat{E}$$

Both matrices E and $\hat{E}$ are saved in computer memory and the difference $E - \hat{E}$ is output.

3.1 Formation of A + F

The matrix A + F can be formed in two different ways from the matrices A and F. In the first way, the matrix A + F is formed by simply adding

the matrices A and F, i.e.

$$(A + F)_{ij} = A_{ij} + F_{ij} \qquad \text{(A-9)}$$

where $(\ )_{ij}$ denotes the matrix element in the ith row and the jth column. In the second way, the matrix A + F is formed by multiplying each element of A by the corresponding element of F and then adding the product to the element of A, i.e.

$$(A + F)_{ij} = A_{ij} + A_{ij} F_{ij}$$

The way in which A + F is formed is specified as an input.

4. SUMMARY OF INPUTS AND OUTPUTS

The inputs to INER are:

1) Matrix A (matrix to be inverted)

2) Matrix B (approximate inverse of matrix A)

3) Matrix F (perturbation matrix)

4) A specification of the way in which the matrix A + F is to be formed.

The outputs of INER are:

1) Matrix E (error matrix A^{-1} - B)

2) Matrix B + E (inverse of matrix A)

3) Matrix E - $\hat{E}$ (error matrix A^{-1} - $(A + F)^{-1}$)

APPENDIX B

Matrices Associated with the Normal-Covariance Matrix Pair

This appendix contains the matrices involved in the determination of the covariance matrix error.

NORMAL MATRIX OF SOLUTION FOR SPACECRAFT STATE AND LUNAR GRAVITATIONAL CONSTRAINTS

Orbit Parameters*		Tracking Station	Data Types	Data Weight, σ	Data Tracking Interval	Number of Data Points
a	2686 km	Lat. = 35 deg	R & $\dot{R}$	σ_R = 10 m	3.47 hrs.	22
e	.336	Radius = 6373 km		$\sigma_{\dot{R}}$ = 0.002 m/s		
i	15 deg	Long. = longitude of				
ω	30 deg	earth-moon line				
Ω	0 deg	at t_o				
$-nt_o$	0 deg					

A priori used; in order of above solution parameters; 0.1×10^7, 0.1, 0.1, 0.1, 0.1, 0.1, 0.01, 0.01, 1000, 1×10^5, 0.1, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0

Solution parameters: a, e, i, ω, Ω, $-nt_o$,
Lat. Sta., Long. Sta., Radius Sta., Earth-moon distance,
C_{00}, C_{20}, C_{21}, C_{22}, C_{30}, C_{40}, C_{50}, S_{21}, S_{22}

*(Referenced to earth-moon plane and earth-moon line. Earth equator, lunar equator and earth-moon plane are coplanar in the tracking model.)

A MATRIX AS INPUT

	1	2	3	4
1	0.2867125510364427 2D 01	0.1080740702372949 8D-00	-0.4740932727787721 7D-02	-0.6553640097754870 9D 00
2	0.1080740702372949 8D-00	0.2253841418039181 9D 01	-0.1706821350303083 8D-01	0.4665701024509769 1D-01
3	-0.4740932727787721 7D-02	-0.1706821350303083 8D-01	0.1970417862607549 7D-01	-0.2026416312725448 1D-01
4	-0.6553640097754870 9D 00	0.4665701024509769 1D-01	-0.2026416312725448 1D-01	0.3073274574532093 9D-00
5	-0.1152251440499679 8D 01	0.4433950951798234 0D-00	-0.6882451127001851 2D-02	0.2920658381244198 3D-00
6	-0.6407683291636061 0D 00	0.1271661907251198 7D-00	0.9018114418565373 3D-03	0.1860173828389163 9D-00
7	-0.1376767045606845 9D-00	-0.2465739197368058 7D-00	0.1878268990318396 9D-01	0.2940352768888883 6D-01
8	-0.2503432836563200 8D-00	-0.3088565674416198 2D-00	0.5329566575831551 0D-01	-0.1019776906228109 8D-00
9	-0.9908020599797797 7D-01	-0.1204027573956563 7D-01	0.8783362848139051 3D-02	-0.6365233800925453 9D-02
10	-0.1277948797129694 9D-00	-0.1256132620648767 2D-00	0.2005073222698006 1D-01	-0.2830794349007859 1D-01
11	-0.1059737267522666 7D 02	-0.3765950728719086 9D 01	0.4796518658340559 5D-01	0.2467013887019340 9D 01
12	0.6277588355787696 6D 01	0.3645080996026487 9D 01	0.5088614535230934 8D-02	-0.1811486660929234 6D 01
13	-0.2275183113604690 7D 03	0.3215353503220402 3D 03	0.1009322839165224 8D 02	0.3443731176117486 0D 02
14	-0.6734917828009724 4D 02	0.4909515817140279 7D 02	0.1239988984982879 0D 01	0.3630489644357926 5D 01
15	-0.2871182062607 798D 02	0.5914279750374789 0D 02	0.9895972142272088 7D 01	-0.8920101871127710 2D 02
16	-0.3706437868762941 8D 01	-0.2695122212928760 5D 01	-0.1924466812117623 9D-01	0.1177611873943263 9D 01
17	0.2578691869941 03160 02	-0.5276005221645572 2D 02	-0.8797749533674179 6D 01	0.7933069643661931 9D 02
18	-0.1585545282274 6689D 03	0.8892946557230318 5D 02	0.8916767561010148 2D 00	0.1766691213260118 1D 02
19	-0.7401076493990370 73D 02	-0.7739186263887557 5D 02	-0.7549194753513982 5D 00	0.1762511646769953 1D 02

NORMAL MATRIX

MATRIX B-1

A MATRIX AS INPUT

	5
1	-0.115225144049967980 01
2	0.443395095179823400-00
3	-0.688245112700185120-02
4	0.292065838124419830-00
5	0.984970747656946480 00
6	0.309555967924175110-00
7	-0.889660102577953690-01
8	-0.122831144546763800-00
9	0.409233637646968360-01
10	-0.250636787027258560-01
11	0.397272653946872060 01
12	-0.100402551576249390 01
13	0.356545785017786390 03
14	0.912940188594529970 02
15	0.234399125060176020 02
16	0.114988961433479090-00
17	-0.214379443432720080 02
18	0.169654960526605760 03
19	-0.573437672503153530 01

NORMAL MATRIX

	6
1	-0.640768329163606100 00
2	0.127166190725119870-00
3	0.901811441856537330-03
4	0.186017382838916390-00
5	0.309555967924175110-00
6	0.201953031541205360-00
7	-0.271193643324176890-02
8	-0.487251433313943830-01
9	0.113636973528621180-01
10	-0.114092628624887170-01
11	0.217007185974780410 01
12	-0.120384332707263900 01
13	0.794616049242594210 02
14	0.159179567786779390 02
15	0.103051926000755080 01
16	0.667487694478065940 00
17	-0.958956556474087120 00
18	0.435345685855531910 02
19	0.158580300785113260 02

	7
1	-0.137676704560684590-00
2	-0.246573919736805870-00
3	0.187826899031839690-01
4	0.294035276888888360-01
5	-0.889660102577953690-01
6	-0.271193643324176890-02
7	0.258496323222210670-00
8	0.417352046534662510-00
9	0.565591992098629700-01
10	0.166913264062864890-00
11	0.621880199087357980 00
12	-0.822661148673960170 00
13	-0.460218959398873810 02
14	-0.161009154786436290 02
15	0.304950289107380480 01
16	0.657710118515488940 00
17	-0.258670320588383800 01
18	-0.264262846048841760 02
19	0.192575722931467520 02

MATRIX B-1

	8
1	-0.250343283656320080-00
2	-0.308856567441619820-00
3	0.532956657583515510-01
4	-0.101977690622810980-00
5	-0.122831144546763800-00
6	-0.487251433313943830-01
7	0.417352046534662510-00
8	0.103987528222996780 01
9	0.161222685436371970-00
10	0.404184850554217160-00
11	0.776602112549840130 00
12	-0.723239011910528530 00
13	-0.115584947796810390 02
14	-0.822582485080364080 01
15	0.131775183379100380 03
16	0.558153158402945600 00
17	-0.117001523962899260 03
18	-0.156756829281767870 02
19	0.320118459731944470 02

A MATRIX AS INPUT

	9
1	-0.990802059979779770-01
2	-0.120402757395556370-01
3	0.878336284813906130-02
4	-0.636523380092545390-02
5	0.409233637648968360-01
6	0.113636973528621180-01
7	0.555591992098629700-01
8	0.161222685436371970-0[illegible]
9	0.416324174325473470-01
10	0.683169888697204300-01
11	0.351985113991536090-00
12	-0.130942408875044490-00
13	0.156324548641941560 02
14	0.528732122218198150 01
15	0.226273845201715670 02
16	0.531637438257500480-01
17	-0.201356231643694480 02
18	0.986628908346694980 01
19	0.322565500300831980 01

NORMAL MATRIX

	10	11
1	-0.127794879712969490-00	-0.105973726752266070 02
2	-0.125613262064876720-00	-0.376595072871908690 01
3	0.200507322269800610-01	0.479651865834055950-01
4	-0.283079434900785910-01	0.246701388701934090 01
5	-0.250636797027258560-01	0.397272653946872060 01
6	-0.114092628624887170-01	0.217007185974780410 01
7	0.166913264062864890-00	0.621880199087357980 00
8	0.404184850554217160-00	0.776602112549840130 00
9	0.683169888697204300-01	0.351985113991536090-00
10	0.159936895076742300-00	0.453896944426688600-00
11	0.453896944426688600-00	0.471675623907186810 02
12	-0.356608137581167990-00	-0.292579977672422780 02
13	-0.235517114702789020 01	0.358164684519883540 03
14	-0.145970047652136670 01	0.249956046984287080 03
15	0.461591669244613370 02	-0.289549010469369480 03
16	0.255497059328587020-00	0.176846047192216190 02
17	-0.409935879555847040 02	0.255913191804033880 03
18	-0.285258486748078410 01	0.512680958895034510 03
19	0.122132941452405[illegible]0 02	0.289703553551012680 03

MATRIX B-1

	12
1	0.627758835578769660 01
2	0.364508099602648790 01
3	0.508861453523093480-02
4	-0.181148666092923460 01
5	-0.100402551576249390 01
6	-0.120384332707263900 01
7	-0.822661148673960170 00
8	-0.723239011910528530 00
9	-0.130942408875044490-00
10	-0.356608137581167990-00
11	-0.292579977672422780 02
12	0.230110157804566780 02
13	0.505151331211928180 03
14	0.547382038431283080 02
15	0.460087635083683330 03
16	-0.155475873175248580 02
17	-0.409722123559176700 03
18	0.418262906445845680 02
19	-0.265121974785590910 03

A MATRIX AS INPUT

	13
1	-0.2275183113604690 70 03
2	0.3215353503226490 230 03
3	0.1009322839165224 80 02
4	0.3443731176117486 00 02
5	0.3565457850177863 90 03
6	0.7946160492425942 10 02
7	-0.4602189593988738 10 02
8	-0.1155849477968103 90 02
9	0.1563245486419415 60 02
10	-0.2355171147027890 20 01
11	0.3581646845198835 40 03
12	0.5951513312119281 80 03
13	0.2381154217413892 80 06
14	0.3836105020292711 60 05
15	0.5345080913481186 60 05
16	-0.5479847338721536 40 03
17	-0.4772627853066019 30 05
18	0.7097585003890234 40 05
19	-0.7299546782573946 80 04

NORMAL MATRIX

	14	15
1	-0.6734917828009724 40 02	-0.2871182062607979 80 02
2	0.4909515817140279 70 02	0.5914279750374789 00 02
3	0.1239988988498287 90 01	0.9895972142272088 70 01
4	0.3630489644357926 50 01	-0.8920101871127710 20 02
5	0.9129401885945299 70 02	0.2343991250601760 20 02
6	0.1591795677867793 90 02	0.1030519260007550 80 01
7	-0.1610091547864362 90 02	0.3049502891073804 80 01
8	-0.8225824850803640 80 01	0.1317751833791003 80 03
9	0.5287321222181981 50 01	0.2262738452017156 70 02
10	-0.1459700476521366 70 01	0.4615916692446133 70 02
11	0.2499560469842870 80 03	-0.2895490104693694 80 03
12	0.5473820384312830 80 02	0.4600876350836833 30 03
13	0.3836105020292711 60 05	0.5345080913488118 60 05
14	0.1203710244728690 70 05	0.9616403993857712 30 04
15	0.9616403993857712 30 04	0.1065974820349235 90 06
16	-0.1028394777760589 50 03	-0.3524246007965068 90 03
17	-0.8635090790066671 20 04	-0.9477117746813473 70 05
18	0.1896723588194513 80 05	0.2015385581975139 80 05
19	-0.4925960462732682 50 04	-0.9339104922899250 10 03

MATRIX B-1

	16
1	-0.3706437868762941 80 01
2	-0.2695122212928760 50 01
3	-0.1924466812117623 90-01
4	0.1177611873943263 90 01
5	0.1149889614334790 90-00
6	0.6674876944780659 40 00
7	0.6577101185154889 40 00
8	0.5581531584029456 00 00
9	0.5316374382575014 80-01
10	0.2554970593285870 20-00
11	0.1768460471922161 90 02
12	-0.1554758731752485 80 02
13	-0.5478847338721536 40 03
14	-0.1028394777760589 50 03
15	-0.3524246007965068 90 03
16	0.1095514712948426 60 02
17	0.3142830782945740 80 03
18	-0.1453742619269063 90 03
19	0.1912781884538752 90 03

A MATRIX AS INPUT

NORMAL MATRIX

MATRIX B-1

	17	18	19
1	0.257869186994103160 02	-0.158554528227486890 03	-0.740076493990370730 02
2	-0.527600522164557220 02	0.889294655723031850 02	-0.773918626388755750 02
3	-0.879774953367417960 01	0.891676756101011482D 00	-0.754919475351398250 00
4	0.793306964366193190 02	0.176669121326011810 02	0.176251164676995310 02
5	-0.214379443432720080 02	0.169654960526605780 03	-0.573437672503153530 01
6	-0.958956556474088712D 00	0.435345685855531910 02	0.158580300785113260 02
7	-0.258670320588383800 01	-0.264262846048841760 02	0.192575722931467520 02
8	-0.117001523962899260 03	-0.156756829281767870 02	0.320118459731944470 02
9	-0.231356231643694480 02	0.986628908346694980 01	0.322565500300831980 01
10	-0.409935879555847040 02	-0.285258486748078410 01	0.122132941452400500 02
11	0.255913191804033880 03	0.512680958895034510 03	0.289703553551012680 03
12	-0.409722123559176700 03	0.418262906445845680 02	-0.265121974785590910 03
13	-0.477262785306600193D 05	0.709758500389023440 05	-0.729954678257394680 04
14	-0.863569079005667120 04	0.189672358819451380 05	-0.492596046273268250 04
15	-0.947711774681347370 05	0.201538558197513980 05	-0.933910492289925010 03
16	0.314283078294574080 03	-0.145374261926906390 03	0.191278188453875290 03
17	0.842577926528885580 05	-0.180484143049152060 05	0.874784118023982540 03
18	-0.180484143049152060 05	0.345541631445610950 05	-0.321112766540236960 04
19	0.874784118023982540 03	-0.321112766540236960 04	0.147723924319019870 05

B MATRIX AS INPUT

COVARIANCE MATRIX

MATRIX B-2

	1	2	3	4
1	0.172173394217051970 03	0.884802917003543850 02	0.212148503540560810 03	0.596573579831065900 02
2	0.884802917003395530 02	0.516043433290023170 02	0.142012797132106790 03	0.101452783325017560 03
3	0.212148503540414590 03	0.142012797132048560 03	0.720497545902278820 03	0.711026568777484880 03
4	0.596573579828822920 02	0.101452783324920190 03	0.711026568777357260 03	0.145177383364662790 04
5	-0.407433037720351610 02	-0.109568123223742490 03	-0.780831786823268980 03	-0.167185685107715200 04
6	-0.559043133950144100 02	-0.412766889794649930 02	-0.243588530379284460 03	-0.284408806749635590 03
7	0.104314959940043360 02	-0.671793990504523260 01	-0.909126946257060200 02	-0.215759450001761890 03
8	0.331104194095720700 02	-0.687888769144042900 02	-0.528870372485466090 03	-0.132571300857225570 04
9	-0.246013709169182970 02	-0.104606779031648000 03	-0.709395406544675480 03	-0.152858680471998460 04
10	-0.856227400056340570 02	0.216454688841067170 03	0.168493427627389780 04	0.416983403435466140 04
11	0.104059580664900510 03	0.695160730978084620 02	0.193440914346922290 03	0.256240198923212430 03
12	0.328555470710103660 03	0.220371884178439890 03	0.680060915427672050 03	0.836585348091813670 03
13	-0.331343819585388110-01	-0.609753587565439240-03	-0.953842783739547450-02	0.224820622701771670-00
14	-0.110203521489439180 01	-0.512199568310293340 00	-0.861177140786395180 00	0.861982582956556160 00
15	-0.124596178210089670 02	-0.104573593460788590 02	-0.445715967603566960 02	-0.755447601402706890 02
16	0.379322392121369090 03	0.241501403874524960 03	0.751696410870308310 03	0.779934120049407880 03
17	-0.141012357915222600 02	-0.118133656987514660 02	-0.502897947582109370 02	-0.851721649191361950 02
18	0.106088618632098510 01	0.757493162233958790 00	0.412871919345489340 01	0.498324058232685940 01
19	0.145677685739877550-00	0.100036053350867680-00	0.424264461938059330-00	0.471082340874167280-00

B MATRIX AS INPUT

COVARIANCE MATRIX

	5	6	7	8
1	-0.40743303772777451D 02	-0.55904313394812871D 02	0.10431495993948431D 02	0.30110419409445538D 02
2	-0.10956812322423659D 03	-0.41276688979293663D 02	-0.67179399050759769D 01	-0.68788876914438196D 02
3	-0.78083178682491777D 03	-0.24358853037857858D 03	-0.90912694625783563D 02	-0.52887037248541108D 03
4	-0.16718568510795456D 04	-0.28440880674845126D 03	-0.21575945000186447D 03	-0.13257130085720675D 04
5	0.20610379420972819D 04	0.22559407417056937D 03	0.28662093159895807D 03	0.16499037522827836D 04
6	0.22559407417219196D 03	0.23884435282881017D 03	-0.31158188226096117D 02	0.43780332534657701D 02
7	0.28662093159933688D 03	-0.31158188226352496D 02	0.13904275928610187D 03	0.47891325536060769D 03
8	0.16499037522856458D 04	0.43780332533357680D 02	0.47891325536076429D 03	0.25321876879831196D 04
9	0.19408802123861035D 04	0.53815342667501176D 02	0.57359201431500878D 03	0.28336880365932177D 04
10	-0.52520493136981455D 04	-0.64271172514120067D 02	-0.15883081200579247D 04	-0.80389088358579236D 04
11	-0.34707036009140257D 03	0.15957275993240055D 02	-0.45261416866206583D 02	-0.23398288944711026D 03
12	-0.11681730144442898D 04	0.62870718878015497D 02	-0.15610770487505926D 03	-0.71632179849578348D 03
13	-0.31790218375426071D-00	0.59153743254751107D-01	-0.69139712262542952D-01	-0.36466938767252360D-00
14	-0.11395393839349571D 01	0.16009481525279817D-00	-0.27740956653526821D-00	-0.17166067059826240D 01
15	0.70646168629802136D 02	0.16835071463493639D 02	0.15348430508606775D 02	0.87124545643358777D 02
16	-0.10899275929132590D 04	0.28179644528097048D 02	-0.13635526694963901D 03	-0.59040113551184198D 03
17	0.79514001068955997D 02	0.19112384041385388D 02	0.17262711021751148D 02	0.98239575452892808D 02
18	-0.59075597176318917D 01	-0.16953656863862987D 01	-0.52689443788458257D 00	-0.31109459325920152D 01
19	-0.40575709950223668D-00	-0.25398892617248198D-00	-0.46478560219714699D-01	-0.50628010165437604D 00

B MATRIX AS INPUT

COVARIANCE MATRIX

MATRIX B-2

	9	10	11	12
1	-0.24601370917463566D 02	-0.85622740004912984D 02	0.10405958066522736D 03	0.32855547071135238D 03
2	-0.10460677903200311D 03	0.21645468884142760D 03	0.69516073098042003D 02	0.22037188417934106D 03
3	-0.70939540654585548D 03	0.16849342762747155D 04	0.19344091434772798D 03	0.68006091543082947D 03
4	-0.15285868047217410D 04	0.41698340343556428D 04	0.25624019892449079D 03	0.83658534809679386D 03
5	0.19408802123851698D 04	-0.52520493136909407D 04	-0.34707036009205272D 03	-0.11681730144474045D 04
6	0.53815342669163141D 02	-0.64271172518383179D 02	0.15957275992704978D 02	0.62870718876218451D 02
7	0.57359201431524598D 03	-0.15883081200577609D 04	-0.45261416866445070D 02	-0.15610770487600867D 03
8	0.28336880365954026D 04	-0.80389088358596728D 04	-0.23398288944866147D 03	-0.71632179850172595D 03
9	0.34225559887756668D 04	-0.91652669324716984D 04	-0.29288736276274313D 03	-0.94031168226358869D 03
10	-0.91652669324766334D 04	0.25704260153422637D 05	0.76077929941639949D 03	0.23744274525172293D 04
11	-0.29288736276169125D 03	0.76077929941205835D 03	0.18207400678760288D 03	0.59132541279791873D 03
12	-0.94031168225912165D 03	0.23744274525002462D 04	0.59132541279758499D 03	0.19753881313324406D 04
13	-0.36300308507256052D-00	0.11467872202290247D 01	0.87204500487063363D-01	0.25954989209374663D-00
14	-0.15253954749511506D 01	0.52600148294000060D 01	-0.60539909410880033D 00	-0.19293216662369189D 01
15	0.83378507263950841D 02	-0.26360300868397368D 03	-0.13105254083127660D 02	-0.35838352650605521D 02
16	-0.83693266672552075D 03	0.19909491184900789D 04	0.58346975714743554D 03	0.19716798537488200D 04
17	0.93970033621096133D 02	-0.29713193981453556D 03	-0.14716225741034161D 02	-0.40143613293810504D 02
18	-0.47039589613266253D 01	0.10278170940589426D 02	0.10025841614524317D 01	0.37681791878610854D 01
19	-0.54544985738846458D 00	0.14872995248722976D 01	0.27868212340206527D-01	0.55672319763318850D-01

B MATRIX AS INPUT

COVARIANCE MATRIX

MATRIX B-2

	13	14	15	16
1	-0.331343819584525300-01	-0.110203521489435300 01	-0.124596178208017660 02	0.379322392122598050 03
2	-0.609753587510270640-03	-0.512199568310204250 00	-0.104573593459057870 02	0.241501403875408860 03
3	-0.953842783722147670-02	-0.861177140785558790 00	-0.445715967596363060 02	0.751696410873380790 03
4	0.224820622703044670-00	0.861982582957704470 00	-0.755447601391055770 02	0.779934120054242230 03
5	-0.317902183754029620-00	-0.113953938393781760 01	0.706461686281969200 02	-0.108992759291626270 04
6	0.591537432544477270-01	0.160094815253323310-00	0.168350714634944780 02	0.281796445263512500 02
7	-0.691397122625746930-01	-0.277409566535487820-00	0.153484305083546270 02	-0.136355266950563990 03
8	-0.364669387872876710-00	-0.171660675598315300 01	0.871245456420794100 02	-0.590401135517634290 03
9	-0.363(030850725[545D-00	-0.152539547495304850 01	0.833785072623284880 02	-0.836932666729866050 03
10	0.114678722022977580 01	0.526001482940271440 01	-0.263603008679839990 03	0.199094911850752570 04
11	0.872045004868480360-01	-0.605399094107695770 00	-0.131052540825927380 02	0.583469757147766670 03
12	0.259549892092848620-00	-0.192932166623263570 01	-0.358383526487956240 02	0.197167985374882890 04
13	0.146762630198901070-03	0.346547745794898330-03	-0.147829241340576680-01	0.200123572435734310-00
14	0.346547745794622390-03	0.104801342970536390-01	0.228405372799152570-01	-0.230223215471994090 01
15	-0.147829241343481(80-01	0.228405372805152610-01	0.158135499285524280 02	-0.343454715118748370 02
16	0.200123572434856290-00	-0.230223215471566880 01	-0.343454715101063790 02	0.200920290011058160 04
17	-0.166015589014412710-01	0.258806583130932190-01	0.178369978420299670 02	-0.384749648626376120 02
18	-0.109848366827072660-03	-0.351725156388731360-02	-0.153956134014307690-00	0.425553702363476230 01
19	-0.438579224580994580-04	0.443875169761012490-04	-0.602294161060103810-01	0.104857690955679590-00

B MATRIX AS INPUT COVARIANCE MATRIX MATRIX B-2

	17	18	19
1	-0.141012357912882860 02	0.106088618632423300 01	0.145677685739152C 7D-00
2	-0.118133656985560550 02	0.757493162236200461D 00	0.100036053350259780-00
3	-0.502397947573976990 02	0.412871919346253890 01	0.424264461935538910-00
4	-0.851721649178206920 02	0.498324058233812710 01	0.471082340870074720-00
5	0.795140C1067144469D 02	-0.590755971763726680 01	-0.405757090496471350-00
6	0.191123840413860990 02	-0.169536568639118090 01	-0.253988926172550590-00
7	0.172627110214665480 02	-0.526894437886653360 00	-0.464785602188255760-01
8	0.982395754514744700 02	-0.311094593260525350 01	-0.506280101649970500 00
9	0.939700336192651590 02	-0.470395896133517290 01	-0.545449857382671320 00
10	-0.297131939809869680 03	0.162781709406261470 02	0.148729952485772250 01
11	-0.147162257404305390 02	0.100258416145250160 01	0.278682123382480270-01
12	-0.401436132917682990 02	0.376817918785841750 01	0.556723197566679760-01
13	-0.166015589011134560-01	-0.109848366825299190-03	-0.438579224591410190-04
14	0.258806583124154550-01	-0.351725156390009010-02	0.443875169782142860-04
15	0.178369978420297280 02	-0.153956134019295480-00	-0.602294161060730580-01
16	-0.384749648606421800 02	0.425553702363231310 01	0.104857690949185290-00
17	0.201195918342300110 02	-0.173484274996777270-00	-0.681206014601709260-01
18	-0.173484274991149210-00	0.318131903132750420-01	0.212572645807216580-02
19	-0.681206014600993610-01	0.212572645809023630-02	0.719866147739895550-03

ERROR MATRIX (E)

COVARIANCE MATRIX ERROR

MATRIX B-3

	1	2	3	4
1	-0.709879409307560490-09	-0.453805747795973880-09	-0.143395719600451780-08	-0.162260907113525140-08
2	-0.455245478620264320-09	-0.287010820307637470-09	-0.868563528816851390-09	-0.910949791422976440-09
3	-0.131859801473594380-08	-0.804419501743145190-09	-0.218783788766190530-08	-0.185709814755749660-08
4	-0.142563344663920180-08	-0.813548595927058970-09	-0.174097464084178870-08	-0.442290656098917210-09
5	0.189889493743098770-08	0.119062120699740650-08	0.331811384444354600-08	0.303624509522659570-08
6	-0.915908788124364380-10	-0.123433829738124060-09	-0.790327929600032180-09	-0.165115811904270330-08
7	0.299143153588718510-09	0.171447498327317820-09	0.368515003047400480-09	0.866384175725209090-10
8	0.135132370815525040-08	0.718106036385756710-09	0.114129803606140220-08	-0.878161174715736510-09
9	0.168590269659718220-08	0.981478065814662130-09	0.224109976071314500-08	0.955462740844750250-09
10	-0.441280029212837490-08	-0.241742402955187730-08	-0.440762344779299430-08	0.117931306376725390-08
11	-0.107186890584904440-08	-0.731642561652160070-09	-0.253052339150129370-08	-0.330507046133610090-08
12	-0.353876308928331830-08	-0.244723811938798000-08	-0.862728688513614060-08	-0.115895118649210930-07
13	-0.444551464286335460-12	-0.280409122891261240-12	-0.806054109926263750-12	-0.742450498999910340-12
14	0.432523230804314370-11	0.290435370352173150-11	0.101602554172693930-10	0.133177599782976390-10
15	0.136988571668511580-09	0.417069749848309630-10	-0.164546038562265240-09	-0.785095399981000250-09
16	-0.357118059479357150-08	-0.246934120242092270-08	-0.871672176462720440-08	-0.117408510677531270-07
17	0.154050639546032990-09	0.467038772840493170-10	-0.186965587336039070-09	-0.887583729696046870-09
18	-0.630177861058052790-11	-0.414883264328979650-11	-0.130707068731733210-10	-0.156157577304970980-10
19	-0.370098547417232860-12	-0.467025102568844770-13	0.104554495422781830-11	0.353746938274869640-11

ERROR MATRIX (E)

COVARIANCE MATRIX ERROR

MATRIX B-3

	5	6	7	8
1	0.260170379162715680-08	-0.294237893796951580-09	0.352838306980644390-09	0.139273863345696030-08
2	0.169253880266250160-08	-0.293394165361872680-09	0.202191349653482620-09	0.712326496981912470-09
3	0.501466590582315130-08	-0.149484115817447360-08	0.445318816191924590-09	0.100688538116165180-08
4	0.558097865335402400-08	-0.282451687108209840-08	0.189226577771616610-09	-0.108394584992413610-08
5	-0.776403385467361430-08	0.212247044798055560-08	-0.732394112112102420-09	-0.197388133674513470-08
6	0.505194773289627750-09	0.962136811963345770-09	0.321659843233335520-09	0.215241927738819280-08
7	-0.116564479118192840-08	0.575793826107063530-09	-0.331546557502729930-10	0.259829695939262580-09
8	-0.518200997678743280-08	0.348608159484372880-08	0.959344380123360100-10	0.292938931130440010-08
9	-0.671809126990142400-08	0.299501505018358760-08	-0.290545742522817950-09	0.743181169994236450-09
10	0.171370953553229010-07	-0.102625126981064315D-07	0.209763438701060120-10	-0.718994755755173130-08
11	0.426242470645506970-08	0.357437835835164860-10	0.768109281363842270-09	0.328686673928934860-08
12	0.142019563030244710-07	0.541398140726903570-09	0.247449625945707020-08	0.118105651824025710-07
13	0.176567511355263940-11	-0.427129552966213850-12	0.170016656459285820-12	0.467134855978070860-12
14	-0.158078415503067730-10	-0.736790443158678110-12	-0.279920711126969150-11	-0.131912869765758280-10
15	-0.358593269814436620-09	0.787018836931671130-09	0.150038652436602420-09	0.128007065337338970-08
16	0.142792991440882590-07	0.594573817688594410-09	0.250541615079362570-08	0.119922893531613670-07
17	-0.402411303820702120-09	0.888084047152918720-09	0.169668595754715160-09	0.144611880179630560-08
18	0.258550461183876760-10	-0.328527162001692130-11	0.354975206244991630-11	0.146494207472636750-10
19	0.785532869504575400-12	-0.308880033410527610-11	-0.680070539583677410-12	-0.539572664096169390-11

ERROR MATRIX (E) COVARIANCE MATRIX ERROR MATRIX B-3

	9	10	11	12
1	0.21672220687365129D-08	-0.50170122788294846D-08	-0.13794457034347279D-08	-0.46823349117415108D-08
2	0.13115368929220972D-08	-0.27401752829655884D-08	-0.97300083171648888D-09	-0.33359914365616089D-08
3	0.33320642763776581D-08	-0.51355603589235543D-08	-0.33497713209780339D-08	-0.11670661737602001D-07
4	0.26164144579436727D-08	0.19766246933684667D-09	-0.46119924474732299D-08	-0.16379609370533910D-07
5	-0.53291274100894459D-08	0.89868617425292441D-08	0.49246555522316304D-08	0.17001226407946451D-07
6	0.13380889560538045D-08	-0.59982059539344290D-08	0.56710550365777962D-09	0.23081611542204239D-08
7	-0.51001122357207224D-09	-0.14586977457180172D-09	0.95166940476203077D-09	0.33913100162690163D-08
8	-0.13748282807659895D-08	-0.54116133735785338D-08	0.49720218330828236D-08	0.17923978569075805D-07
9	-0.32855716899932119D-08	0.11197962569533915D-08	0.51871968100468235D-08	0.18333937845117293D-07
10	0.57780916229398466D-08	0.11239732007733327D-07	-0.15398824355312457D-07	-0.55221859338099821D-07
11	0.40354064737674422D-08	-0.10877636716196548D-07	-0.17850294962300417D-08	-0.58172302385677532D-08
12	0.13862981015092779D-07	-0.38519608694431889D-07	-0.55896983701514774D-08	-0.17987674025166300D-07
13	0.12283526021552055D-11	-0.21170917886304780D-11	-0.10911695662759086D-11	-0.37754482717182047D-11
14	-0.15569803229567974D-10	0.43243601026604106D-10	0.64224979707964136D-11	0.20930807296879989D-10
15	0.41708580698391551D-09	-0.32221873047731342D-08	0.81275003917019789D-09	0.30695755478439252D-08
16	0.13996595011559743D-07	-0.39042337377060449D-07	-0.55891272543195131D-08	-0.17966210651759423D-07
17	0.47272301955341217D-09	-0.36415110604386186D-08	0.91619361388599785D-09	0.34607208533904982D-08
18	0.21691332042697786D-10	-0.51360721165407025D-10	-0.13346639834965734D-10	-0.44651251372876599D-10
19	-0.22076573358156110D-11	0.14005234178097864D-10	-0.29007541707567991D-11	-0.11053834339861490D-10

ERROR MATRIX (E)

COVARIANCE MATRIX ERROR

MATRIX B-3

	13	14	15	16
1	-0.5263667[illegible]138428160D-12	[illegible].4093649976820543 7D-11	-0.713227992022320900-10	-0.469000800616959590-08
2	-0.3355777123[illegible]5414280D-12	[illegible].2816424939820766 9D-11	-0.131362555781651740-09	-0.334078569910404910-08
3	-0.9797657237136[illegible]253D-12	[illegible].9273788857377309 7D-11	-0.886131322748271780-09	-0.116727224656791080-07
4	-0.1[illegible]1545422886940[illegible]20-11	0.121947784458956 82D-10	-0.195017735741003560-08	-0.163851452081383630-07
5	0.1493123936746850[illegible]7D-11	-0.131736746028330 13D-10	0.125648560067748270-08	0.169818127359526950-07
6	-0.1260459215768864 30-12	-0.126960205860405 73D-11	0.788431166118547520-09	0.231039576039938690-08
7	0.2017620535841765D-12	-0.259093438833513 16D-11	0.402179573661874120-09	0.339782987078340650-08
8	0.8530979190123532 7D-12	-0.133001802174083 03D-10	0.253607426664868850-08	0.179602795078805390-07
9	0.1292769921593162 0D-11	-0.139565436961714 47D-10	0.203532592076571090-08	0.183453660686316630-07
10	-0.2891030503985351 2D-11	0.412908963700911 85D-10	-0.735563836763695020-08	-0.553166512790761790-07
11	-0.8659486665132089 0D-12	0.525354017891959 13D-11	0.276372600503127340-09	-0.581497930569040760-08
12	-0.2913585603345[illegible]80D-11	0.165300739956587 17D-10	0.126773975207098040-08	-0.179662964419963380-07
13	-0.3215421690424143 9D-15	[illegible].3036884406141828 8D-14	-0.257950395289869240-12	-0.378465828464195960-11
14	0.3304927766883119 5D-14	-0.204015161[illegible]3557974D-13	-0.159679048955226000-11	0.209812623788335590-10
15	0.3247252704152435 7D-13	-0.219877946132794 77D-11	0.617230941919836020-09	0.308683507914908170-08
16	-0.2942807393163626 7D-11	0.165886767682327 46D-10	0.132643542932367020-08	-0.179429534376899510-07
17	0.3620563777553446 33D-13	-0.247847714794248 44D-11	0.696604639088719220-09	0.348019741257983070-08
18	-0.5405805073300[illegible]329D-14	0.361172237326483 79D-13	-0.887211258759497 52D-12	-0.444391701613589040-10
19	-0.2778638581684865 2D-16	0.767940983827102 74D-14	-0.243141229726940[illegible]8D-11	-0.111030653819932210-10

ERROR MATRIX (E) COVARIANCE MATRIX ERROR MATRIX B-3

	17	18	19
1	-0.795670412243515650-10	-0.933641637271866660-11	0.366009187465770270-12
2	-0.147362092899374300-09	-0.639471660556725050-11	0.558419815400552740-12
3	-0.995839162771353310-09	-0.206806531852730290-10	0.355984624369217850-11
4	-0.219307778041367810-08	-0.268580741373065370-10	0.759700822858819460-11
5	0.141120469261269870-08	0.308400429309336480-10	-0.500011491070521790-11
6	0.887740804649755800-09	0.158254800270920870-11	-0.302086175634238560-11
7	0.452298348848345300-09	0.561267978005672800-11	-0.156484607127060470-11
8	0.285282287565429500-08	0.280599646755148870-10	-0.981441447714669570-11
9	0.228841387558979200-08	0.306260431852809820-10	-0.796161051558267110-11
10	-0.827337947592902580-08	-0.881354775546423610-10	0.285245367266719400-10
11	0.312608102964291480-09	-0.132963920431047540-10	-0.945043372472611720-12
12	0.143215572464667980-08	-0.426252677971687920-10	-0.446765817117064480-11
13	-0.289701052875838580-12	-0.716261770114371750-14	0.100948357126431520-14
14	-0.180142110968563030-11	0.488870303802371840-13	0.554179104581549950-14
15	0.694816861805075290-09	0.409889379444661420-11	-0.236694366238769940-11
16	0.149820779691108130-08	-0.426388785400750150-10	-0.467266753210151100-11
17	0.784168563526728200-09	0.461826645406533950-11	-0.267129350149116430-11
18	-0.988188461662529160-12	-0.868351359137846670-13	0.438795535729796020-14
19	-0.273713534070333330-11	-0.135662078894844660-13	0.934629355295721440-14

B MATRIX PLUS E MATRIX CORRECT COVARIANCE MATRIX MATRIX B-4

	1	2	3	4
1	0.172173394216342150 03	0.8848029169990(1087D 02	0.212148503539126840 03	0.596573579814839880 02
2	0.884802916998843110 02	0.5160434332871530 70 02	0.142012797131238210 03	0.101452783324106620 03
3	0.212148503539095980 03	0.1420127971312441 5D 03	0.720497545900091020 03	0.711026568775627810 03
4	0.596573579814506600 02	0.1014527833241066 2D 03	0.711026568775616320 03	0.145177383364618550 04
5	-0.497433037701362690 02	-0.109568123222551830 03	-0.780831786819950910 03	-0.167185685107411550 04
6	-0.559043133951059580 02	-0.412766889795884220 02	-0.243588530380074770 03	-0.284408806751286710 03
7	0.104314959943034800 02	-0.671793990487378590 01	-0.909126946253375150 02	-0.215759450001675230 03
8	0.301104194109233950 02	-0.687888769136861870 02	-0.528870372484324840 03	-0.132571300857313390 04
9	-0.246013709152323960 02	-0.104606779030666510 03	-0.709395406542434440 03	-0.152858680471902930 04
10	-0.856227400100468490 02	0.216454688838649770 03	0.168493427626949020 04	0.416983403435584040 04
11	0.104659580663828590 03	0.695160730970768250 02	0.193440914344391760 03	0.256240198919907350 03
12	0.328555470706564880 03	0.220371884175992630 03	0.680060915419044790 03	0.836585348080224220 03
13	-0.331343819589833610-01	-0.609753587845848320-03	-0.953842783820152860-02	0.224820622701029200-00
14	-0.110203521489006640 01	-0.512199568307389000 00	-0.861177140776234970 00	0.861982582969873900 00
15	-0.124596178208719820 02	-0.104573593460371540 02	-0.445715967605212430 02	-0.755447601410557780 02
16	0.379322392117797890 03	0.241501403872055550 03	0.751696410861591610 03	0.779934120037667040 03
17	-0.141012357913682110 02	-0.118133656987047640 02	-0.502897947583978990 02	-0.851721649200237800 02
18	0.106088618631468350 01	0.757493162229810000 00	0.412871919344182330 01	0.498324058231124360 01
19	0.145677685739507460-00	0.100036053350821000-00	0.424264461939104830-00	0.471082340877704730-00

B MATRIX PLUS E MATRIX

CORRECT COVARIANCE MATRIX

MATRIX B-4

	5	6	7	8
1	-0.407433037701757480 02	-0.559043133951071080 02	0.104314959943012650 02	0.301104194108382740 02
2	-0.109568123222544060 03	-0.412766889795870560 02	-0.671793990487378590 01	-0.687888769137258720 02
3	-0.780831786819903170 03	-0.243588530380073440 03	-0.909126946253382420 02	-0.528870372484404220 03
4	-0.167185685107396510 04	-0.284408806751275780 03	-0.215759450001675230 03	-0.132571300857315170 04
5	0.206103794208951810 04	0.225594074172691840 03	0.286620931598225710 03	0.164990375228080970 04
6	0.225594074172697170 03	0.238844352829772340 03	-0.311581882257744580 02	0.437803325368101180 02
7	0.286620931598171260 03	-0.311581882257767010 02	0.130042759286068730 03	0.478913255360867480 03
8	0.164990375228046380 04	0.437803325368437580 02	0.478913255360860210 03	0.253218768798604890 04
9	0.194088021237938560 04	0.538153426704961910 02	0.573592014314718230 03	0.283368803659396100 04
10	-0.525204931368100870 04	-0.642711725243825750 02	-0.158830812005790360 04	-0.803890883586511280 04
11	-0.347070360087140210 03	0.159572759932757990 02	-0.452614168654984720 02	-0.233982889443823450 03
12	-0.116817301443008780 04	0.628707188785568970 02	-0.156107704872584800 03	-0.716321798483972980 03
13	-0.317902183752495020-00	0.591537432543238820-01	-0.691397122623729320-01	-0.366669387672056480-00
14	-0.113953938395076450 01	0.160094815252061480-00	-0.277409566538067420-00	-0.171660670599581510 01
15	0.706461686294435510 02	0.168350714642806540 02	0.153484305087568160 02	0.871245456446159420 02
16	-0.108992759289897930 04	0.281796445286916220 02	-0.136355266947133570 03	-0.590401135499849740 03
17	0.795140010685535860 02	0.191123840422734730 02	0.172627110219208180 02	0.982395754543389230 02
18	-0.590755971760603680 01	-0.169536568638958380 01	-0.526894437881032850 00	-0.311094593257736530 01
19	-0.405757090501451150-00	-0.253988926175570730-00	-0.464785602203947660-01	-0.506280101659771720 00

B MATRIX PLUS E MATRIX CORRECT COVARIANCE MATRIX MATRIX B-4

	9	10	11	12
1	-0.24601376915296350D 02	-0.85622740009929987D 02	0.10405958066384796D 03	0.32855547070667002D 03
2	-0.10460677903069154D 03	0.21645468883687740D 03	0.69516073097069009D 02	0.22037188417600512D 03
3	-0.70939540654252342D 03	0.16849342762695801D 04	0.19344091434437821D 03	0.68006091541915881D 03
4	-0.15285868047191242D 04	0.41698340343558404D 04	0.25624019891987881D 03	0.83658534808041424D 03
5	0.19408802123798408D 04	-0.52520493136819540D 04	-0.34707036008712810D 03	-0.11681730144304037D 04
6	0.53815342670501226D 02	-0.64271172524381381D 02	0.15957275993272080D 02	0.62870718878526605D 02
7	0.57359201431473594D 03	-0.15883081200579069D 04	-0.45261416865493403D 02	-0.15610770487261738D 03
8	0.28336880365940281D 04	-0.80389088358658408D 04	-0.23398288944368950D 03	-0.71632179848380206D 03
9	0.34225559887723811D 04	-0.91652669324765793D 04	-0.29288736275755595D 03	-0.94031168224525474D 03
10	-0.91652669324708558D 04	0.25704260153433878D 05	0.76077929940100070D 03	0.23744274524620074D 04
11	-0.29288736275765581D 03	0.76077929940118072D 03	0.18207400678581787D 03	0.59132541279210155D 03
12	-0.94031168224525863D 03	0.23744274524617265D 04	0.59132541279199530D 03	0.19753881313144533D 04
13	-0.36300308507133217D-00	0.11467872022690750D 01	0.87204500485972192D-01	0.25954989208997120D-00
14	-0.15253954749667203D 01	0.52600148294432492D 01	-0.60539909410237785D 00	-0.19293216662159879D 01
15	0.83378507264367924D 02	-0.26360300868719583D 03	-0.13105254082314904D 02	-0.35838352647535948D 02
16	-0.83693266671152422D 03	0.19909491184519362D 04	0.58346975714184651D 03	0.19716798537308539D 04
17	0.93970033621568849D 02	-0.29713193981817709D 03	-0.14716225740117966D 02	-0.40143613290349783D 02
18	-0.47039589613049343D 01	0.10278170940538067D 02	0.10025841614390851D 01	0.37681791878164345D 01
19	-0.54544985739067220D 00	0.14872995248863030D 01	0.27868212337305776D-01	0.55672319752265015D-01

	13	14	15	16
1	-0.331343819589788920-01	-0.110203521489C2590D 01	-0.124596178208730920 02	0.379322392117908080 03
2	-0.609753587845848320-03	-0.512199568307387830 00	-0.10457359346037148D 02	0.241501403872068090 03
3	-0.953842783820164190-02	-0.861177140776285040 00	-0.445715967605224360 02	0.751696410861708130 03
4	0.224820622701029200-00	0.861982582969899210 00	-0.755447601410557500 02	0.779934120037857110 03
5	-0.317902183752536480-00	-0.113953938395099150 01	0.706461686294534040 02	-0.108992759289928080 04
6	0.591537432543216830-01	0.160094815252C62710-00	0.168350714642829080 02	0.281796445286616460 02
7	-0.691397122623729320-01	-0.277409566538078740-00	0.153484305087568050 02	-0.136355266947166150 03
8	-0.364669387672023610-00	-0.171660670599645290 01	0.871245456446154750 02	-0.590401135499674050 03
9	-0.363C0308507130269D-00	-0.152539547496700510 01	0.833785072643638100 02	-0.836932666711520670 03
10	0.114678722022688470 01	0.526001482944400470 01	-0.263603008687195610 03	0.199094911845220930 04
11	0.872045004859820840-01	-0.605399094102442250 00	-0.131052540823163640 02	0.583469757141951710 03
12	0.259549892089935C60-00	-0.192932166621610560 01	-0.358383526475278820 02	0.197167985373086270 04
13	0.146762630198579550-03	0.346547745797935240-03	-0.147829241343156170-01	0.200123572431949610-00
14	0.346547745797927300-03	0.104801342970332390-01	0.228405372783184680-01	-0.230223215469895940 01
15	-0.147829241343156340-01	0.228405372783164810-01	0.158135499291696570 02	-0.343454715087880060 02
16	0.200123572431913480-00	-0.230223215469908040 01	-0.343454715087799460 02	0.200920290009263870 04
17	-0.166015589014050610-01	0.258806583106147400-01	0.178369978427265710 02	-0.384749648591574180 02
18	-0.109848366832478510-03	-0.351725156385119640-02	-0.153956134015194870-00	0.425553702359032340 01
19	-0.438579224581272460-04	0.443875169837806560-04	-0.602294161084417910-01	0.104857690944576530-00

B MATRIX PLUS E MATRIX CORRECT COVARIANCE MATRIX MATRIX B-4

	17	18	19
1	-0.141012357913678550 02	0.106088618631489660 01	0.145677685739518060-00
2	-0.118133656987034210 02	0.757493162229809950 00	0.100036053350818220-00
3	-0.502897947583935300 02	0.412871919344190870 01	0.424264461939098720-00
4	-0.851721649200140650 02	0.498324058231126910 01	0.471082340877671700-00
5	0.795140010685556680 02	-0.590755971760642650 01	-0.405757C90501471460-00
6	0.191123840422738390 02	-0.169536568638959830 01	-0.253988926175571450-00
7	0.172627110219188470 02	-0.526894437881040680 00	-0.464785602203904190-01
8	0.982395754543272940 02	-0.311094593257719380 01	-0.506280101659784880 00
9	0.939700336215535670 02	-0.470395896130454740 01	-0.545449857390632900 00
10	-0.297131939818143060 03	0.102781709405380120 02	0.148729952488624750 01
11	-0.147162257401179280 02	0.100258416143920560 01	0.278682123373029830-01
12	-0.401436132903361500 02	0.376817918781579220 01	0.556723197522003220-01
13	-0.166015589014031570-01	-0.109848366832461800-03	-0.438579224581315370-04
14	0.258806583106140350-01	-0.351725156385120310-02	0.443875169837560760-04
15	0.178369978427245450 02	-0.153956134C15196590-00	-0.602294161084400040-01
16	-0.384749648591439730 02	0.425553702358967450 01	0.104857690944512640-00
17	0.201195918350141780 02	-0.173484274992159020-00	-0.681206014628422120-01
18	-0.173484274992137370-00	0.318131903131882050-01	0.212572645807656390-02
19	-0.681206014628364940-01	0.212572645807666990-02	0.719866147749241790-03

APPENDIX C

Matrices Associated with Normal Matrix 1

This appendix contains the matrices involved in the sensitivity study of covariance matrix 1.

MATRIX NUMBER 1. NORMAL MATRIX OF SOLUTION FOR SPACECRAFT STATE

Orbit Parameters*		Tracking Stations	Data Types	Data Weight, σ	Data Tracking Interval (Min.)	Number of Data Points
a	2817.9896 km	Goldstone	range rate	0.015 m/s	46	45
e	0.29138044					
i	8.3826441 deg	Woomera	range rate	0.015 m/s	46	45
Ω	15.586228 deg					
ω	354.80842 deg					
T_p	66 yr. 6 mo. 27 da. 3 hr. 41 min. 54.355 sec.					
t_o	66 yr. 6 mo. 27 da. 3 hr. 41 min. 48.0 sec.					

A priori used: None

Solution Parameters: x, y, z, $\dot{x}$, $\dot{y}$, $\dot{z}$

*(Reference to true lunar equatorial plane and the line of intersection with the ecliptic)

A MATRIX AS INPUT

NORMAL MATRIX 1

MATRIX C-1

	1	2	3	4	5	6
1	C.461C2683E C4	0.312123?2E 04	C.13894983E 04	-C.15994639E 08	-0.60819087E 07	-0.15262295E 07
2	0.312123?2E C4	0.30104721E 05	0.19956227E C5	-C.60157872E C8	0.33807880E 07	0.12946162E 08
3	C.13894983E C4	0.19956227E 05	C.13342755E C5	-C.38363532E C8	0.32576722E 07	0.90301707E 07
4	-0.15994639E C8	-0.6C157872E 08	-0.38363532E 08	C.15565617E 12	0.12893567E 11	-0.18043497E 11
5	-C.6C819087E C7	0.33807880E 07	0.32576722E 07	C.12893567E 11	0.11961991E 11	0.62593658E 10
6	-C.15262295E C7	0.12946162E 08	C.9C3C17C7E 07	-C.18043497E 11	0.62593658E 1C	0.76318640E 10

B MATRIX AS INPUT

APPROXIMATE COVARIANCE MATRIX 1

MATRIX C-2

	1	2	3	4	5	6
1	0.24584736E-C1	-0.68270449E-01	0.74833374E-01	0.13149662E-05	-0.14835627E-04	0.47457916E-04
2	-0.68270449E-C1	0.29057129E-0C	-C.427656C8E-C0	-0.34790702E-04	0.14094884E-03	-0.19840086E-03
3	C.74833374E-01	-0.42765608E-00	C.71807174E 00	0.74997199E-04	-0.26821507E-03	0.28806540E-03
4	0.13149662E-05	-0.34790702E-04	C.74997199E-04	C.11997382E-C7	-0.39034588E-07	0.30920629E-07
5	-C.14835627E-C4	0.14C94884E-03	-0.26821507E-03	-C.39034588E-07	0.13439149E-06	-0.12721498E-06
6	0.47457916E-04	-0.19840086E-03	C.2880654CE-03	C.30920629E-07	-0.12721498E-06	0.18277098E-06

ERROR MATRIX (E)

	1	2	3	4	5	6
1	-0.24198113D-05	0.11885976D-04	-0.18785869D-04	-0.17499847D-08	0.65690177D-08	-0.79427272D-08
2	0.11885976D-04	-0.56918798D-04	0.88922335D-04	0.80680952D-08	-0.30611429D-07	0.37881675D-07
3	-0.18785869D-04	0.88922335D-04	-0.13819421D-03	-0.12380733D-07	0.47211942D-07	-0.59086160D-07
4	-0.17499847D-08	0.80680952D-08	-0.12380733D-07	-0.10717205D-11	0.41386163D-11	-0.53157348D-11
5	0.65690177D-08	-0.30611429D-07	0.47211942D-07	0.41386163D-11	-0.15892438D-10	0.20195649D-10
6	-0.79427272D-08	0.37881675D-07	-0.59086160D-07	-0.53157348D-11	0.20195649D-10	-0.25066509D-10

ERROR IN MATRIX C-2

MATRIX C-3

3 MATRIX PLUS E MATRIX

	1	2	3	4	5	6
1	0.24582316D-01	-0.68258563D-01	0.74814589D-01	0.13132162D-05	-0.14829058D-04	0.47449973D-04
2	-0.68258563D-01	0.29051437D-00	-0.42756715D-00	-0.34782634D-04	0.14091823D-03	-0.19836299D-03
3	0.74814589D-01	-0.42756715D-00	0.71793354D 00	0.74984819D-04	-0.26816786D-03	0.28800631D-03
4	0.13132162D-05	-0.34782634D-04	0.74984819D-04	0.11996210D-07	-0.39030450D-07	0.30915314D-07
5	-0.14829058D-04	0.14091823D-03	-0.26816786D-03	-0.39030450D-07	0.13437561D-06	-0.12719478D-06
6	0.47449973D-04	-0.19836299D-03	0.28800631D-03	0.30915314D-07	-0.12719478D-06	0.18274592D-06

COVARIANCE MATRIX 1

MATRIX C-4

A MATRIX AS INPUT

COVARIANCE MATRIX 1

MATRIX C-5

	1	2	3	4	5	6
1	0.24582315E-01	-0.68258562E-01	0.74814589E-01	0.13132162E-05	-0.14829057E-04	0.47449972E-04
2	-0.68258562E-01	0.29051436E-00	-0.42756715E-00	-0.34782633E-04	0.14091823E-03	-0.19836298E-03
3	0.74814589E-01	-0.42756715E-00	0.71793354E 00	0.74984818E-04	-0.26816785E-03	0.28800631E-03
4	0.13132162E-05	-0.34782633E-04	0.74984818E-04	0.11996309E-07	-0.39030449E-07	0.30915313E-07
5	-0.14829057E-04	0.14091823E-03	-0.26816785E-03	-0.39030449E-07	0.13437560E-06	-0.12719478E-06
6	0.47449972E-04	-0.19836298E-03	0.28800631E-03	0.30915313E-07	-0.12719478E-06	0.18274591E-06

B MATRIX AS INPUT

NORMAL MATRIX 1

MATRIX C-6

	1	2	3	4	5	6
1	0.46102683E 04	0.31212322E 04	0.13894983E 04	-0.15994639E 08	-0.60819087E 07	-0.15262295E 07
2	0.31212322E 04	0.30104721E 05	0.19956227E 05	-0.60157872E 08	0.33807888E 07	0.12946162E 08
3	0.13894983E 04	0.19956227E 05	0.13342755E 05	-0.38363532E 08	0.32576722E 07	0.90301707E 07
4	-0.15994639E 08	-0.60157872E 08	-0.38363532E 08	0.15565617E 12	0.12893567E 11	-0.18043497E 11
5	-0.60819087E 07	0.33807888E 07	0.32576722E 07	0.12893567E 11	0.11961991E 11	0.62593658E 10
6	-0.15262295E 07	0.12946162E 08	0.90301707E 07	-0.18043497E 11	0.62593658E 10	0.76318640E 10

F MATRIX AS INPUT

TYPE 1 PERTURBATION

MATRIX C-7

	1	2	3	4	5	6
1	C.9999999E-07	C.9999999E-07	C.9999999E-07	C.9999999E-07	0.99999999E-07	-0.99999999E-07
2	C.9999999E-07	-0.9999999E-07	-C.9999999E-07	C.9999999E-07	-0.9999999E-07	0.99999999E-07
3	0.99999999E-07	-0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.99999999E-07	0.99999999E-07
4	C.9999999E-07	0.9999999E-07	-C.9999999E-07	C.9999999E-07	-0.9999999E-07	-0.99999999E-07
5	C.99999999E-07	-0.9999999E-07	C.9999999E-07	-C.99999999E-07	0.99999999E-07	0.99999999E-07
6	-0.9999999E-07	0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.99999999E-07	-0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 1 PERTURBATION

MATRIX C-8

	1	2	3	4	5	6
1	C.31309229D 01	0.17674125D 02	C.11515169D 02	-C.3995C269D 05	-0.59963731D 03	0.65654213D 04
2	0.17674125D 02	0.7920C697D 02	C.51C39186D 02	-C.19131962D 06	-0.96789369D 04	0.2657C638D 05
3	0.11515169D 02	C.51C39186D 02	0.3267175CD 02	-C.12371519D 06	-0.64781221D 04	0.17024743D 05
4	-0.3995026SD 05	-0.19131962D 06	-C.12371519D 06	C.45294876D 09	0.18135C82D 08	-0.66325960D 08
5	-C.59963731D 03	-0.96789369D 04	-C.64781221D 04	C.18135082D 08	-0.18035796D 07	-0.44655828D 07
6	0.65654213D 04	0.2657C638D 05	C.17024743D 05	-C.66325960D 08	-0.44655828D 07	0.8417C911D 07

F MATRIX AS INPUT

TYPE 2 PERTURBATION

MATRIX C-9

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	C.09999999E-05	C.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.09999999E-05	-0.09999999E-05	-C.09999999E-05	C.09999999E-05	-0.09999999E-05	0.09999999E-05
3	0.09999999E-05	-0.09999999E-05	C.09999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	-C.09999999E-05	0.09999999E-05	-0.09999999E-05	-0.09999999E-05
5	C.09999999E-05	-0.09999999E-05	C.09999999E-05	-C.09999999E-05	0.09999999E-05	0.09999999E-05
6	-0.09999999E-05	0.09999999E-05	C.09999999E-05	-0.09999999E-05	0.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 2 PERTURBATION

MATRIX C-10

	1	2	3	4	5	6
1	C.3C685363D 02	0.17186486D 03	C.11193585C C3	-0.38919189D 06	-0.625542560 04	0.63666629C 05
2	0.17186486D 03	0.776258590 03	C.50045797D 03	-C.18714944D 07	-0.926042270 05	0.26139403C 06
3	C.11193585D C3	0.5C045797D 03	C.32247341C 03	-0.12104360D 07	-0.61895747C 05	0.16763024C 06
4	-0.38919189D C6	-0.18714944C 07	-C.12104360C 07	0.44266887D 1C	0.174829870 09	-0.649926510 09
5	-0.625542560 C4	-0.926042270 05	-C.61895747C 05	C.17482987D C9	-0.16420960C 08	-0.42365654C 08
6	0.63666629C C5	0.26139403C 06	C.16763C24C 06	-0.64992651D C9	-0.42365654C 08	0.8347C096C 08

F MATRIX AS INPUT

TYPE 3 PERTURBATION

MATRIX C-11 1

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 3 PERTURBATION

MATRIX C-12

	1	2	3	4	5	6
1	-0.14479847D-01	-0.11377033D-01	-0.75042571D-01	0.23640198D 03	-0.76647524D 01	-0.46763723D 02
2	-0.11377033D-01	-0.33471699D 01	-0.22562813D 01	0.60614547D 04	-0.76409730D 03	-0.16059139D 04
3	-0.75042571D-01	-0.22562813D 01	-0.15211877D 01	0.40812557D 04	-0.51799454D 03	-0.10831298D 04
4	0.23640198D 03	0.60614547D 04	0.40812557D 04	-0.11062194D 08	0.13319362D 07	0.28843800D 07
5	-0.76647524D 01	-0.76409730D 03	-0.51799454D 03	0.13319362D 07	-0.20577145D 06	-0.37978867D 06
6	-0.46763723D 02	-0.16059139D 04	-0.10831298D 04	0.28843800D 07	-0.37978867D 06	-0.77533699D 06

F MATRIX AS INPUT

TYPE 4 PERTURBATION

MATRIX C-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 4 PERTURBATION

MATRIX C-14

	1	2	3	4	5	6
1	0.11966396D-01	-0.13326998D-00	-0.92395444D-01	0.18374224D 03	-0.62737126D 02	-0.76907354D 02
2	-0.13326998D-00	-0.72181750D 00	-0.46873759D-00	0.15794867D 04	0.90217019D 01	-0.27114986D 03
3	-0.92395444D-01	-0.46873759D-00	-0.30344853D-00	0.10428831D 04	0.16144950D 02	-0.17179577D 03
4	0.18374224D 03	0.15794867D 04	0.10428831D 04	-0.31173873D 07	0.17799721D 06	0.67454922D 06
5	-0.62737126D 02	0.90217019D 01	0.16144950D 02	0.17799721D 06	0.11625592D 06	0.51436260D 05
6	-0.76907354D 02	-0.27114986D 03	-0.17179577D 03	0.67454922D 06	0.51436260D 05	-0.81935215D 05

APPENDIX D

Matrices Associated with Normal Matrix 2

This appendix contains the matrices involved in the sensitivity study of covariance matrix 2.

MATRIX NUMBER 2. NORMAL MATRIX OF SOLUTION FOR SPACECRAFT STATE

Orbit Parameters*		Tracking Station	Data Types	Data Weight, σ	Data Tracking Interval (Min.)	Number of Data Points
a	2817.9896	Goldstone	range rate	0.015 m/s	486	200
e	0.24138044					
i	8.3826441	Woomera	range rate	0.015 m/s		348
Ω	15.586228					
ω	354.80892					
T_p	66 yr. 6 mo. 27 da. 3 hr. 41 min. 54.355 sec.					
t_o	66 yr. 6 mo. 27 da. 4 hr. 4 min. 48.0 sec.					

A Priori Used: None

Solution Parameters: $x, y, z, \dot{x}, \dot{y}, \dot{z}$

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic)

A MATRIX AS INPUT

NORMAL MATRIX 2

MATRIX D-1

	1	2	3	4	5	6
1	C.876571156 C7	-0.398721516 08	-0.275395266 08	C.837352336 11	0.481080446 09	-0.167749926 11
2	-0.398721516 C8	0.186842496 09	C.128793276 09	-C.391557196 12	-0.398446146 10	0.773241636 11
3	-0.275395266 C8	0.128793276 09	0.887911136 08	-C.269944606 12	-0.266570876 10	0.533602846 11
4	0.837352336 11	-0.391557196 12	-0.269944606 12	0.821076216 15	0.814943136 13	-0.162272856 15
5	0.481080446 C9	-0.398446146 10	-0.266570876 10	C.814943136 13	0.663247566 12	-0.123500626 13
6	-0.167749926 11	C.773241636 11	C.533602846 11	-C.162272856 15	-0.123500626 13	0.323139886 14

B MATRIX AS INPUT

APPROXIMATE COVARIANCE MATRIX 2

MATRIX D-2

	1	2	3	4	5	6
1	0.7C230046E-C3	-0.27555236E-02	0.423170C4E-02	0.29226029E-06	-0.10426970E-05	0.13982516E-05
2	-0.27555236E-02	0.11890014E-01	-C.18249568E-01	-C.12745219E-05	0.46233496E-05	-0.59700985E-05
3	0.42317C04E-C2	-0.18249568E-01	C.28035755E-01	C.19584894E-05	-0.70772339E-05	0.91351371E-05
4	C.29226029E-C6	-0.12745219E-05	C.195848S4E-05	C.17651273E-C9	-0.62020576E-09	0.83015817E-09
5	-C.1042697CE-C5	0.46233498E-05	-C.7C772339E-05	-0.62020576E-C9	0.22201116E-08	-0.29474968E-08
6	0.13982516E-C5	-0.5970C985E-05	C.91351371E-05	C.83015817E-C9	-0.29474968E-08	0.39830422E-08

ERROR MATRIX (E)

	1	2	3	4	5	6
1	-C.76330278D-C5	C.32957988D-04	-C.50629617D-04	-C.41298058D-C8	0.14726286D-07	-0.19494433D-07
2	C.32997988D-C4	-0.14263571D-03	C.21885025D-03	C.17842613D-07	-0.63626689D-07	0.84224727D-07
3	-0.50629617D-C4	0.21885025D-03	-0.33578855D-C3	-C.273751C5D-07	0.97619409D-07	-0.12922098D-06
4	-0.41298058D-C8	0.17842613D-07	-C.27375105D-07	-C.22040877D-11	0.78718359D-11	-0.10402336D-10
5	C.14726286D-C7	-0.63626689D-07	C.976194C9D-07	0.78718359D-11	-0.28109245D-10	0.37153606D-10
6	-0.19494433D-C7	0.84224727D-07	-C.12922C98D-06	-C.10402336D-1C	0.37153606D-10	-0.49096080D-10

ERROR IN MATRIX D-2

MATRIX D-3

B MATRIX PLUS E MATRIX

COVARIANCE MATRIX 2

MATRIX D-4

	1	2	3	4	5	6
1	0.69466744D-C3	-0.27225257D-02	C.41810708D-02	C.28813049D-06	-0.10279707D-05	0.13787572D-05
2	-0.27225257D-02	0.11747379D-01	-0.18030718D-01	-0.12566794D-05	0.45597232D-05	-0.58858739D-05
3	0.41810708D-C2	-0.18030718D-01	C.27699966D-01	C.19311144D-05	-0.69796146D-05	0.90059162D-05
4	C.28813049D-06	-0.12566794D-05	0.19311144D-C5	C.17430865D-09	-0.61233393D-09	0.81975584D-09
5	-0.10279707D-C5	0.45597232D-05	-0.69796146D-05	-C.61233393D-C9	0.21920023D-08	-0.29103432D-08
6	0.13787572D-05	-0.58858739D-05	C.90059162D-05	C.81975584D-09	-0.29103432D-08	0.39339461D-08

A MATRIX AS INPUT

COVARIANCE MATRIX 2

MATRIX D-5

	1	2	3	4	5	6
1	C.69466743E-03	-0.27225257E-02	0.4181C7C8E-02	0.28813048E-06	-0.102797C7E-05	0.13787571E-05
2	-C.27225257E-C2	0.11747379E-C1	-0.18C3C718E-01	-C.12566794E-05	0.45597231E-05	-0.58858739E-05
3	C.418107C8E-C2	-0.1803C718E-01	0.27699966E-01	C.19311143E-05	-0.69796146E-05	0.90059161E-05
4	0.28813048E-C6	-0.12566794E-05	0.19311143E-05	C.17430865E-09	-0.61233392E-09	0.81975584E-09
5	-C.1C2797C7E-C5	0.45597231E-05	-C.69796146E-05	-C.61233392E-C9	C.2192C022E-08	-0.29103432E-08
6	0.13787571E-C5	-0.58858739E-05	C.90C59161E-05	C.81975584E-C9	-0.29103432E-08	0.39339460E-08

B MATRIX AS INPUT

NORMAL MATRIX 2

MATRIX D-6

	1	2	3	4	5	6
1	C.87657115E C7	-C.39872151E 08	-C.27539526E C8	C.93735233E 11	0.48108C44E 09	-0.16774992E 11
2	-0.39872151E C8	0.18684249E 09	C.12879327E 09	-C.39155719E 12	-0.39844614E 10	0.77324163E 11
3	-0.27539526E C8	0.12879327E C9	0.88791113E 08	-C.26994460E 12	-0.26657087E 10	0.53360284E 11
4	C.83735233E 11	-0.39155719E 12	-C.26994460E 12	C.82107621E 15	0.81494313E 13	-0.16227285E 15
5	C.48108044E 09	-0.39844614E 10	-C.26657087E 10	C.81494313E 13	0.66324756E 12	-0.12350062E 13
6	-0.16774992E 11	0.77324163E 11	C.53360284E 11	-0.16227285E 15	-0.1235C062E 13	0.32313988E 14

F MATRIX AS INPUT

TYPE 1 PERTURBATION

MATRIX D-7

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
2	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07
3	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07
5	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
6	-0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 1 PERTURBATION

MATRIX D-8

	1	2	3	4	5	6
1	0.48103693D 07	-0.22548801D 08	-0.15542869D 08	0.47258456D 11	0.48475912D 09	-0.93299529D 10
2	-0.22548801D 08	0.10569788D 09	0.72857488D 08	-0.22152483D 12	-0.22721195D 10	0.43734445D 11
3	-0.15542869D 08	0.72857488D 08	0.50220621D 08	-0.15269693D 12	-0.15661799D 10	0.30146120D 11
4	0.47258456D 11	-0.22152483D 12	-0.15269693D 12	0.46427847D 15	0.47619890D 13	-0.91659571D 14
5	0.48475912D 09	-0.22721195D 10	-0.15661799D 10	0.47619890D 13	0.48770188D 11	-0.94018063D 12
6	-0.93299529D 10	0.43734445D 11	0.30146120D 11	-0.91659571D 14	-0.94018063D 12	0.18095898D 14

F MATRIX AS INPUT

TYPE 2 PERTURBATION

MATRIX D-9

	1	2	3	4	5	6
1	C.C9999999E-C5	0.09999999E-05	C.C9999999E-05	0.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.C9999999E-05	-0.C9999999E-05	-C.C9999999E-05	0.09999999E-05	-0.09999999E-05	0.09999999E-05
3	0.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	-C.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-C5	0.C9999999E-05	-C.C9999999E-05	C.09999999E-C5	-0.09999999E-05	-0.09999999E-05
5	0.C9999999E-C5	-0.C9999999E-05	0.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
6	-0.C9999999E-C5	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 2 PERTURBATION

MATRIX D-10

	1	2	3	4	5	6
1	0.93633834D C7	-0.43880365D 08	-0.30247205D 08	C.919670980 11	0.939722980 09	-0.181588630 11
2	-0.43880365D C8	0.205636950 09	0.141747890 09	-0.430986280 12	-0.440262330 10	0.850988430 11
3	-C.3C247205D C8	0.14174789D 09	C.977C8434C 08	-C.297083760 12	-0.303483590 10	0.586595660 11
4	0.919670980 11	-0.43C98628D 12	-0.297C83760 12	C.903287020 15	0.922732470 13	-0.178355260 15
5	C.939722980 C9	-0.440262330 10	-0.303483590 10	C.922732470 13	0.937952710 11	-0.182225100 13
6	-0.181588630 11	C.85098843D 11	0.586595660 11	-0.178355260 15	-0.182225100 13	0.352162910 14

F MATRIX AS INPUT

TYPE 3 PERTURBATION

MATRIX D-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 3 PERTURBATION

MATRIX D-12

	1	2	3	4	5	6
1	0.252634420 06	-0.118503910 07	-0.816810300 06	0.248327840 10	0.256732160 08	-0.490131750 09
2	-0.118503910 07	0.555861550 07	0.383138180 07	-0.116482230 11	-0.120398110 09	0.229976010 10
3	-0.816810300 06	0.383138180 07	0.264085280 07	-0.802875990 10	-0.829879180 08	0.158467020 10
4	0.248327840 10	-0.116482230 11	-0.802875990 10	0.244091550 14	0.252300320 12	-0.481773830 13
5	0.256732160 08	-0.120398110 09	-0.829879180 08	0.252300320 12	0.259912930 10	-0.498032000 11
6	-0.490131750 09	0.229976010 10	0.158467020 10	-0.481773830 13	-0.498032000 11	0.950893790 12

F MATRIX AS INPUT

TYPE 4 PERTURBATION

MATRIX D-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 4 PERTURBATION

MATRIX D-14

	1	2	3	4	5	6
1	-0.27806339D 05	0.13346505D 06	0.91852538D 05	-0.27909561D 09	-0.38396790D 07	0.54473466D 08
2	0.13346505D 06	-0.64027118D 06	-0.44065919D 06	0.13389694D 10	0.18316171D 08	-0.26140529D 09
3	0.91852538D 05	-0.44065919D 06	-0.30327785D 06	0.92152717D 09	0.12610601D 08	-0.17990552D 09
4	-0.27909561D 09	0.13389694D 10	0.92152717D 09	-0.28001123D 13	-0.38323716D 11	0.54664942D 12
5	-0.38396790D 07	0.18316171D 08	0.12610601D 08	-0.38323716D 11	-0.49237425D 09	0.70233320D 10
6	0.54473466D 08	-0.26140529D 09	-0.17990552D 09	0.54664942D 12	0.70233320D 10	-0.10670592D 12

APPENDIX E

Matrices Associated with Covariance Matrix 3

This appendix contains the matrices involved in the sensitivity study of normal matrix 3.

MATRICES NUMBERS 3, 4, and 5
COVARIANCE MATRICES BEFORE AND AFTER FORWARDING
DATA PROCESSING EPOCH

*ORBIT PARAMETERS:	a	2817.9896 km
	e	0.29138044
	i	8.3826441 deg
	Ω	15.586228 deg
	ω	354.80842 deg
	T_p	66 yr. 6 mo. 27 da. 3 hr. 41 min. 54.355 sec.
	t_o	66 yr. 6 mo. 27 da. 4 hr. 4 min. 48.0 sec.

MATRIX NO. 3: Matrix No. 3 is the covariance matrix of spacecraft state at t_o after two lunar orbits of range and range rate data from Goldstone and Woomera have been processed.

MATRIX NO. 4: Matrix No. 4 is Matrix No. 3 mapped forward for 270 minutes from t_o.

MATRIX NO. 5: Matrix No. 5 is Matrix No. 3 mapped forward for 488 minutes from t_o.

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic)

A MATRIX AS INPUT

COVARIANCE MATRIX 3

MATRIX E-1

	1	2	3	4	5	6
1	0.19658600E-02	-0.71124937E-02	0.93380303E-02	-0.16412069E-05	0.71805584E-05	-0.11377481E-04
2	-0.71124937E-02	0.26187169E-01	-0.34609561E-01	0.56983013E-05	-0.25034054E-04	0.39856990E-04
3	0.93380303E-02	-0.34609561E-01	0.46043772E-01	-0.70909791E-05	0.31280483E-04	-0.49966583E-04
4	-0.16412069E-05	0.56983013E-05	-0.70909791E-05	0.19325811E-08	-0.82850698E-08	0.12936071E-07
5	0.71805584E-05	-0.25034054E-04	0.31280483E-04	-0.82850698E-08	0.35602301E-07	-0.55635363E-07
6	-0.11377481E-04	0.39856990E-04	-0.49966583E-04	0.12936071E-07	-0.55635363E-07	0.87024891E-07

B MATRIX AS INPUT

APPROXIMATE NORMAL MATRIX 3

MATRIX E-2

	1	2	3	4	5	6
1	0.87612825E 06	0.29684836E 06	0.55903244E 04	0.27483767E 09	-0.12559249E 10	-0.86197388E 09
2	0.29684836E 06	0.19288427E 06	0.65058360E 05	0.72069424E 08	-0.41526014E 09	-0.28836691E 09
3	0.55903244E 04	0.65058360E 05	0.43518429E 05	-0.16589344E 08	0.23176435E 07	-0.13117573E 06
4	0.27483767E 09	0.72069424E 08	-0.16589344E 08	0.47020809E 12	-0.30703040E 12	-0.27278190E 12
5	-0.12559249E 10	-0.41526014E 09	0.23176435E 07	-0.30703040E 12	0.19332179E 13	0.13088738E 13
6	-0.86197388E 09	-0.28836691E 09	-0.13117573E 06	-0.27278190E 12	0.13088738E 13	0.89663072E 12

ERROR MATRIX (E)

	1	2	3	4	5	6
1	0.453075340 03	0.131377130 03	-0.131283450 02	C.903591100 05	-0.703267090 06	-0.471490980 06
2	C.131377130 C3	0.372825060 02	-0.434558940 01	C.246950240 05	-0.204361020 06	-0.136716420 06
3	-0.131283450 02	-0.434558940 01	0.250978360-01	-0.361728840 04	0.200850910 05	0.136661050 05
4	C.9C3591100 C5	0.246950240 05	-0.361728840 04	C.148469360 08	-0.141355620 09	-0.941555140 08
5	-0.703267090 06	-0.204361020 06	C.2CC85C910 05	-0.141355620 C9	0.109113930 10	0.731770240 09
6	-C.471490980 C6	-0.136716420 06	0.136661050 05	-C.941555140 08	0.731770240 09	0.490636040 09

ERROR IN MATRIX E-2

MATRIX E-3

B MATRIX PLUS E MATRIX

NORMAL MATRIX 3

MATRIX E-4

	1	2	3	4	5	6
1	C.876581330 06	0.296979740 06	0.557719610 04	0.274928040 09	-0.125662830 10	-0.862445380 09
2	C.296979740 C6	0.192921550 06	0.650540150 C5	C.720941190 08	-0.415464510 09	-0.288503640 09
3	C.557719610 C4	C.650540150 05	C.435184540 C5	-C.165929610 C8	0.233772860 07	-0.117509630 06
4	0.274928040 09	0.720941190 08	-C.165929610 08	C.470222950 12	-0.307171770 12	-0.272876060 12
5	-0.125662830 10	-0.415464510 09	C.233772860 07	-C.307171770 12	0.193430900 13	0.130960570 13
6	-C.862445380 09	-0.288503640 09	-0.117509630 06	-0.272876060 12	0.130960570 13	0.897121360 12

A MATRIX AS INPUT

NORMAL MATRIX 3

MATRIX E-5

	1	2	3	4	5	6
1	0.87658132E 06	0.29697973E 06	0.55771960E 04	0.27492803E 09	-0.12566283E 10	-0.86244537E 09
2	0.29697973E 06	0.19292154E 06	0.65054014E 05	0.72094119E 08	-0.41546451E 09	-0.28850364E 09
3	0.55771960E 04	0.65054014E 05	0.43518453E 05	-0.16592561E 08	0.23377286E 07	-0.11750963E 06
4	0.27492803E 09	0.72094119E 08	-0.16592561E 08	0.47022294E 12	-0.30717176E 12	-0.27287605E 12
5	-0.12566283E 10	-0.41546451E 09	0.23377286E 07	-0.30717176E 12	0.19343089E 13	0.13096057E 13
6	-0.86244537E 09	-0.28850364E 09	-0.11750963E 06	-0.27287605E 12	0.13096057E 13	0.89712135E 12

B MATRIX AS INPUT

COVARIANCE MATRIX 3

MATRIX E-6

	1	2	3	4	5	6
1	0.19658600E-02	-0.71124937E-02	0.93380303E-02	-0.16412069E-05	0.71805584E-05	-0.11377481E-04
2	-0.71124937E-02	0.26187169E-01	-0.34609561E-01	0.56983013E-05	-0.25034054E-04	0.39856599E-04
3	0.93380303E-02	-0.34609561E-01	0.46043772E-01	-0.70909791E-05	0.31280483E-04	-0.49966583E-04
4	-0.16412069E-05	0.56983013E-05	-0.70909791E-05	0.19325811E-08	-0.82850698E-08	0.12936071E-07
5	0.71805584E-05	-0.25034054E-04	0.31280483E-04	-0.82850698E-08	0.35602301E-07	-0.55635363E-07
6	-0.11377481E-04	0.39856599E-04	-0.49966583E-04	0.12936071E-07	-0.55635363E-07	0.87024891E-07

F MATRIX AS INPUT

TYPE 1 PERTURBATION

MATRIX E-7

	1	2	3	4	5	6
1	C.9999999E-07	0.9999999E-07	C.9999999E-07	C.9999999E-07	0.9999999E-07	-0.9999999E-07
2	C.9999999E-07	-0.9999999E-07	-C.9999999E-07	0.9999999E-07	-0.9999999E-07	0.9999999E-07
3	0.9999999E-07	-0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.9999999E-07	0.9999999E-07
4	C.9999999E-07	C.9999999E-07	-C.9999999E-07	C.9999999E-07	-C.9999999E-07	-0.9999999E-07
5	C.9999999E-07	-0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.9999999E-07	0.9999999E-07
6	-0.9999999E-07	0.9999999E-07	C.9999999E-07	-C.9999999E-07	C.9999999E-07	-0.9999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 1 PERTURBATION

MATRIX E-8

	1	2	3	4	5	6
1	-0.38340589D-04	0.13550393D-03	-C.17178168D-03	C.4C964995D-07	-0.17674364D-06	0.27716569D-06
2	0.13550393D-03	-0.47883287D-03	C.6C694125D-03	-C.14489528D-06	0.62512386D-06	-0.98026992D-06
3	-0.17178168D-03	0.6C694125D-03	-C.7652CC97D-03	C.18385419D-06	-0.79316603D-06	0.12437294D-05
4	0.4C964995D-07	-0.14489528D-06	C.18385419D-06	-C.43542399D-10	0.18791649D-09	-0.29475584D-09
5	-C.17674364D-06	0.62512386D-06	-0.79316603D-06	C.18791649D-09	-0.8109813CD-09	0.12720461D-08
6	0.27716569D-06	-0.98026992D-06	C.12437294D-05	-C.29475584D-09	0.12720461D-08	-0.19952173D-08

F MATRIX AS INPUT TYPE 2 PERTURBATION MATRIX E-9

	1	2	3	4	5	6
1	0.C9999999E-05	0.C9999999E-05	C.C9999999E-05	C.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.C9999999E-05	-0.09999999E-05	-C.C9999999E-05	C.09999999E-05	-0.09999999E-05	0.09999999E-05
3	0.C9999999E-05	-0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.C9999999E-05	0.09999999E-05	-0.C9999999E-05	0.09999999E-05	-0.09999999E-05	-0.09999999E-05
5	0.09999999E-05	-0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
6	-0.C9999999E-05	0.09999999E-05	C.C9999999E-05	-C.09999999E-05	0.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX E-10

	1	2	3	4	5	6
1	-0.51831950D-03	0.18312949D-02	-0.23208710D-02	0.55474329D-06	-0.23932163D-05	0.37526879D-05
2	0.18312949D-02	-0.64696206D-02	0.81983640D-02	-0.19611156D-05	0.84601794D-05	-0.13265654D-04
3	-0.23208710D-02	0.81983640D-02	-0.10387866D-01	C.24870005D-05	-0.10728455D-04	0.16821845D-04
4	0.55474329D-06	-0.19611156D-05	C.24870005D-05	-C.59155539D-09	0.25525318D-08	-0.40031656D-08
5	-0.23932163D-05	0.84601794D-05	-C.10728455D-04	0.25525318D-08	-0.11013929D-07	0.17273119D-07
6	0.37526879D-05	-0.13265654D-04	C.16821845D-04	-0.40031656D-08	0.17273119D-07	-0.27089189D-07

F MATRIX AS INPUT

TYPE 3 PERTURBATION

MATRIX E-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 3 PERTURBATION

MATRIX E-12

	1	2	3	4	5	6
1	0.10396639D-05	-0.35171752D-05	0.43957896D-05	-0.11619637D-08	0.49934035D-08	-0.78031734D-08
2	-0.35171752D-05	0.12255515D-04	-0.15313499D-04	0.40551837D-08	-0.17425514D-07	0.27229175D-07
3	0.43957896D-05	-0.15313499D-04	0.19129577D-04	-0.50747397D-08	0.21805159D-07	-0.34070812D-07
4	-0.11619637D-08	0.40551837D-08	-0.50747397D-08	0.13297814D-11	-0.57164562D-11	0.89357097D-11
5	0.49934035D-08	-0.17425514D-07	0.21805159D-07	-0.57164562D-11	0.24573445D-10	-0.38411481D-10
6	-0.78031734D-08	0.27229175D-07	-0.34070812D-07	0.89357097D-11	-0.38411481D-10	0.60041392D-10

F MATRIX AS INPUT

TYPE 4 PERTURBATION

MATRIX E-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 4 PERTURBATION

MATRIX E-14

	1	2	3	4	5	6
1	0.14582391D-05	-0.50523458D-05	0.62640560D-05	-0.17492395D-08	0.75028349D-08	-0.11706741D-07
2	-0.50523458D-05	0.17501454D-04	-0.21693791D-04	0.60673796D-08	-0.26022805D-07	0.40601815D-07
3	0.62640560D-05	-0.21693791D-04	0.26883338D-04	-0.75318715D-08	0.32302020D-07	-0.50396281D-07
4	-0.17492395D-08	0.60673796D-08	-0.75218715D-08	0.20859750D-11	-0.89497408D-11	0.13967857D-10
5	0.75028349D-08	-0.26022805D-07	0.32302020D-07	-0.89497408D-11	0.38397788D-10	-0.59926684D-10
6	-0.11706741D-07	0.40601815D-07	-0.50396281D-07	0.13967857D-10	-0.59926684D-10	0.93525458D-10

APPENDIX F

Matrices Associated with Covariance Matrix 4

This appendix contains the matrices involved in the sensitivity study of normal matrix 4.

MATRICES NUMBERS 3, 4, and 5
COVARIANCE MATRICES BEFORE AND AFTER FORWARDING
DATA PROCESSING EPOCH

*ORBIT PARAMETERS:	a	2817.9896 km
	e	0.29138044
	i	8.3826441 deg
	Ω	15.586228 deg
	ω	354.80842 deg
	T_p	66 yr. 6 mo. 27 da. 3 hr. 41 min. 54.355 sec.
	t_o	66 yr. 6 mo. 27 da. 4 hr. 4 min. 48.0 sec.

MATRIX NO. 3: Matrix No. 3 is the covariance matrix of spacecraft state at t_o after two lunar orbits of range and range rate data from Goldstone and Woomera have been processed.

MATRIX NO. 4: Matrix No. 4 is Matrix No. 3 mapped forward for 270 minutes from t_o.

MATRIX NO. 5: Matrix No. 5 is Matrix No. 3 mapped forward for 488 minutes from t_o.

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic)

A MATRIX AS INPUT

COVARIANCE MATRIX 4

MATRIX F-1

	1	2	3	4	5	6
1	0.32907563E-00	0.678242C8E 00	0.74C12478E 00	-0.42219780E-C3	-0.36957033E-04	0.18840832E-03
2	0.67824208E 00	0.15660232E 01	0.14102188E 01	-0.91449309E-03	-0.42055506E-04	0.35203539E-03
3	0.74012478E 00	0.14102188E 01	C.17441680E 01	-0.91900583E-03	-0.10752825E-03	0.45017806E-03
4	-0.42219780E-03	-0.91449309E-03	-0.91900583E-03	C.55345443E-06	0.37965064E-07	-0.23146582E-06
5	-0.36957033E-04	-0.42055506E-04	-0.10752825E-03	C.37965064E-07	0.13313317E-07	-0.31916483E-07
6	0.18840832E-03	0.35203539E-03	0.450178C6E-03	-0.23146582E-06	-0.31916483E-07	0.12084840E-06

B MATRIX AS INPUT

APPROXIMATE NORMAL MATRIX 4

MATRIX F-2

	1	2	3	4	5	6
1	0.2C946921E 06	0.13726279E 06	0.49652259E 05	C.38633942E 09	-0.26316001E 09	-0.24091533E 09
2	0.13726279E 06	0.21181627E 06	0.11063685E 06	0.52885114E 09	-0.31709686E 09	-0.31398192E 09
3	0.49652259E 05	0.11063685E 06	0.61569302E 05	C.27002976E 09	-0.14699372E 09	-0.15216642E 09
4	0.38633942E 09	0.52885114E 09	C.27002976E 09	0.13615771E 13	-0.69635987E 12	-0.72481009E 12
5	-0.26316001E 09	-0.31709686E 09	-0.14699372E 09	-0.69635987E 12	0.10349818E 13	0.82114165E 12
6	-0.24091533E 09	-0.31398192E 09	-0.15216642E 09	-C.72481009E 12	0.82114165E 12	0.68569683E 12

ERROR MATRIX (E)

	1	2	3	4	5	6
1	C.156C6768D C3	0.1C734876D 03	C.38C24985D 02	C.26774255D 06	-0.34675185D 06	-0.27642723D 06
2	C.1C734876D C3	0.103158930 03	C.448000100 02	C.248687740 06	-0.28151073D 06	-0.23275716D 06
3	C.38024985C C2	0.448C0010D 02	C.211029C9D 02	C.106C9724D 06	-0.11254687C 06	-0.94900009D 05
4	0.26774255D C6	0.24868774D 06	0.1C6C9724D 06	C.599129940 C9	-0.699556480 09	-0.57429210C 09
5	-0.34675185D 06	-0.28151073D 06	-0.11254687C 06	-0.699556480 C9	0.787645600 09	0.648076110 09
6	-0.27642723D 06	-0.23275716D 06	-0.94900C09C 05	-C.574292100 C9	0.648076110 09	0.533716450 09

ERROR IN MATRIX F-2

MATRIX F-3

B MATRIX PLUS E MATRIX

	1	2	3	4	5	6
1	0.2C5625290 C6	0.137370150 06	0.4969C285D 05	C.386607160 C9	-0.26350676C 09	-0.24119176C 09
2	0.137370150 06	0.211919430 06	0.110681660 06	0.529099830 C9	-0.317378370 09	-0.31421469D 09
3	C.496902850 C5	0.110681660 06	0.619904060 05	C.270135870 C9	-0.147106270 09	-0.15226132C 09
4	0.386607160 C9	0.529C99830 09	0.27C135870 09	C.136217620 13	-0.697059440 12	-0.72538439C 12
5	-0.263506760 C9	-0.317378370 09	-0.147106270 09	-C.697059440 12	0.103576950 13	0.821789740 12
6	-0.241191760 C9	-0.31421469D 09	-0.152261320 09	-0.725384390 12	0.821789740 12	0.686230550 12

NORMAL MATRIX 4

MATRIX F-4

A MATRIX AS INPUT

NORMAL MATRIX 4

MATRIX F-5

	1	2	3	4	5	6
1	0.2C962528E C6	0.13737015E 06	0.49690284E 05	C.38660716E C9	-0.26350676E 09	-0.24119176E 09
2	0.13737015E C6	0.21191943E 06	0.11068165E 06	C.529C9582E C9	-0.31737836E C9	-0.31421468E 09
3	0.49690284E C5	0.11068165E 06	0.61990405E 05	C.27013586E C9	-0.1471C627E 09	-0.15226132E 09
4	0.38660716E C9	0.529C9582E 09	C.27C13586E C9	C.13621762E 13	-0.69705943E 12	-0.72538438E 12
5	-0.26350676E C9	-0.31737836E 09	-C.14710627E 09	-C.69705943E 12	0.10357694E 13	0.82178973E 12
6	-0.24119176E 09	-0.3142146EE 09	-0.15226132E 09	-C.725384 38E 12	0.82178973E 12	0.68623054E 12

B MATRIX AS INPUT

COVARIANCE MATRIX 4

MATRIX F-6

	1	2	3	4	5	6
1	0.32907563E-00	0.678242C8E 0C	C.74C12478E 00	-C.42219780E-C3	-0.36957033E-04	0.18840832E-C3
2	0.678242C8E C0	0.15660232E 01	C.14102188E 01	-C.91449309E-03	-0.42055506E-04	0.35203539E-03
3	0.74C12478E C0	0.1410218 8E 01	C.17441680E 01	-C.91900583E-03	-0.10752825E-03	0.45017806E-03
4	-0.42219780E-C3	-0.914493C9E-03	-C.919005 83E-03	C.55345443E-06	0.37565064E-07	-0.23146582E-06
5	-C.36957033E-04	-0.42055506E-04	-C.1C752825E-03	C.37965C64E-07	0.13313317E-07	-0.31916483E-07
6	0.18840832E-03	0.35203539E-03	C.45C17EC6E-03	-0.23146582E-06	-0.31916483E-07	0.12084840E-06

F MATRIX AS INPUT

TYPE 1 PERTURBATION

MATRIX F-7

	1	2	3	4	5	6
1	C.9999999E-07	0.99999999E-07	C.99999999E-07	C.99999999E-07	0.99999999E-07	-0.99999999E-07
2	C.99999999E-07	-C.99999999E-07	-C.99999999E-07	C.99999999E-07	-0.99999999E-07	0.99999999E-07
3	0.99999999E-07	-0.99999999E-07	C.99999999E-07	-C.99999999E-07	0.99999999E-07	0.99999999E-07
4	C.99999999E-07	C.99999999E-07	-C.99999999E-07	C.99999999E-07	-0.99999999E-07	-0.99999999E-07
5	C.99999999E-07	-0.99999999E-07	C.99999999E-07	-C.99999999E-07	0.99999999E-07	0.99999999E-07
6	-C.99999999E-07	C.99999999E-07	C.99999999E-07	-C.99999999E-07	0.99999999E-07	-0.99999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 1 PERTURBATION

MATRIX F-8

	1	2	3	4	5	6
1	-0.32238140D-01	-0.73317637D-01	-C.67897920D-01	C.43127006D-04	0.24484116D-05	-0.17311644D-04
2	-C.73317637D-01	-0.16676572D-00	-C.15507235D-00	C.97830755D-04	0.57346116D-05	-0.39533446D-04
3	-C.67897920D-01	-0.15507235D-00	-C.14256288D-00	C.90999551D-04	0.50456803D-05	-0.36352575D-04
4	C.43127006D-04	0.97830755D-04	C.90999551D-04	-C.57629352D-07	-0.33178552D-08	0.23200217D-07
5	0.24484116D-05	0.57346116D-05	C.50456803D-05	-C.33178552D-08	-0.15885350D-09	0.12889696D-08
6	-0.17311644D-04	-0.39533446D-04	-C.36352575D-04	C.23200217D-07	0.12889696D-08	-0.92720120D-08

F MATRIX AS INPUT TYPE 2 PERTURBATION MATRIX F-9

	1	2	3	4	5	6
1	0.C9999999E-C5	0.09999999E-05	C.C9999999E-05	C.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.C9999999E-05	-0.09999999E-05	-C.C9999999E-05	0.09999999E-05	-0.09999999E-05	0.09999999E-05
3	0.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.C9999999E-05	0.09999999E-05	-C.09999999E-05	0.09999999E-05	-0.09999999E-05	-0.09999999E-05
5	C.09999999E-C5	-0.09999999E-05	0.C9999999E-05	-C.09999999E-05	0.09999999E-05	0.09999999E-05
6	-0.09999999E-05	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX F-10

	1	2	3	4	5	6
1	-C.1C427124D 02	-0.23518972D 02	-0.22C93715D 02	0.13898049D-01	0.82954650C-03	-0.56384399D-02
2	-0.23518972D 02	-0.53039248D 02	-0.45839767D 02	0.31345492D-01	0.18726610D-02	-0.12719366D-01
3	-C.22C93715D 02	-0.45839767D 02	-0.46BC9575C C2	0.29449729D-01	0.17566493D-02	-0.11946087D-01
4	0.13898049D-01	0.31345492D-01	0.29449729D-01	-0.18523753D-04	-0.11060838D-05	0.75157277D-05
5	0.82954650C-C3	0.18726610D-02	C.17566493C-02	-C.11060838D-05	-0.65734490D-07	0.44832311D-06
6	-0.56384399D-C2	-0.12719366D-01	-0.11946087D-01	0.75157277D-05	0.44832311D-06	-0.30487313D-05

F MATRIX AS INPUT TYPE 3 PERTURBATION MATRIX F-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 3 PERTURBATION MATRIX F-12

	1	2	3	4	5	6
1	0.64965528D-03	0.12204780D-02	0.15406347D-02	-0.80298199D-06	-0.93371760D-07	0.39201363D-06
2	0.12204780D-02	0.22112243D-02	0.29505978D-02	-0.14870976D-05	-0.19194476D-06	0.75404816D-06
3	0.15406347D-02	0.29505978D-02	0.36154221D-02	-0.19191581D-05	-0.21009825D-06	0.91766100D-06
4	-0.80298199D-06	-0.14870976D-05	-0.19191581D-05	0.98689561D-09	0.11978071D-09	-0.48920832D-09
5	-0.93371760D-07	-0.19194476D-06	-0.21009825D-06	0.11978071D-09	0.10021825D-10	-0.52709530D-10
6	0.39201363D-06	0.75404816D-06	0.91766100D-06	-0.48920832D-09	-0.52709530D-10	0.23266176D-09

F MATRIX AS INPUT

TYPE 4 PERTURBATION

MATRIX F-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 4 PERTURBATION

MATRIX F-14

	1	2	3	4	5	6
1	0.45430815D-03	0.10120704D-02	0.96667417D-03	-0.60429894D-06	-0.28520657D-07	0.23295074D-06
2	0.10120704D-02	0.21995999D-02	0.21921854D-02	-0.13312602D-05	-0.76886930D-07	0.53413912D-06
3	0.96667417D-03	0.21921854D-02	0.20296315D-02	-0.12963483D-05	-0.51260270D-07	0.48493492D-06
4	-0.60429894D-06	-0.13312602D-05	-0.12963483D-05	0.79574491D-09	0.41578770D-10	-0.31400901D-09
5	-0.28520657D-07	-0.76886930D-07	-0.51260270D-07	0.41578770D-10	-0.15183743D-11	-0.10833615D-10
6	0.23295074D-06	0.53413912D-06	0.48493492D-06	-0.31400901D-09	-0.10833615D-10	0.11509558D-09

APPENDIX G

Matrices Associated with Covariance Matrix 5

This appendix contains the matrices involved in the sensitivity study of normal matrix 5.

MATRICES NUMBERS 3, 4, and 5
COVARIANCE MATRICES BEFORE AND AFTER FORWARDING
DATA PROCESSING EPOCH

*ORBIT PARAMETERS:	a	2817.9896 km
	e	0.29138044
	i	8.3826441 deg
	Ω	15.586228 deg
	ω	354.80842 deg
	T_p	66 yr. 6 mo. 27 da. 3 hr. 41 min. 54.355 sec.
	t_o	66 yr. 6 mo. 27 da. 4 hr. 4 min. 48.0 sec.

MATRIX NO. 3: Matrix No. 3 is the covariance matrix of spacecraft state at t_o after two lunar orbits of range and range rate data from Goldstone and Woomera have been processed.

MATRIX NO. 4: Matrix No. 4 is Matrix No. 3 mapped forward for 270 minutes from t_o.

MATRIX NO. 5: Matrix No. 5 is Matrix No. 3 mapped forward for 488 minutes from t_o.

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic)

A MATRIX AS INPUT

COVARIANCE MATRIX 5

MATRIX G-1

	1	2	3	4	5	6
1	0.28661618E 01	0.43362577E 01	0.30E61E75E 01	-0.24428885E-02	0.15329207E-03	0.99615463E-03
2	0.43362577E 01	0.66645047E 01	0.45676750E 01	-0.37197106E-02	0.26525205E-03	0.14677069E-02
3	0.3C861875E 01	0.4567675CE 01	0.34224737E 01	-0.26069710E-02	0.13147227E-03	0.11126911E-02
4	-0.24428885E-C2	-0.37197106E-02	-0.26C69710E-02	0.20E77186E-05	-0.13891769E-06	-0.8390643CE-06
5	0.15329207E-03	0.26525205E-03	0.13147227E-03	-0.13891769E-06	0.21794763E-07	0.36231168E-07
6	0.99615463E-03	0.14677069E-02	0.11126911E-02	-C.83906430E-06	0.36231168E-07	0.36785509E-06

B MATRIX AS INPUT

APPROXIMATE NORMAL MATRIX 5

MATRIX G-2

	1	2	3	4	5	6
1	0.22160377E 06	0.15645461E 06	0.58637449E 05	0.47751717E C9	-0.30291305E 09	-0.28267655E 09
2	0.15645461E 06	0.2349309SE 06	0.12C89699E 06	0.58109490E C9	-0.38027941E 09	-0.36381137E 09
3	0.58637449E C5	0.12089699E 06	C.66426495E 05	C.28442248E C9	-0.17964495E 09	-0.17563438E 09
4	0.47751717E C9	0.58109490E 09	0.28442248E 09	0.15560950E 13	-0.83041202E 12	-0.84077037E 12
5	-0.30291305E C9	-0.38027941E 09	-0.17964495E 09	-C.83041202E 12	0.10869369E 13	0.87976554E 12
6	-0.28267655E 09	-0.36381137E 09	-0.17563438E 09	-0.84077037E 12	0.87976554E 12	0.74390848E 12

ERROR MATRIX (E)

ERROR IN MATRIX G

MATRIX G-3

	1	2	3	4	5	6
1	0.45952894D 04	0.90068658D 04	C.49134781D 04	C.21553605D 08	-0.12903720D 08	-0.12808999D 08
2	C.90C68658D 04	0.15310562D 05	C.8121624CD 04	0.373906500 08	-0.22954503D 08	-0.22497119D 08
3	C.491347810 04	0.81216240D 04	0.42820293D 04	C.19920362D 08	-0.12289790D 08	-0.12014465D 08
4	C.21553605D C8	0.373906500 08	0.19920362D 08	C.91052155D 11	-0.55629169D 11	-0.54642121D 11
5	-0.12903720D C8	-0.22954503D 08	-0.12289790D C8	-C.55629169D 11	0.34059610D 11	0.334611710 11
6	-0.12C8C999D C8	-0.22497119D 08	-0.12014465D 08	-0.546421210 11	0.334611710 11	0.328572750 11

B MATRIX PLUS E MATRIX

NORMAL MATRIX 5

MATRIX G-4

	1	2	3	4	5	6
1	C.22619906D C6	0.165461480 06	C.6355C928D 05	C.499070780 09	-0.31581678D 09	-0.29548555D 09
2	0.165461480 06	0.25024154D 06	0.12901861D 06	0.618485550 09	-0.40323391D 09	-0.38630850D 09
3	0.635505280 C5	0.12901861D 06	C.70708525D 05	C.304342840 C9	-0.19193474D 09	-0.18764885D 09
4	0.499070780 C9	0.618485550 09	0.304342840 09	0.164714720 13	-0.886041200 12	-0.89541250D 12
5	-C.315816780 09	-0.403233910 09	-0.191934740 C9	-C.886041200 12	0.112059650 13	0.913226720 12
6	-C.295485550 09	-0.3863C850D 09	-C.187648850 C9	-C.895412500 12	0.913226720 12	0.776765760 12

A MATRIX AS INPUT

NORMAL MATRIX 5

MATRIX G-5

	1	2	3	4	5	6
1	C.22619505E C6	0.16546147E 06	C.63550927E 05	C.49907078E C9	-0.31581677E 09	-0.29548554E 09
2	C.16546147E C6	0.25024153E C6	0.12901860E 06	C.61848554E C9	-0.40323390E 09	-0.38630850E C9
3	0.63550927E C5	0.12901860E 06	C.7C7C8524E 05	C.30434284E C9	-0.19193473E 09	-0.18764885E C9
4	0.49907078E C9	0.61848554E C9	0.30434284E C9	0.16471472E 13	-0.88604119E 12	-0.89541249E 12
5	-C.31581677E C9	-0.40323390E 09	-0.19193473E C9	-C.88604119E 12	0.11209965E 13	0.91322671E 12
6	-0.29548554E C9	-0.38630850E 09	-C.18764885E 09	-C.89541249E 12	0.91322671E 12	0.77676576E 12

B MATRIX AS INPUT

COVARIANCE MATRIX 5

MATRIX G-6

	1	2	3	4	5	6
1	0.28661618E C1	0.43262577E 01	0.3C861875E 01	-C.24428885E-C2	0.15329207E-C3	0.99615463E-03
2	C.43362577E C1	0.66645047E 01	0.4567675CE C1	-C.37197106E-02	0.26525205E-03	0.14677069E-02
3	C.3C861875E C1	0.4567675CE 01	0.34224737E 01	-C.26C69710E-02	0.13147227E-03	0.11126911E-02
4	-0.24428885E-C2	-0.37197106E-02	-C.26C69710E-02	C.2CE77186E-C5	-0.13891769E-06	-0.83906430E-06
5	C.15329207E-C3	0.26525205E-03	0.13147227E-C3	-C.13891769E-C6	0.21794763E-07	0.36231168E-07
6	C.99615463E-03	0.14677069E-02	C.11126911E-02	-C.83906430E-06	0.36231168E-07	0.36785509E-06

F MATRIX AS INPUT

TYPE 1 PERTURBATION

MATRIX G-7

	1	2	3	4	5	6
1	C.9999999E-C7	C.9999999E-07	C.9999999E-07	C.9999999E-07	0.9999999E-07	-0.9999999E-07
2	C.9999999E-C7	-C.9999999E-07	-C.9999999E-07	C.9999999E-07	-0.9999999E-07	0.9999999E-07
3	0.9999999E-C7	-0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.9999999E-07	0.9999999E-07
4	C.9999999E-C7	0.9999999E-07	-C.9999999E-07	C.9999999E-07	-0.9999999E-07	-0.9999999E-07
5	C.9999999E-C7	-C.9999999E-07	C.9999999E-07	-0.9999999E-07	0.9999999E-07	0.9999999E-07
6	-C.9999999E-C7	0.9999999E-07	C.9999999E-07	-C.9999999E-07	0.9999999E-07	-0.9999999E-07

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 1 PERTURBATION

MATRIX G-8

	1	2	3	4	5	6
1	-C.27833383D C1	-0.42439186D 01	-C.29661809D 01	C.23790927D-02	-0.1559743CD-03	-0.96012225D-03
2	-0.42439186D C1	-C.647C6083D 01	-C.45230353D C1	C.36274682D-C2	-0.23773525D-03	-0.14640511D-02
3	-0.29661905D 01	-0.45230353D 01	-C.316C7255D C1	C.25354496D-C2	-0.16630322D-03	-0.10231040D-C2
4	C.23790927D-C2	0.36274682D-02	C.25354496D-02	-C.20335432D-05	C.1333C258D-06	0.82069631D-06
5	-0.1559743CD-C3	-0.23773525D-03	-C.1663C322D-03	C.13330258D-C6	-0.87203823D-08	-0.53825069D-07
6	-C.96012225D-C3	-0.14640511D-02	-C.1023104CD-C2	C.82C69631D-06	-0.53825069D-07	-0.33117575D-06

F MATRIX AS INPUT TYPE 2 PERTURBATION MATRIX G-9

	1	2	3	4	5	6
1	0.C9999999E-05	0.09999999E-05	C.C9999999E-05	0.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.09999999E-05	-0.09999999E-05	-C.C9999999E-05	0.09999999E-05	-0.09999999E-05	0.09999999E-05
3	0.C9999999E-C5	-0.09999999E-05	C.C9999999E-C5	-C.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.C9999999E-C5	0.09999999E-05	-C.C9999999E-05	0.09999999E-05	-0.09999999E-05	-0.09999999E-05
5	0.C9999999E-05	-0.09999999E-05	0.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
6	-0.09999999E-05	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX G-10

	1	2	3	4	5	6
1	0.37366891D 01	0.56959681D 01	C.39E34E21D 01	-C.31937461D-02	0.20947350C-03	0.12887004D-02
2	0.56959681D 01	0.868602130 01	0.6C6886E8D 01	-0.48690889D-02	0.320219710-03	0.19633998D-02
3	0.39834821D C1	0.6C6886E8D 01	0.42497137C 01	-C.34039683C-02	0.22244701D-03	0.13747665D-02
4	-0.31937461D-02	-0.48690889D-02	-0.34039683C-02	C.27298541D-05	-0.17922960C-06	-0.11012396D-05
5	0.2C947350D-C3	0.32021971D-03	C.222447C1C-03	-0.17922960D-06	0.11961687D-07	0.72008627D-07
6	C.12887004D-C2	0.19633998C-02	0.13747665C-02	-C.11012396D-05	0.72008627D-07	0.44669028C-06

F MATRIX AS INPUT TYPE 3 PERTURBATION MATRIX G-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 3 PERTURBATION MATRIX G-12

	1	2	3	4	5	6
1	0.11622009D-00	0.17658146D-00	0.12440677D-00	-0.99231379D-04	0.64685186D-05	0.40090359D-04
2	0.17658146D-00	0.26825134D-00	0.18906143D-00	-0.15075928D-03	0.98123313D-05	0.60931583D-04
3	0.12440677D-00	0.18906143D-00	0.13312890D-00	-0.10623136D-03	0.69398765D-05	0.42894983D-04
4	-0.99231379D-04	-0.15075928D-03	-0.10623136D-03	0.84723607D-07	-0.55191601D-08	-0.34234772D-07
5	0.64685186D-05	0.98123313D-05	0.69398765D-05	-0.55191601D-08	0.35403308D-09	0.22387226D-08
6	0.40090359D-04	0.60931583D-04	0.42894983D-04	-0.34234772D-07	0.22387226D-08	0.13820123D-07

F MATRIX AS INPUT

TYPE 4 PERTURBATION

MATRIX G-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT)

EFFECT OF TYPE 4 PERTURBATION

MATRIX G-14

	1	2	3	4	5	6
1	0.29813923D-01	0.45587415D-01	0.31629670D-01	-0.25523441D-04	0.17589925D-05	0.10164333D-04
2	0.45587415D-01	0.69696921D-01	0.48373048D-01	-0.39024724D-04	0.26859074D-05	0.15546557D-04
3	0.31629670D-01	0.48373048D-01	0.33546701D-01	-0.27080169D-04	0.18698559D-05	0.10778692D-04
4	-0.25523441D-04	-0.39024724D-04	-0.27080169D-04	0.21849836D-07	-0.15049390D-08	-0.87027482D-08
5	0.17589925D-05	0.26859074D-05	0.18698559D-05	-0.15049390D-08	0.10226379D-09	0.60158618D-09
6	0.10164333D-04	0.15546557D-04	0.10778692D-04	-0.87027482D-08	0.60158618D-09	0.34628971D-08

APPENDIX H

Matrices Associated with Normal Matrix 6

This appendix contains the matrices involved in the sensitivity study of covariance matrix 6.

MATRIX NUMBER 6. NORMAL MATRIX OF SOLUTION FOR SPACECRAFT STATE AND LUNAR GRAVITATIONAL CONSTANTS

Orbit Parameters*		Tracking Stations	Data Types	Data Weight, σ	Data Tracking Interval (Min)	Number of Data Points
a	2781.4394					
e	0.28346639	Goldstone	C3, CC3**	0.01 Cps	257	149,C3
i	14.142304					56,CC3
Ω	330.20977	Woomera	C3,CC3**	0.01 Cps		43,C3
ω	344.65778					149,CC3
T_p	66 yr. 6 mo. 27 da. 3 hr. 17 min. 26.208 sec					
t_o	66 yr. 6 mo. 27 da. 3 hr. 45 min. 00 sec					

A Priori Used: None

Solution Parameters: $x, y, z, \dot{x}, \dot{y}, \dot{z}$ J_{20} J_{30} C_{22} S_{41}

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic.)

**Doppler types

A MATRIX AS INPUT

NORMAL MATRIX 6

MATRIX H-1

	1	2	3	4	5	6
1	C.90540325E 09	0.4280166CE 10	0.29565924E 10	-C.83848413E 13	0.31242430E 13	0.30079319E 13
2	0.428C1660E 10	0.22010721E 11	0.152342C1E 11	-0.42805866E 14	0.16559950E 14	0.15784565E 14
3	0.29565924E 10	0.15234201E 11	0.10544790E 11	-C.29621308E 14	0.11469140E 14	0.10929167E 14
4	-C.83848413E 13	-0.42805866E 14	-0.296213C8E 14	0.83431312E 17	-0.32132185E 17	-0.30668461E 17
5	0.31242430E 13	0.16559950E 14	0.11469140E 14	-C.32132185E 17	0.12589923E 17	0.11960394E 17
6	C.30079319E 13	0.15784565E 14	0.10929167E 14	-0.30668461E 17	0.11960394E 17	0.11377563E 17
7	-0.45275009E 13	-0.23178486E 14	-0.16044368E 14	0.44975685E 17	-0.17398231E 17	-0.16576314E 17
8	-0.12877422E 13	-0.70405821E 13	-0.48788C92E 13	C.13698550E 17	-0.54152184E 16	-0.51347883E 16
9	0.86618150E 13	0.45605659E 14	0.31579752E 14	-C.88638347E 17	0.34600405E 17	0.32907321E 17
10	0.72881401E 13	0.37522615E 14	0.2597939?E 14	-C.72629612E 17	0.28204922E 17	0.26838189E 17

	7	8	9	10
1	-0.45275009E 13	-0.12877422E 13	0.86618150E 13	C.72881401E 13
2	-0.23178486E 14	-0.70405821E 13	0.45605659E 14	0.37522615E 14
3	-C.16044368E 14	-0.48788092E 13	C.31579752E 14	C.25979397E 14
4	0.44975685E 17	0.13698550E 17	-0.88638347E 17	-0.72629612E 17
5	-C.17398231E 17	-0.54152184E 16	0.34600405E 17	C.28204922E 17
6	-C.16576314E 17	-0.51347883E 16	0.32907321E 17	C.26838189E 17
7	0.24604009E 17	0.73023961E 16	-0.47815267E 17	-C.40034118E 17
8	0.73023961E 16	0.23989975E 16	-0.14916497E 17	-0.11763993E 17
9	-0.47815267E 17	-0.14916497E 17	C.95589459E 17	0.77411004E 17
10	-C.40034118E 17	-0.11763993E 17	0.77411004E 17	0.65428179E 17

B MATRIX AS INPUT

APPROXIMATE COVARIANCE MATRIX 6

MATRIX H-2

	1	2	3	4	5	6
1	0.11294790E-04	-0.44498220E-04	0.57725110E-04	0.41028355E-08	-0.20492616E-07	0.37778919E-07
2	-0.44498220E-04	0.18110037E-03	-0.23768204E-03	-0.16878318E-07	0.85595206E-07	-0.15440591E-06
3	0.57725110E-04	-0.23768204E-03	0.32501049E-03	0.24409160E-07	-0.12372666E-06	0.20932513E-06
4	0.41028355E-08	-0.16878318E-07	0.24409160E-07	0.27157292E-11	-0.12914578E-10	0.18751478E-10
5	-0.20492616E-07	0.85595206E-07	-0.12372666E-06	-0.12914578E-10	0.62636892E-10	-0.91960916E-10
6	0.37778919E-07	-0.15440591E-06	0.20932513E-06	0.18751478E-10	-0.91960916E-10	0.14939754E-09
7	0.12690342E-08	-0.55064095E-08	0.11360891E-07	-0.55254648E-12	0.88512412E-12	-0.63824581E-12
8	0.16627487E-08	-0.62635250E-08	0.31329829E-08	-0.11850160E-11	0.50424975E-11	-0.10344949E-11
9	-0.57618982E-10	0.27815599E-09	-0.81247096E-09	-0.28484435E-13	0.22721895E-12	-0.16376700E-12
10	0.37592021E-09	-0.16502170E-08	0.38723662E-08	-0.96802536E-13	-0.11429580E-12	0.19786932E-13

	7	8	9	10
1	0.12690342E-08	0.16627487E-08	-0.57618982E-10	0.37592021E-09
2	-0.55064095E-08	-0.62635250E-08	0.27815599E-09	-0.16502170E-08
3	0.11360891E-07	0.31329829E-08	-0.81247096E-09	0.38723662E-08
4	-0.55254648E-12	-0.11850160E-11	-0.28484435E-13	-0.96802536E-13
5	0.88512412E-12	0.50424975E-11	0.22721895E-12	-0.11429580E-12
6	-0.63824581E-12	-0.10344949E-11	-0.16376700E-12	0.19786932E-13
7	0.60930797E-11	0.65506314E-12	-0.35214245E-12	0.20350111E-11
8	0.65506314E-12	0.33934399E-11	0.86493554E-13	0.66586466E-14
9	-0.35214245E-12	0.86493554E-13	0.27834298E-13	-0.12573909E-12
10	0.20350111E-11	0.66586466E-14	-0.12573909E-12	0.69578087E-12

ERROR MATRIX (E)

ERROR IN MATRIX H-2

MATRIX H-3

	1	2	3	4	5	6
1	0.10954941D-05	-0.44824485D-05	0.60265343D-05	0.43649023D-09	-0.22191297D-08	0.38691155D-08
2	-0.44824485D-05	0.18340101D-04	-0.24653770D-04	-0.17842461D-08	0.90722774D-08	-0.15824481D-07
3	0.60265343D-05	-0.24653770D-04	0.33115345D-04	0.23895771D-08	-0.12155224D-07	0.21239865D-07
4	0.43549023D-09	-0.17842461D-08	0.23895771D-08	0.16883765D-12	-0.86200077D-12	0.15212322D-11
5	-0.22191297D-08	0.90722774D-08	-0.12155224D-07	-0.86200077D-12	0.43979980D-11	-0.77488550D-11
6	0.38691155D-08	-0.15824481D-07	0.21239865D-07	0.15212322D-11	-0.77488550D-11	0.13583038D-10
7	0.19846411D-09	-0.81317564D-09	0.10957013D-08	0.84157674D-13	-0.42296115D-12	0.72262171D-12
8	0.10543656D-09	-0.43412956D-09	0.59895927D-09	0.49494732D-13	-0.24658669D-12	0.40214107D-12
9	-0.12540215D-10	0.51276945D-10	-0.68510408D-10	-0.50159476D-14	0.25401779D-13	-0.44455245D-13
10	0.64991138D-10	-0.26613686D-09	0.35766844D-09	0.27151811D-13	-0.13669236D-12	0.23503736D-12

	7	8	9	10
1	0.19846411D-09	0.10543656D-09	-0.12540215D-10	0.64991138D-10
2	-0.81317564D-09	-0.43412956D-09	0.51276945D-10	-0.26613686D-09
3	0.10957013D-08	0.59895927D-09	-0.68510408D-10	0.35766844D-09
4	0.84157674D-13	0.49494732D-13	-0.50159476D-14	0.27151811D-13
5	-0.42296115D-12	-0.24658669D-12	0.25401779D-13	-0.13669236D-12
6	0.72262171D-12	0.40214107D-12	-0.44455245D-13	0.23503736D-12
7	0.25325048D-13	0.12890356D-13	-0.18777658D-14	0.85483822D-14
8	0.12890356D-13	-0.11771433D-14	-0.12650156D-14	0.48569008D-14
9	-0.18777658D-14	-0.12650156D-14	0.11816409D-15	-0.60613010D-15
10	0.85483822D-14	0.48569008D-14	-0.60613010D-15	0.28460224D-14

B MATRIX PLUS E MATRIX COVARIANCE MATRIX 6 MATRIX H-4

	1	2	3	4	5	6
1	C.123902840-C4	-0.48S8C669C-04	C.63751645C-04	C.453932580-C8	-0.22711746C-07	0.41648C35C-07
2	-C.48S806690-04	0.19944047D-03	-0.26233582C-C3	-C.18662565C-07	0.94667484D-07	-0.17023040D-06
3	C.63751645C-C4	-0.26233582C-C3	0.35512583C-03	C.26798738C-07	-0.13588198C-06	0.230564S9C-06
4	0.453932580-C8	-C.18662565C-07	0.26798738C-07	C.29845669D-11	-0.13776579C-10	0.20272711C-10
5	-C.22711746C-C7	C.94667484C-07	-0.13588188C-06	-C.13776579C-1C	0.67034890C-1C	-0.99709771C-10
6	0.41648035D-C7	-0.17023040C-06	0.23056499C-06	0.20272711C-1C	-0.99709771D-10	0.16298059D-09
7	C.14674984C-C8	-0.63195851D-C8	0.12456593C-C7	-C.46838881D-12	0.46216298D-12	0.8437589EC-13
8	0.17681853C-C8	-0.66976545D-08	0.37319423C-C8	-0.11355213D-11	0.47959109D-11	-0.63235382C-12
9	-0.701591960-10	0.32943294D-09	-C.88C98137C-C9	-C.33500382D-13	0.25262073D-12	-0.20822225C-12
10	C.44C91136C-C9	-0.19163538C-08	C.42300347C-C8	-C.69650725D-13	-0.25098817C-12	0.25482429C-12

	7	8	9	10
1	0.14674984C-C8	0.17681853C-08	-0.701591960-10	C.44C91136C-C9
2	-0.63195851C-C8	-0.66976545C-C8	0.32943294D-09	-C.19163538C-C8
3	C.12456593C-C7	0.37319423C-08	-C.88C98137C-C9	C.42300347C-C8
4	-C.46838881C-12	-0.11355213C-11	-0.33500382C-13	-C.69650725C-13
5	C.46216298C-12	0.47959109C-11	C.25262073C-12	-C.25C98817C-12
6	C.84375898C-13	-0.63235382C-12	-C.20822225C-12	C.25482429C-12
7	C.61184048C-11	0.66795349C-12	-C.35402022C-12	C.2C4355950-11
8	0.667953490-12	0.33922626C-11	C.85228539C-13	C.11515547C-13
9	-0.35402022C-12	C.85228539C-13	C.27952463C-13	-C.12634522C-12
10	0.20435595C-11	0.11515547C-13	-C.12634522C-12	0.69862690C-12

A MATRIX AS INPUT

COVARIANCE MATRIX 6

MATRIX H-5

	1	2	3	4	5	6
1	C.12390283E-C4	-0.48S8C668E-04	C.63751644E-04	C.45393257E-C8	-0.22711746E-07	0.41648035E-07
2	-C.48S80668E-04	0.19944046E-03	-0.26233581E-C3	-C.18662564E-07	0.94667483E-07	-0.17023C40E-06
3	C.63751644E-04	-0.26233581E-C3	C.35912582E-03	C.26798738E-07	-0.13598187E-06	0.23056498E-06
4	C.45393257E-C8	-0.18662564E-07	0.26798738E-07	C.28845659E-11	-0.13776579E-10	0.20272710E-10
5	-C.22711746E-C7	0.94667483E-07	-C.13588187E-C6	-0.13776579E-1C	0.67C34890E-10	-0.9970977CE-10
6	0.41648035E-C7	-0.17023040E-06	C.23C56498E-06	0.2C272710E-1C	-0.9970977CE-10	0.16298059E-C9
7	0.14674983E-C8	-0.63155851E-08	0.1245E552E-07	-C.46838881E-12	0.46216297E-12	0.84375896E-13
8	0.17681853E-C8	-C.66976544E-08	C.37319423E-C8	-C.11355212E-11	0.47959109E-11	-0.63235381E-12
9	-C.7C159195E-10	0.32542293E-09	-C.88C98137E-09	-C.33500382E-13	0.25262073E-12	-0.20822225E-12
10	C.44C91135E-C9	-0.19163538E-08	0.42300346E-C8	-0.69650724E-13	-0.25C98816E-12	0.25482429E-12

	7	8	9	10
1	C.14674983E-C8	0.17681853E-08	-C.7C159195E-10	C.44C91135E-C9
2	-C.63155851E-C8	-0.66976544E-08	C.32942253E-09	-C.19163538E-C8
3	0.12456552E-C7	0.37319423E-08	-C.88C98137E-09	C.42300346E-C8
4	-C.46838881E-12	-0.11355212E-11	-0.335CC382E-13	-0.69650724E-13
5	C.46216297E-12	0.47959109E-11	C.25262C73E-12	-0.25C98816E-12
6	0.84375896E-13	-0.63235381E-12	-C.2C822225E-12	C.25482429E-12
7	0.61184047E-11	C.66795346E-12	-0.35402022E-12	C.20435595E-11
8	C.66795348E-12	0.33922628E-11	C.85228538E-13	0.11515547E-13
9	-0.35402022E-12	0.85228538E-13	0.27952462E-13	-C.12634522E-12
10	0.20435595E-11	0.11515547E-13	-0.12634522E-12	C.65862690E-12

B MATRIX AS INPUT

NORMAL MATRIX 6

MATRIX H-6

	1	2	3	4	5	6
1	0.90540325E 09	0.42801660E 10	0.29565924E 10	-0.83848413E 13	0.31242430E 13	0.30079319E 13
2	0.42801660E 10	0.22010721E 11	0.15234201E 11	-0.42805866E 14	0.16555950E 14	0.15784565E 14
3	0.29565924E 10	0.15234201E 11	0.10544790E 11	-0.29621308E 14	0.11469140E 14	0.10929167E 14
4	-0.83848413E 13	-0.42805866E 14	-0.29621308E 14	0.83431312E 17	-0.32132185E 17	-0.30668461E 17
5	0.31242430E 13	0.16555950E 14	0.11469140E 14	-0.32132185E 17	0.12589923E 17	0.11960394E 17
6	0.30079319E 13	0.15784565E 14	0.10929167E 14	-0.30668461E 17	0.11960394E 17	0.11377563E 17
7	-0.45275009E 13	-0.23178486E 14	-0.16044368E 14	0.44975685E 17	-0.17398231E 17	-0.16576314E 17
8	-0.12877422E 13	-0.70405821E 13	-0.48788092E 13	0.13698550E 17	-0.54152184E 16	-0.51347883E 16
9	0.86618150E 13	0.45605659E 14	0.31579752E 14	-0.88638347E 17	0.34600405E 17	0.32907321E 17
10	0.72881401E 13	0.37522615E 14	0.25979397E 14	-0.72629612E 17	0.28204922E 17	0.26838189E 17

	7	8	9	10
1	-0.45275009E 13	-0.12877422E 13	0.86618150E 13	0.72881401E 13
2	-0.23178486E 14	-0.70405821E 13	0.45605659E 14	0.37522615E 14
3	-0.16044368E 14	-0.48788092E 13	0.31579752E 14	0.25979397E 14
4	0.44975685E 17	0.13698550E 17	-0.88638347E 17	-0.72629612E 17
5	-0.17398231E 17	-0.54152184E 16	0.34600405E 17	0.28204922E 17
6	-0.16576314E 17	-0.51347883E 16	0.32907321E 17	0.26838189E 17
7	0.24604009E 17	0.73023961E 16	-0.47815267E 17	-0.40034118E 17
8	0.73023961E 16	0.23989975E 16	-0.14916497E 17	-0.11763993E 17
9	-0.47815267E 17	-0.14916497E 17	0.95589459E 17	0.77411004E 17
10	-0.40034118E 17	-0.11763993E 17	0.77411004E 17	0.65428179E 17

F MATRIX AS INPUT TYPE 1 PERTURBATION MATRIX H-7

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
6	-0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
8	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07
9	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07
10	-0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

	7	8	9	10
1	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07
2	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
3	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
4	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07
5	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
6	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
7	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
8	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
9	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07
10	0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 1 PERTURBATION MATRIX H-8

	1	2	3	4	5	6
1	-C.504653610 09	-0.262942540 10	-0.182033120 10	C.511236270 13	-0.198781560 13	-0.189241670 13
2	-C.262942540 10	-0.136588190 11	-C.948357220 10	C.266346120 14	-0.103557740 14	-0.985888120 13
3	-C.182033120 10	-0.948357220 10	-0.656539340 10	C.184389090 14	-0.716920710 13	-0.682521370 13
4	C.511236270 13	0.266346120 14	C.184389090 14	-C.517856630 17	0.201347700 17	0.191686500 17
5	-C.198781560 13	-0.103557740 14	-C.716920710 13	C.201347700 17	-0.782846250 16	-0.745286200 16
6	-0.189241670 13	-0.985888120 13	-C.682521370 13	C.191686500 17	-0.745286200 16	-0.709527570 16
7	C.276123910 13	0.143857800 14	C.995915240 13	-C.279702270 17	0.108751510 17	0.103533180 17
8	C.851975150 12	0.443825460 13	C.307256010 13	-C.862934370 16	0.335504830 16	0.319409310 16
9	-C.547282270 13	-0.285114790 14	-C.197382350 14	0.554349690 17	-0.215533270 17	-0.205192170 17
10	-0.446730060 13	-0.232741960 14	-C.161125270 14	C.452519260 17	-0.175944840 17	-0.167502270 17

	7	8	9	10
1	C.276123910 13	0.851975150 12	-C.547282270 13	-C.446730060 13
2	0.143857800 14	0.443825460 13	-0.285114790 14	-C.232741960 14
3	C.995915240 13	0.307256010 13	-C.197382350 14	-C.161125270 14
4	-C.279702270 17	-0.862934370 16	0.554349690 17	C.452519260 17
5	C.108751510 17	C.335504830 16	-C.215533270 17	-C.175944840 17
6	0.103533180 17	0.319409310 16	-0.205192170 17	-C.167502270 17
7	-0.151071820 17	-C.466C87150 16	C.299413850 17	C.244413580 17
8	-C.466C87150 16	-0.143784640 16	C.923714630 16	C.754063030 16
9	C.299413850 17	0.923714630 16	-C.593406320 17	-C.484409840 17
10	0.244413580 17	C.754C63030 16	-0.484409840 17	-C.395428180 17

F MATRIX AS INPUT TYPE 2 PERTURBATION MATRIX H-9

	1	2	3	4	5	6
1	0.C9999999E-C5	0.09999999E-05	0.C9999999E-05	0.09999999E-05	0.09999999E-05	-0.09999999E-05
2	0.C9999999E-05	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.C9999999E-C5	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.C9999999E-05	-0.09999999E-05	-C.C9999999E-05	0.09999999E-05	-0.09999999E-05	0.09999999E-05
5	C.C9999999E-05	0.09999999E-05	C.C9999999E-05	-C.09999999E-05	-0.09999999E-05	0.09999999E-05
6	-0.C9999999E-05	0.C9999999E-05	C.C9999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	-0.C9999999E-C5	0.09999999E-05	-C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
8	-0.C9999999E-05	-0.09999999E-05	-0.C9999999E-05	0.09999999E-05	-0.09999999E-05	-0.09999999E-05
9	0.C9999999E-05	-0.09999999E-05	0.C9999999E-05	-0.09999999E-05	-0.09999999E-05	-0.09999999E-05
10	-0.C9999999E-C5	0.C9999999E-05	C.C9999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

	7	8	9	10
1	-0.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	-0.09999999E-05
2	0.C9999999E-C5	-0.C9999999E-05	-0.C9999999E-05	0.09999999E-05
3	-C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	C.09999999E-05
4	-0.C9999999E-C5	0.09999999E-05	-0.09999999E-05	0.09999999E-05
5	0.C9999999E-C5	-0.C9999999E-05	-0.C9999999E-05	0.09999999E-05
6	0.09999999E-C5	-0.C9999999E-05	-C.C9999999E-05	0.09999999E-05
7	C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	0.09999999E-05
8	-C.C9999999E-05	-0.09999999E-05	-C.C9999999E-05	0.09999999E-05
9	0.09999999E-C5	-0.09999999E-05	-C.C9999999E-05	-0.09999999E-05
10	0.C9999999E-C5	0.C9999999E-05	-C.09999999E-05	-0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX H-10

	1	2	3	4	5	6
1	0.11750597D 10	0.61269851D 10	0.42417250D 10	-0.11912616D 14	0.46332166D 13	0.44105583D 13
2	0.61269851D 10	0.31962655D 11	0.22127990D 11	-0.62143026D 14	0.24174194D 14	0.23011384D 14
3	0.42417250D 10	0.22127990D 11	0.15319378D 11	-0.43022079D 14	0.16736026D 14	0.15930990D 14
4	-0.11912616D 14	-0.62143026D 14	-0.43022079D 14	0.12082094D 18	-0.46999984D 17	-0.44739317D 17
5	0.46332166D 13	0.24174194D 14	0.16736026D 14	-0.46999984D 17	0.18284661D 17	0.17404859D 17
6	0.44105583D 13	0.23011384D 14	0.15930990D 14	-0.44739317D 17	0.17404859D 17	0.16567463D 17
7	-0.64330504D 13	-0.33556712D 14	-0.23231531D 14	0.65242687D 17	-0.25379148D 17	-0.24158587D 17
8	-0.19867867D 13	-0.10368609D 14	-0.71783176D 13	0.20158571D 17	-0.78431431D 16	-0.74655785D 16
9	0.12755950D 14	0.66553934D 14	0.46075916D 14	-0.12939562D 18	0.50339116D 17	0.47917027D 17
10	0.10407314D 14	0.54287532D 14	0.37583604D 14	-0.10554882D 18	0.41057979D 17	0.39083414D 17

	7	8	9	10
1	-0.64330504D 13	-0.19867867D 13	0.12755950D 14	0.10407314D 14
2	-0.33556712D 14	-0.10368609D 14	0.66553934D 14	0.54287532D 14
3	-0.23231531D 14	-0.71783176D 13	0.46075916D 14	0.37583604D 14
4	0.65242687D 17	0.20158571D 17	-0.12939562D 18	-0.10554882D 18
5	-0.25379148D 17	-0.78431431D 16	0.50339116D 17	0.41057979D 17
6	-0.24158587D 17	-0.74655785D 16	0.47917027D 17	0.39083414D 17
7	0.35230391D 17	0.10885149D 17	-0.69871692D 17	-0.56994854D 17
8	0.10885149D 17	0.33646141D 16	-0.21592525D 17	-0.17609935D 17
9	-0.69871692D 17	-0.21592525D 17	0.13858757D 18	0.11303752D 18
10	-0.56994854D 17	-0.17609935D 17	0.11303752D 18	0.92204469D 17

F MATRIX AS INPUT TYPE 3 PERTURBATION MATRIX H-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
8	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
9	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
10	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

	7	8	9	10
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
8	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
9	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
10	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 3 PERTURBATION MATRIX H-12

	1	2	3	4	5	6
1	-0.51400436D 08	-0.26491887D 09	-0.18336787D 09	0.51519489D 12	-0.199469290 12	-0.19008963D 12
2	-0.26491887D 09	-0.13654423D 10	-0.94511364D 09	0.26554048D 13	-0.10281146D 13	-0.97976571D 12
3	-0.18336787D 09	-0.94511364D 09	-0.65417614D 09	0.18379825D 13	-0.71162682D 12	-0.67816126D 12
4	0.51519489D 12	0.26554048D 13	0.18379825D 13	-0.51640228D 16	0.19993942D 16	0.19053698D 16
5	-0.19946929D 12	-0.10281146D 13	-0.71162682D 12	0.19993942D 16	-0.77412562D 15	-0.73772000D 15
6	-0.19008963D 12	-0.97976571D 12	-0.67816126D 12	0.19053698D 16	-0.73772000D 15	-0.70302677D 15
7	0.27887068D 12	0.14373506D 13	0.99488607D 12	-0.27952476D 16	0.10822577D 16	0.10313630D 16
8	0.84916212D 11	0.43768433D 12	0.30295066D 12	-0.85117182D 15	0.32955854D 15	0.31405957D 15
9	-0.54930164D 12	-0.28312305D 13	-0.19596837D 13	0.55059490D 16	-0.21317915D 16	-0.20315380D 16
10	-0.45141741D 12	-0.23266937D 13	-0.16104597D 13	0.45247732D 16	-0.17518930D 16	-0.16695074D 16

	7	8	9	10
1	0.27887068D 12	0.84916212D 11	-0.54930164D 12	-0.45141741D 12
2	0.14373506D 13	0.43768433D 12	-0.28312305D 13	-0.23266937D 13
3	0.99488607D 12	0.30295066D 12	-0.19596837D 13	-0.16104597D 13
4	-0.27952476D 16	-0.85117182D 15	0.55059490D 16	0.45247732D 16
5	0.10822577D 16	0.32955854D 15	-0.21317915D 16	-0.17518930D 16
6	0.10313630D 16	0.31405957D 15	-0.20315380D 16	-0.16695074D 16
7	-0.15130442D 16	-0.46073439D 15	0.29803315D 16	0.24492195D 16
8	-0.46073439D 15	-0.14029895D 15	0.90753895D 15	0.74581028D 15
9	0.29803315D 16	0.90753895D 15	-0.58705401D 16	-0.48243795D 16
10	0.24492195D 16	0.74581028D 15	-0.48243795D 16	-0.39646390D 16

F MATRIX AS INPUT TYPE 4 PERTURBATION MATRIX H-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
8	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
9	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
10	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

	7	8	9	10
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
8	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
9	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
10	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 4 PERTURBATION MATRIX H-14

	1	2	3	4	5	6
1	-0.150378530 07	-0.702888620 07	-0.485695590 07	0.136382780 11	-0.508782120 10	-0.488998160 10
2	-0.702888620 07	-0.324631690 08	-0.224269380 08	0.629796210 11	-0.233771580 11	-0.224949630 11
3	-0.485695590 07	-0.224269380 08	-0.154934150 08	0.435089080 11	-0.161483410 11	-0.155393030 11
4	0.136382780 11	0.629796210 11	0.435089080 11	-0.122180860 15	0.453493690 14	0.436384800 14
5	-0.508782120 10	-0.233771580 11	-0.161483410 11	0.453493690 14	-0.167961730 14	-0.161707670 14
6	-0.488998160 10	-0.224949630 11	-0.155393030 11	0.436384800 14	-0.161707670 14	-0.155667420 14
7	0.761781290 10	0.353026810 11	0.243901300 11	-0.684930610 14	0.254596560 14	0.244907350 14
8	0.199021180 10	0.904118910 10	0.624407180 10	-0.175355520 14	0.646327510 13	0.622977480 13
9	-0.140019830 11	-0.643374450 11	-0.444427090 11	0.124807160 15	-0.462261180 14	-0.445046080 14
10	-0.124560340 11	-0.577840450 11	-0.399229360 11	0.112114130 15	-0.416918100 14	-0.401012080 14

	7	8	9	10
1	0.761781290 10	0.199021180 10	-0.140019830 11	-0.124560340 11
2	0.353026810 11	0.904118910 10	-0.643374450 11	-0.577840450 11
3	0.243901300 11	0.624407180 10	-0.444427090 11	-0.399229360 11
4	-0.684930610 14	-0.175355520 14	0.124807160 15	0.112114130 15
5	0.254596560 14	0.646327510 13	-0.462261180 14	-0.416918100 14
6	0.244907350 14	0.622977480 13	-0.445046080 14	-0.401012080 14
7	-0.383512060 14	-0.987996000 13	0.700695590 14	0.627527740 14
8	-0.987996000 13	-0.245848200 13	0.177879150 14	0.161964760 14
9	0.700695590 14	0.177879150 14	-0.127221350 15	-0.114744580 15
10	0.627527740 14	0.161964760 14	-0.114744580 15	-0.102667950 15

APPENDIX I

Matrices Associated with Normal Matrix 7

This appendix contains the matrices involved in the sensitivity study of covariance matrix 7.

MATRIX NUMBER 7. NORMAL MATRIX OF SOLUTION FOR GRAVITATIONAL CONSTANTS

Orbit Parameters*		Tracking Stations	Data Types	Data Weight, σ	Data Tracking Interval (Min)	Number of Data Points
a	2788.0082	Goldstone	C3, CC3**	0.1 cps	428	158,C3
e	0.28628437					46,CC3
i	14.337031	Woomera	C3, CC3**	0.1 cps		32,C3
Ω	331.01127					
ω	344.19240					315,CC3
T_p	66 yr. 6 mo. 27 da. 10 hr. 37 min. 57.993 sec.					
t_o	66 yr. 6 mo. 27 da. 3hr. 43.min. 14.726 sec.					

A Priori Used: None

Solution Parameters: J_{20}, J_{30}, J_{40}, C_{22}, S_{41}, S_{22}, S_{44}

*(Referenced to true lunar equatorial plane and the line of intersection with the ecliptic)

**Doppler types

A MATRIX AS INPUT

NORMAL MATRIX 7

MATRIX I-1

	1	2	3	4	5	6
1	0.34836812E 15	0.10204089E 15	-0.13730261E 15	-0.66155706E 15	-0.56647307E 15	0.13486011E 16
2	0.10204089E 15	0.33248559E 14	-0.38601744E 14	-0.20307755E 15	-0.16405702E 15	0.40425406E 15
3	-0.13730261E 15	-0.38601744E 14	0.55327217E 14	0.25529159E 15	0.22520632E 15	-0.52376056E 15
4	-0.66155706E 15	-0.20307755E 15	0.25529159E 15	0.12894265E 16	0.10696299E 16	-0.25927524E 16
5	-0.56647307E 15	-0.16405702E 15	0.22520632E 15	0.10696299E 16	0.92538855E 15	-0.21786854E 16
6	0.13486011E 16	0.40425406E 15	-0.52376056E 15	-0.25927524E 16	-0.21786854E 16	0.52786069E 16
7	-0.22490596E 17	-0.67909534E 16	0.87204457E 16	0.43393084E 17	0.36351164E 17	-0.87965207E 17

	7
1	-0.22490596E 17
2	-0.67909534E 16
3	0.87204457E 16
4	0.43393084E 17
5	0.36351164E 17
6	-0.87965207E 17
7	0.14722984E 19

B MATRIX AS INPUT

APPROXIMATE COVARIANCE MATRIX 7

MATRIX I-2

	1	2	3	4	5	6
1	C.16865695E-10	-0.10586554E-12	0.82538881E-11	-C.22297907E-12	0.34489977E-11	-0.15676246E-11
2	-C.10586554E-12	0.14496879E-11	-C.15322105E-11	C.22193461E-12	0.33608305E-12	0.34426990E-13
3	0.82538881E-11	-0.15322105E-11	0.32602161E-10	0.25701945E-11	-0.79812930E-11	-0.30603907E-12
4	-0.22297907E-12	0.22193461E-12	0.257C1945E-11	C.44478719E-12	-0.98348612E-12	0.79304042E-13
5	C.34489577E-11	0.33608305E-12	-0.79812930E-11	-0.98348612E-12	0.40327034E-11	-0.47008289E-12
6	-0.15676246E-11	0.34426990E-13	-0.30603907E-12	0.79304042E-13	-C.47008289E-12	0.20189650E-12
7	C.36016659E-13	0.13626871E-14	0.28937164E-13	-C.16945288E-14	0.28424037E-14	-0.64357957E-15

	7
1	C.36C16659E-13
2	C.13626871E-14
3	0.28937164E-13
4	-C.16945288E-14
5	C.28424C37E-14
6	-0.64357957E-15
7	0.327C6594E-15

ERROR MATRIX (E)

ERROR IN MATRIX I-2

MATRIX I-3

	1	2	3	4	5	6
1	0.13430795D-15	0.25222943D-16	-0.25299888D-15	-C.25777429D-16	0.13384190D-15	-0.21663030D-16
2	0.25222943D-16	0.11936843D-17	-0.37558510D-16	-C.54380693D-17	0.22300248D-16	-0.31135349D-17
3	-C.25299888D-15	-0.37558510D-16	C.79321140D-15	C.85478736D-16	-0.36933353D-15	0.31494628D-16
4	-0.25777429D-16	-0.54380693D-17	0.85478736D-16	C.85039135D-17	-0.39118049D-16	0.33587527D-17
5	0.13384190D-15	0.22300248D-16	-0.36933353D-15	-C.39118049D-16	0.17658268D-15	-0.18615960D-16
6	-0.21663030D-16	-0.31135349D-17	C.31494628D-16	C.33587527D-17	-0.18615960D-16	0.31157537D-17
7	-C.17935198D-18	0.37215491D-19	-0.25424858D-18	-C.98281774D-20	0.15316719D-19	0.15297813D-19

	7
1	-C.17935198D-18
2	C.37215491D-19
3	-C.25424858D-18
4	-C.98281774D-20
5	C.15316719D-19
6	0.15297813D-19
7	-0.24181104D-21

P MATRIX PLUS E MATRIX COVARIANCE MATRIX 7 MATRIX I-4

	1	2	3	4	5	6
1	0.16865829D-10	-0.10584032D-12	0.82536351D-11	-0.22300485D-12	0.34491316D-11	-0.15676463D-11
2	-0.10584032D-12	0.14496891D-11	-0.15322481D-11	0.22192917D-12	0.33610535D-12	0.34423877D-13
3	0.82536351D-11	-0.15322481D-11	0.32602955D-10	0.25702800D-11	-0.79816624D-11	-0.30600757D-12
4	-0.22300485D-12	0.22192917D-12	0.25702800D-11	0.44479569D-12	-0.98352524D-12	0.79307402D-13
5	0.34491316D-11	0.33610535D-12	-0.79816624D-11	-0.98352524D-12	0.40328801D-11	-0.47010151D-12
6	-0.15676463D-11	0.34423877D-13	-0.30600757D-12	0.79307402D-13	-0.47010151D-12	0.20189963D-12
7	0.36016480D-13	0.13627243D-14	0.28936910D-13	-0.16945386D-14	0.28424190D-14	-0.64356428D-15

	7
1	0.36016480D-13
2	0.13627243D-14
3	0.28936910D-13
4	-0.16945386D-14
5	0.28424190D-14
6	-0.64356428D-15
7	0.32706570D-15

A MATRIX AS INPUT

COVARIANCE MATRIX 7

MATRIX I-5

	1	2	3	4	5	6
1	C.16E65829E-10	-0.1C584C32E-12	C.82536350E-11	-C.22300485E-12	0.34491315E-11	-0.15676463E-11
2	-C.1C584032E-12	0.1449E89CE-11	-0.153224BCE-11	C.22192917E-12	0.33610535E-12	0.34423877E-13
3	0.82536350E-11	-0.153224BCE-11	0.32602954E-10	0.257C2799E-11	-0.79816623E-11	-0.30600756E-12
4	-0.223C0485E-12	0.22192917E-12	0.257C2799E-11	0.44479569E-12	-0.98352523E-12	0.79307401E-13
5	C.34491315E-11	0.33610535E-12	-C.79816623E-11	-C.98352523E-12	0.40328801E-11	-0.47010151E-12
6	-0.15676463E-11	0.34423877E-13	-0.30600756E-12	C.79307401E-13	-0.47010151E-12	0.20189963E-12
7	C.36016479E-13	0.13627242E-14	C.289369C9E-13	-C.16945385E-14	0.28424189E-14	-0.64356428E-15

	7
1	C.36C16479E-13
2	C.13627242E-14
3	0.28936909E-13
4	-C.16945385E-14
5	C.28424189E-14
6	-0.64356428E-15
7	0.327C657CE-15

B MATRIX AS INPUT NORMAL MATRIX 7 MATRIX I-6

	1	2	3	4	5	6
1	0.34836812E 15	0.1C204C89E 15	-C.137302E1E 15	-C.66155706E 15	-0.56647307E 15	0.13486011E 16
2	0.1C20408SE 15	0.3324S55SE 14	-C.3E601744E 14	-C.20307755E 15	-0.16405702E 15	0.40425406E 15
3	-0.13730261E 15	-0.3E6C1744E 14	0.553272 17E 14	C.2552S159E 15	0.22520632E 15	-0.52376056E 15
4	-0.66155706E 15	-0.203C7755E 15	C.2552S159E 15	C.12894265E 16	0.10696299E 16	-0.25927524E 16
5	-C.56647307E 15	-0.164C57C2E 15	0.22520632E 15	C.10S962S9E 16	0.92538855E 15	-0.21786854E 16
6	C.13486011E 16	0.404254C6E 15	-C.52376C56E 15	-C.25927524E 16	-0.21786854E 16	0.52786069E 16
7	-0.22490596E 17	-0.679C9534E 16	C.87204457E 16	C.43393C84E 17	0.36351164E 17	-0.87965207E 17

	7
1	-0.22490596E 17
2	-0.67909534E 16
3	C.87204457E 16
4	C.43393084E 17
5	C.36351164E 17
6	-0.87965207E 17
7	C.14722584E 19

F MATRIX AS INPUT TYPE 1 PERTURBATION MATRIX I-7

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
2	0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
4	0.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
6	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07
7	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07

	7
1	-0.99999999E-07
2	-0.99999999E-07
3	-0.99999999E-07
4	0.99999999E-07
5	-0.99999999E-07
6	0.99999999E-07
7	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 1 PERTURBATION MATRIX I-8

	1	2	3	4	5	6
1	0.214639C2D 12	0.64569C32D 11	-C.83258705D 11	-C.41336774D 12	-0.34670402D 12	0.84007168D 12
2	C.64569032D 11	0.19422728D 11	-C.25047233D 11	-C.12434849D 12	-0.10429914D 12	0.25270981D 12
3	-C.83258705D 11	-0.25047233D 11	C.3229560 9D 11	C.16034805D 12	0.13448595D 12	-0.32586826D 12
4	-0.41336774D 12	-0.12434849D 12	0.16034805D 12	C.796C8615D 12	C.66771271D 12	-0.16178562D 13
5	-C.34670402D 12	-0.10429914D 12	0.13448595D 12	C.667712710 12	0.56002581D 12	-0.13569641D 13
6	C.84007168D 12	0.2527C981D 12	-C.32586826D 12	-C.16178562D 13	-0.13569641D 13	0.3287918CD 13
7	-C.14018732D 14	-0.42171C19D 13	0.54379459D 13	C.26998045D 14	0.22644417D 14	-0.54867208D 14

	7
1	-C.14C18732D 14
2	-0.42171C19D 13
3	0.54379459D 13
4	C.26998045D 14
5	C.22644417D 14
6	-0.548672C8D 14
7	C.91559871D 15

F MATRIX AS INPUT TYPE 2 PERTURBATION MATRIX I-9

	1	2	3	4	5	6
1	0.C5555555E-C5	0.05555555E-05	C.C5555555E-05	C.05555555E-05	0.05555555E-05	-0.05555555E-05
2	0.05555555E-05	-0.05555555E-05	C.C5555555E-05	-C.05555555E-05	0.05555555E-05	0.05555555E-05
3	0.C5555555E-05	0.05555555E-05	0.C5555555E-05	0.05555555E-05	0.05555555E-05	-0.05555555E-05
4	0.C5555555E-C5	-0.05555555E-05	C.C5555555E-05	0.05555555E-05	0.05555555E-05	-0.05555555E-05
5	C.C5555555E-05	0.05555555E-05	0.C5555555E-05	0.05555555E-05	0.05555555E-05	-0.05555555E-05
6	-0.05555555E-05	0.05555555E-05	-0.C5555555E-05	-0.05555555E-05	-0.05555555E-05	0.05555555E-05
7	-0.C5555555E-05	-0.05555555E-05	-0.C5555555E-05	0.05555555E-05	-0.05555555E-05	0.05555555E-05

	7
1	-0.C5555555E-C5
2	-0.C5555555E-05
3	-0.C5555555E-C5
4	0.C5555555E-C5
5	-0.C5555555E-C5
6	0.C5555555E-C5
7	0.C5555555E-C5

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX I-10

	1	2	3	4	5	6
1	0.220725980 13	0.66332234D 12	-0.856693C3D 12	-0.42486270D 13	-0.35661640C 13	0.86356699D 13
2	0.66332234D 12	0.199335300 12	-0.257454110 12	-0.127678390 13	-0.107170200 13	0.259516430 13
3	-0.85669303D 12	-0.257454110 12	0.3325C382C 12	C.164900050 13	0.138411770 13	-0.335172190 13
4	-0.42486270D 13	-0.127678390 13	C.164900050 13	C.817794350 13	0.686431000 13	-0.166222850 14
5	-0.35661640D 13	-0.107170200 13	0.138411770 13	C.686431000 13	0.576168260 13	-0.139522350 14
6	C.863566990 13	0.259516430 13	-0.335172190 13	-0.166222850 14	-0.139522350 14	0.337861480 14
7	-0.144102760 15	-0.433053110 14	C.559299450 14	0.277374940 15	0.232820010 15	-0.563786430 15

	7
1	-0.144102760 15
2	-0.433053110 14
3	C.559299450 14
4	C.277374940 15
5	C.232820010 15
6	-0.563786430 15
7	C.940786340 16

F MATRIX AS INPUT TYPE 3 PERTURBATION MATRIX I-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

	7
1	0.99999999E-07
2	0.99999999E-07
3	0.99999999E-07
4	0.99999999E-07
5	0.99999999E-07
6	0.99999999E-07
7	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 3 PERTURBATION MATRIX I-12

	1	2	3	4	5	6
1	-0.17575136D 11	-0.51607362D 10	0.69182327D 10	0.33421916D 11	0.28567017D 11	-0.68103563D 11
2	-0.51607362D 10	-0.15154411D 10	0.20316515D 10	0.98129028D 10	0.83886305D 10	-0.19996654D 11
3	0.69182327D 10	0.20316515D 10	-0.27231186D 10	-0.13156814D 11	-0.11244781D 11	0.26809173D 11
4	0.33421916D 11	0.98129028D 10	-0.13156814D 11	-0.63553113D 11	-0.54325634D 11	0.12950546D 12
5	0.28567017D 11	0.83886305D 10	-0.11244781D 11	-0.54325634D 11	-0.46432886D 11	0.11069905D 12
6	-0.68103563D 11	-0.19996654D 11	0.26809173D 11	0.12950546D 12	0.11069905D 12	-0.26389302D 12
7	0.11358305D 13	0.33349932D 12	-0.44712433D 12	-0.21598751D 13	-0.18462352D 13	0.44012129D 13

	7
1	0.11358305D 13
2	0.33349932D 12
3	-0.44712433D 12
4	-0.21598751D 13
5	-0.18462352D 13
6	0.44012129D 13
7	-0.73402898D 14

F MATRIX AS INPUT TYPE 4 PERTURBATION MATRIX I-13

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

	7
1	0.09999999E-05
2	0.09999999E-05
3	0.09999999E-05
4	0.09999999E-05
5	0.09999999E-05
6	0.09999999E-05
7	0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 4 PERTURBATION MATRIX I-14

	1	2	3	4	5	6
1	-0.109101490 11	-0.321381710 10	0.428684680 10	0.207752400 11	0.177197030 11	-0.423103180 11
2	-0.321381710 10	-0.942831830 09	0.126480820 10	0.610866960 10	0.522226610 10	-0.124514630 11
3	0.428684680 10	0.126480820 10	-0.168286250 10	-0.816995540 10	-0.695999330 10	0.166346050 11
4	0.207752400 11	0.610866960 10	-0.816995540 10	-0.395208810 11	-0.337505480 11	0.805266250 11
5	0.177197030 11	0.522226610 10	-0.695999330 10	-0.337505480 11	-0.287742600 11	0.687360690 11
6	-0.423103180 11	-0.124514630 11	0.166346050 11	0.805266250 11	0.687360690 11	-0.164010240 12
7	0.706179960 12	0.207769220 12	-0.277656140 12	-0.134386490 13	-0.114722470 13	0.273746380 13

	7
1	0.706179960 12
2	0.207769220 12
3	-0.277656140 12
4	-0.134386490 13
5	-0.114722470 13
6	0.273746380 13
7	-0.456840800 14

APPENDIX J

Matrices Associated with Normal Matrix 8

This appendix contains the matrices involved in the sensitivity study of covariance matrix 8.

MATRIX NUMBER 8. NORMAL MATRIX OF SOLUTION FOR SPACECRAFT STATE AND LUNAR GRAVITATIONAL CONSTANTS

Orbit Parameters*		Tracking Stations	Data Types	Data Weight, σ	Data Tracking Interval	Number of Data Points
a	2693.7513	Goldstone	C3**	0.01 cps	55	56
e	0.25222282					
i	14.191572	Woomera	CC3**	0.01 cps		42
ω	326.60738					
Ω	346.02514					
T_p	66 yr. 6 mo. 27 da. 4 hr. 46 min. 44.726 sec					
t_o	66 yr. 6 mo. 27 da. 3 hr. 45 min. 00 sec					

A Priori Used: None

Solution Parameters: x, y, z, $\dot{x}$, $\dot{y}$, $\dot{z}$ J_{20}, J_{30}, C_{22}, S_{41}

*(Referenced to true lunar equztorial plane and the line of intersection with the ecliptic)

**Doppler types

A MATRIX AS INPUT NORMAL MATRIX 8 MATRIX J-1

	1	2	3	4	5	6
1	C.86771213E C7	0.5C741000E 07	0.201060C3E C7	-C.21602677E 11	-0.24940284E 10	0.13175937E 10
2	C.5C741000E 07	0.12624656E 08	0.795995 35E 07	-C.15186966E 11	0.10239287E 11	0.88023427E 10
3	0.2C1060C3E C7	C.795995 35E 07	0.52220629E 07	-C.67514995E 10	0.76533487E 1C	0.59497157E 10
4	-0.21602677E 11	-0.15186966E 11	-0.67514995E 10	C.67151836E 14	0.66822405E 13	-0.48174232E 13
5	-0.24940284E 10	0.102392 87E 11	C.765334E7E 10	0.66822405E 13	0.15987068E 14	0.95748618E 13
6	0.13175937E 10	0.88023427E 1C	0.59497157E 10	-C.48174232E 13	0.95748618E 13	0.69435662E 13
7	-0.22886986E 10	-0.89968412E 10	-C.59C88436E 10	C.81424455E 13	-0.85353392E 13	-0.67181303E 13
8	0.41621073E C8	-0.49878137E 10	-0.35119765E 10	C.11124586E 13	-0.61167417E 13	-0.41687454E 13
9	-C.36050697E 10	0.42817901E 11	0.30748130E 11	C.37551352E 13	0.56865574E 14	0.36848170E 14
10	-C.11844146E 10	0.17350511E 11	0.12405259E 11	-C.77266072E 12	0.22462711E 14	0.14857005E 14

	7	8	9	10
1	-C.22886986E 10	0.41621C73E C8	-0.36C50697E 10	-C.11844146E 1C
2	-C.89968412E 10	-0.49878137E 10	0.42817901E 11	C.17350511E 11
3	-0.59C88436E 10	-0.35119765E 10	0.30748130E 11	C.12405259E 11
4	C.81424455E 13	0.11124586E 13	0.37551352E 13	-C.77266C72E 12
5	-0.85353392E 13	-0.61167417E 13	0.56865574E 14	0.22462711E 14
6	-0.67181303E 13	-0.41687454E 13	C.36848170E 14	C.14857005E 14
7	C.67043188E 13	0.39617600E 13	-C.34280304E 14	-C.13953315E 14
8	C.39617600E 13	0.26029687E 13	-0.23371074E 14	-0.93795146E 13
9	-0.34280304E 14	-0.23371074E 14	0.21628311E 15	C.85C923C8E 14
10	-0.13953315E 14	-0.93795146E 13	C.85C923C8E 14	0.3397065CE 14

B MATRIX AS INPUT

APPROXIMATE COVARIANCE MATRIX 8

MATRIX J-2

	1	2	3	4	5	6
1	-0.274101738 10	0.186406938 09	C.15C58619E 11	C.58904632E 06	-0.66248742E 06	-0.18228056E 07
2	C.186406938 09	0.477424SCE 08	C.385681?6E 10	C.15086637E 06	-0.16967624E 06	-0.46685761E 06
3	C.15058619E 11	0.385681?6E 10	-C.92C85557E 11	-0.36C2C998E 07	0.4C512027E 07	0.11146711E 08
4	0.58904632E C6	0.15086637E 06	-0.3602C998E 07	-C.13674976E 03	0.15379944E 03	0.42317254E 03
5	-C.66248742E C6	-0.16967624E 06	0.40512C27E C7	C.15379944E 03	-0.15536924E 03	-0.42749163E 03
6	-0.18228056E C7	-0.46685761E 06	0.11146711E 08	C.42317254E C3	-0.42749163E 03	-0.14513008E 04
7	-0.17246C18E C7	-0.4417C492E 06	0.1054618CE 08	C.40037410E C3	-0.40446C48E 03	-0.13731118E 04
8	0.14777689E C8	0.37848592E 07	-0.9C367617E 08	-C.34307C72E 04	0.34657229E 04	0.11765856E 05
9	-0.32462388E C6	-0.83142809E 05	C.198512C5E 07	C.75362909E 02	-0.76132115E 02	-0.25846247E 03
10	-0.25617309E 06	-0.6561C994E 05	0.15665339E 07	C.59471732E 02	-0.60078720E 02	-0.20396260E 03

	7	8	9	10
1	-C.17246C18E C7	0.14777689E 08	-0.3246238EE 06	-0.25617309E 06
2	-0.44170492E C6	0.37848592E 07	-C.83142EC9E 05	-C.65610994E 05
3	C.1C546I8CE C8	-0.9C367617E 08	C.19851205E 07	C.15665339E 07
4	C.40037410E C3	-0.34307C72E 04	0.753629C9E 02	C.59471732E 02
5	-C.4C446048E C3	0.34657229E 04	-C.761321I5E 02	-C.60078720E 02
6	-0.13731118E C4	0.11765856E 05	-0.25846247E 03	-C.2039626CE 03
7	-C.174637C3E C4	0.14964216E 05	-C.32872141E C3	-C.25940657E C3
8	C.14964216E C5	-0.85046127E 05	C.18682223E 04	C.14742853E 04
9	-C.32872141E 03	0.18682223E 04	-0.22688551E C2	-C.25795779E C2
10	-0.25940657E C3	0.14742853E 04	-0.25795779E 02	-C.52074771E 02

ERROR MATRIX (E)

	1	2	3	4	5	6
1	C.27410173C 10	-0.18640693D 09	-0.15058619C 11	-0.589046330 06	0.662487430 06	0.18228056C 07
2	-C.18640693D 09	-0.47742490D 08	-0.38568177D 10	-0.150866380 06	0.16967625D 06	0.46685762D 06
3	-0.15C58619C 11	-0.38568177D 10	C.92C8555EC 11	C.3602C998D C7	-0.40512027C 07	-0.11146711C 08
4	-0.589046330 C6	-0.150866380 06	0.3602C998C 07	C.136749760 03	-0.153799450 03	-0.423172550 03
5	0.662487430 06	0.169676250 06	-0.40512027C 07	-C.153799450 03	0.155369240 03	0.427491630 03
6	C.18228056D C7	0.466857620 06	-0.11146711C 08	-0.423172550 03	0.427491630 03	0.145130080 04
7	C.17246019D C7	0.441704930 06	-0.10546180C 08	-C.400374100 03	0.404460490 03	0.137311180 04
8	-C.147776890 C8	-0.378485920 07	C.903676170 08	C.343070720 04	-0.346572290 04	-0.117658560 05
9	0.324623890 C6	0.821428100 05	-C.158512C6C 07	-C.753629090 02	0.761321150 02	0.258462480 03
10	0.256173090 06	0.656109940 05	-C.156653390 07	-0.594717320 02	0.600787200 02	0.203962610 03

ERROR IN MATRIX J-2

	7	8	9	10
1	0.17246019C C7	-0.147776890 C8	C.324623890 06	C.256173090 06
2	0.4417C493D C6	-0.378485920 07	C.831428100 05	0.656109950 05
3	-0.1C546180D C8	0.903676170 08	-C.158512C6C 07	-0.156653390 07
4	-C.4CC374100 03	0.343070720 04	-0.753629C9C 02	-C.594717330 02
5	C.404460490 03	-0.346572290 04	C.761321150 02	0.600787210 02
6	0.137311180 C4	-0.117658560 C5	C.258462480 03	C.203962610 03
7	C.174637C3C 04	-0.149642170 05	C.328721420 03	C.259406570 03
8	-0.145642170 C5	C.650461280 05	-C.186822230 04	-C.147428530 04
9	0.328721420 03	-0.186822230 04	0.226885510 02	C.257957790 02
1C	0.259406560 C3	-0.147428530 04	0.257957790 02	C.520747710 02

MATRIX J-3

B MATRIX PLUS E MATRIX

CORRECTED APPROXIMATE COVARIANCE MATRIX 8

MATRIX J-4

	1	2	3	4	5	6
1	-0.13635118D C1	-0.24747744C-01	-0.294276C5D 01	C.63801650D-04	-0.36712392D-03	-0.52508491D-03
2	0.622756S7D 00	0.11156914D-00	0.25657468D 01	-0.37071586D-05	0.17367338C-03	0.21241404D-03
3	C.61C13184D C1	-0.21555781D-00	0.14787148C 02	-0.24343026D-03	0.163094S2D-02	0.22298507D-02
4	C.415C7900D-03	0.48442729C-04	-0.9544726SC-03	-C.59499570D-07	0.10250241D-06	0.25115506C-06
5	-C.45517844D-03	-0.32906231C-04	0.64012548C-03	C.53C98788D-07	-0.10034061D-06	-0.27676609D-06
6	-0.13810828D-02	-0.23414308C-03	C.48C92967C-02	0.2433583CD-06	-0.37496494D-06	-0.85309659D-06
7	-0.14780883D-02	-0.32923787D-03	0.12148884D-01	C.41037393D-06	-0.36154651D-06	-0.12463368D-05
8	C.2C494405C-03	-0.22545899C-02	C.74C96933C-01	C.16248080D-05	0.27717829D-06	-0.34698578D-05
9	-0.36C643S0D-C4	0.4564C38CC-04	-C.1881342CC-02	-C.38509043C-07	-0.14049860C-07	0.68739155C-07
10	-0.21394256D-02	-0.72593110C-03	0.20799992D-01	C.66375585D-06	-0.50119565D-06	-0.20214260C-05

	7	8	9	10
1	-C.19S780100-C2	0.1C210458C-01	-0.21816485C-03	0.33077576D-C3
2	0.64451629D-03	-0.49826340C-02	C.11464017C-03	-C.15067963D-03
3	C.95500043C-02	-0.45844451C-01	0.96182071C-03	-C.162707490-02
4	0.55161442D-06	-0.27291187C-05	0.57937157C-07	-C.35625813D-07
5	-0.55266787C-06	0.3058C889C-05	-0.6435745EC-07	C.51419072D-07
6	-0.19704995C-C5	0.88011957C-05	-0.188596S1C-06	0.65743279D-07
7	-0.20520458C-C5	0.7941273SC-05	-C.164170S7C-06	-0.15112778C-06
8	0.31207474C-C5	-0.16163125C-04	0.32178002C-06	-0.27955293D-05
9	-C.527300S0D-C7	0.63202663D-06	-C.13497832C-07	C.72400391D-07
10	-0.23954207C-C5	0.10924733C-04	-0.23581330C-06	-C.396195340-06

	1	2	3	4	5	6
1	0.86771213E 07	0.50741000E 07	0.20106003E 07	-0.21602677E 11	-0.24940284E 10	0.13175937E 10
2	0.50741000E 07	0.12624656E 08	0.79599535E 07	-0.15186966E 11	0.10239287E 11	0.88023427E 10
3	0.20106003E 07	0.79599535E 07	0.52320629E 07	-0.67514995E 10	0.76533487E 10	0.59497157E 10
4	-0.21602677E 11	-0.15186966E 11	-0.67514995E 10	0.67151836E 14	0.66822405E 13	-0.48174232E 13
5	-0.24940284E 10	0.10239287E 11	0.76533487E 10	0.66822405E 13	0.15987068E 14	0.95748618E 13
6	0.13175937E 10	0.88023427E 10	0.59497157E 10	-0.48174232E 13	0.95748618E 13	0.69435662E 13
7	-0.22886986E 10	-0.89968412E 10	-0.59088436E 10	0.81424455E 13	-0.85353392E 13	-0.67181303E 13
8	0.41621073E 08	-0.49878137E 10	-0.35119765E 10	0.11124586E 13	-0.61167417E 13	-0.41687454E 13
9	-0.36050697E 10	0.42817901E 11	0.30748130E 11	0.37551352E 13	0.56865574E 14	0.36848170E 14
10	-0.11844146E 10	0.17350511E 11	0.12405259E 11	-0.77266072E 12	0.22462711E 14	0.14857005E 14

	7	8	9	10
1	-0.22886986E 10	0.41621073E 08	-0.36050697E 10	-0.11844146E 10
2	-0.89968412E 10	-0.49878137E 10	0.42817901E 11	0.17350511E 11
3	-0.59088436E 10	-0.35119765E 10	0.30748130E 11	0.12405259E 11
4	0.81424455E 13	0.11124586E 13	0.37551352E 13	-0.77266072E 12
5	-0.85353392E 13	-0.61167417E 13	0.56865574E 14	0.22462711E 14
6	-0.67181303E 13	-0.41687454E 13	0.36848170E 14	0.14857005E 14
7	0.67043188E 13	0.39617600E 13	-0.34280304E 14	-0.13953315E 14
8	0.39617600E 13	0.26029687E 13	-0.23371074E 14	-0.93795146E 13
9	-0.34280304E 14	-0.23371074E 14	0.21628311E 15	0.85092308E 14
10	-0.13953315E 14	-0.93795146E 13	0.85092308E 14	0.33970650E 14

B MATRIX AS INPUT

ZERO MATRIX

MATRIX J-6

	1	2	3	4	5	6
1	-0.	-0.	-0.	-0.	-0.	-0.
2	-0.	-0.	-0.	-0.	-0.	-0.
3	-0.	-0.	-0.	-0.	-0.	-0.
4	-0.	-0.	-0.	-0.	-0.	-0.
5	-0.	-0.	-0.	-0.	-0.	-0.
6	-0.	-0.	-0.	-0.	-0.	-0.
7	-0.	-0.	-0.	-0.	-0.	-0.
8	-0.	-0.	-0.	-0.	-0.	-0.
9	-0.	-0.	-0.	-0.	-0.	-0.
10	-0.	-0.	-0.	-0.	-0.	-0.

	7	8	9	10
1	-0.	-0.	-0.	-0.
2	-0.	-0.	-0.	-0.
3	-0.	-0.	-0.	-0.
4	-0.	-0.	-0.	-0.
5	-0.	-0.	-0.	-0.
6	-0.	-0.	-0.	-0.
7	-0.	-0.	-0.	-0.
8	-0.	-0.	-0.	-0.
9	-0.	-0.	-0.	-0.
10	-0.	-0.	-0.	-0.

ERROR MATRIX (E)

	1	2	3	4	5	6
1	-0.54933820D 00	0.32284234D-00	0.25250434D 01	0.73499983D-04	-0.10548965D-03	-0.14925685D-03
2	0.32284234D-00	-0.61990991D-01	-0.17397918D 01	-0.55213793D-04	0.78328314D-04	0.11788421D-03
3	0.25250434D 01	-0.17397918D 01	-0.11078386D 02	-0.31360033D-03	0.44183713D-03	0.65526348D-03
4	0.73499983D-04	-0.55213793D-04	-0.31360033D-03	-0.74717094D-08	0.93230341D-08	0.18414450D-07
5	-0.10548965D-03	0.78328314D-04	0.44183713D-03	0.93230341D-08	-0.27300772D-08	-0.48621457D-07
6	-0.14925685D-03	0.11788421D-03	0.65526348D-03	0.18414450D-07	-0.48621457D-07	0.28953145D-07
7	0.19969143D-03	0.30758341D-04	-0.11852985D-02	-0.44350740-07	0.47375577D-07	0.14417905D-06
8	0.38168568D-02	-0.23084116D-02	-0.17317374D-01	-0.53376434D-06	0.73126486D-06	0.12016983D-05
9	-0.10712386D-03	0.55686068D-04	0.50366460D-03	0.15513985D-07	-0.20545892D-07	-0.37070397D-07
10	0.43478646D-03	-0.19057820D-03	-0.20935888D-02	-0.73560947D-07	0.91080585D-07	0.19908131D-06

ERROR IN MATRIX J-6

	7	8	9	10
1	0.19969143D-03	0.38168568D-02	-0.10712386D-03	0.43478646D-03
2	0.30758342D-04	-0.23084116D-02	0.55686068D-04	-0.19057820D-03
3	-0.11852985D-02	-0.17317374D-01	0.50366460D-03	-0.20935888D-02
4	-0.44350740-07	-0.53376434D-06	0.15513985D-07	-0.73560947D-07
5	0.47375577D-07	0.73126486D-06	-0.20545892D-07	0.91080585D-07
6	0.14417905D-06	0.12016983D-05	-0.37070397D-07	0.19908131D-06
7	0.16844900D-06	-0.11753764D-05	0.22428444D-07	0.17183351D-07
8	-0.11753764D-05	-0.25050151D-04	0.71270220D-06	-0.25697767D-05
9	0.22428444D-07	0.71270220D-06	-0.19513038D-07	0.68920340D-07
10	0.17183351D-07	-0.25697767D-05	0.68920340D-07	-0.14705280D-06

MATRIX J-7

B MATRIX PLUS E MATRIX COVARIANCE MATRIX 8 MATRIX J-8

	1	2	3	4	5	6
1	-0.5493382D 00	0.32284234D-00	0.25250434D 01	0.73499983D-04	-0.10548965D-03	-0.14925685D-03
2	0.32284234D-00	-0.61990991D-01	-0.17397918D 01	-0.55213793D-04	0.78328314D-04	0.11788421D-03
3	0.25250434D 01	-0.17397918D 01	-0.11078386D 02	-0.31360033D-03	0.44183713D-03	0.65526348D-03
4	0.73499983D-04	-0.55213793D-04	-0.31360033D-03	-0.74717094D-08	0.93230341D-08	0.18414450D-07
5	-0.10548965D-03	0.78328314D-04	0.44183713D-03	0.93230341D-08	-0.27300772D-08	-0.48621457D-07
6	-0.14925685D-03	0.11788421D-03	0.65526348D-03	0.18414450D-07	-0.48621457D-07	0.28953145D-07
7	0.19969143D-03	0.30758341D-04	-0.11852985D-02	-0.44355074D-07	0.47375577D-07	0.14417905D-06
8	0.38168568D-02	-0.23084116D-02	-0.17317374D-01	-0.53376434D-06	0.73126486D-06	0.12016983D-05
9	-0.10712386D-03	0.55686068D-04	0.50366460D-03	0.15513985D-07	-0.20545892D-07	-0.37070397D-07
10	0.43478646D-03	-0.19057820D-03	-0.20935888D-02	-0.73560947D-07	0.91080585D-07	0.19908131D-06

	7	8	9	10
1	0.19969143D-03	0.38168568D-02	-0.10712386D-03	0.43478646D-03
2	0.30758342D-04	-0.23084116D-02	0.55686068D-04	-0.19057820D-03
3	-0.11852985D-02	-0.17317374D-01	0.50366460D-03	-0.20935888D-02
4	-0.44355074D-07	-0.53376434D-06	0.15513985D-07	-0.73560947D-07
5	0.47375577D-07	0.73126486D-06	-0.20545892D-07	0.91080585D-07
6	0.14417905D-06	0.12016983D-05	-0.37070397D-07	0.19908131D-06
7	0.16849000D-06	-0.11753764D-05	0.22428444D-07	0.17183351D-07
8	-0.11753764D-05	-0.25050151D-04	0.71270220D-06	-0.25697767D-05
9	0.22428444D-07	0.71270220D-06	-0.19513038D-07	0.68920340D-07
10	0.17183351D-07	-0.25697767D-05	0.68920340D-07	-0.14705280D-06

A MATRIX AS INPUT

COVARIANCE MATRIX 8

MATRIX J-9

	1	2	3	4	5	6
1	-0.54933820E 00	0.32284234E-00	0.25250433E 01	0.73499982E-04	-0.10548965E-03	-0.14925685E-03
2	0.32284234E-00	-0.61990990E-01	-0.17397917E 01	-0.55213792E-04	0.78328313E-04	0.11788420E-03
3	0.25250433E 01	-0.17397917E 01	-0.11078385E 02	-0.31360032E-03	0.44183712E-03	0.65526348E-03
4	0.73499982E-04	-0.55213792E-04	-0.31360032E-03	-0.74717093E-08	0.93230340E-08	0.18414450E-07
5	-0.10548965E-03	0.78328313E-04	0.44183712E-03	0.93230340E-08	-0.27300771E-08	-0.48621457E-07
6	-0.14925685E-03	0.11788420E-03	0.65526348E-03	0.18414450E-07	-0.48621457E-07	0.28953145E-07
7	0.19969142E-03	0.30758341E-04	-0.11852585E-02	-0.44355074E-07	0.47375576E-07	0.14417905E-06
8	0.38168567E-02	-0.23084115E-02	-0.17317373E-01	-0.53376433E-06	0.73126485E-06	0.12016983E-05
9	-0.10712386E-03	0.55686067E-04	0.50366460E-03	0.15513985E-07	-0.20545892E-07	-0.37070397E-07
10	0.43478645E-03	-0.19057819E-03	-0.20935888E-02	-0.73560947E-07	0.91080584E-07	0.19908131E-06

	7	8	9	10
1	0.19969142E-03	0.38168567E-02	-0.10712386E-03	0.43478645E-03
2	0.30758341E-04	-0.23084115E-02	0.55686067E-04	-0.19057819E-03
3	-0.11852585E-02	-0.17317373E-01	0.50366460E-03	-0.20935888E-02
4	-0.44355074E-07	-0.53376433E-06	0.15513985E-07	-0.73560947E-07
5	0.47375576E-07	0.73126485E-06	-0.20545892E-07	0.91080584E-07
6	0.14417905E-06	0.12016983E-05	-0.37070397E-07	0.19908131E-06
7	0.16844899E-06	-0.11753763E-05	0.22428443E-07	0.17183351E-07
8	-0.11753763E-05	-0.25050151E-04	0.71270219E-06	-0.25697766E-05
9	0.22428443E-07	0.71270219E-06	-0.19513038E-07	0.68920340E-07
10	0.17183351E-07	-0.25697766E-05	0.68920340E-07	-0.14705279E-06

B MATRIX AS INPUT NORMAL MATRIX 8 MATRIX J-10

	1	2	3	4	5	6
1	0.86771213E 07	0.50741000E 07	0.20106003E 07	-0.21602677E 11	-0.24940284E 10	0.13175937E 10
2	0.50741000E 07	0.12624656E 08	0.79599535E 07	-0.15186966E 11	0.10239287E 11	0.88023427E 10
3	0.20106003E 07	0.79599535E 07	0.52326629E 07	-0.67514995E 10	0.76533487E 10	0.59497157E 10
4	-0.21602677E 11	-0.15186966E 11	-0.67514995E 10	0.67151836E 14	0.66822405E 13	-0.48174232E 13
5	-0.24940284E 10	0.10239287E 11	0.76533487E 10	0.66822405E 13	0.15987068E 14	0.95748618E 13
6	0.13175937E 10	0.88023427E 10	0.59497157E 10	-0.48174232E 13	0.95748618E 13	0.69435662E 13
7	-0.22886986E 10	-0.89568412E 10	-0.59088436E 10	0.81424455E 13	-0.85353392E 13	-0.67181303E 13
8	0.41621073E 08	-0.49878137E 10	-0.35119765E 10	0.11124586E 13	-0.61167417E 13	-0.41687454E 13
9	-0.36050697E 10	0.42817901E 11	0.30748130E 11	0.37551352E 13	0.56865574E 14	0.36848170E 14
10	-0.11844146E 10	0.17350511E 11	0.12405259E 11	-0.77266072E 12	0.22462711E 14	0.14857005E 14

	7	8	9	10
1	-0.22886986E 10	0.41621073E 08	-0.36050697E 10	-0.11844146E 10
2	-0.89568412E 10	-0.49878137E 10	0.42817901E 11	0.17350511E 11
3	-0.59088436E 10	-0.35119765E 10	0.30748130E 11	0.12405259E 11
4	0.81424455E 13	0.11124586E 13	0.37551352E 13	-0.77266072E 12
5	-0.85353392E 13	-0.61167417E 13	0.56865574E 14	0.22462711E 14
6	-0.67181303E 13	-0.41687454E 13	0.36848170E 14	0.14857005E 14
7	0.67043188E 13	0.39617600E 13	-0.34280304E 14	-0.13953315E 14
8	0.39617600E 13	0.26029687E 13	-0.23371074E 14	-0.93795146E 13
9	-0.34280304E 14	-0.23371074E 14	0.21628311E 15	0.85092308E 14
10	-0.13953315E 14	-0.93795146E 13	0.85092308E 14	0.33970650E 14

F MATRIX AS INPUT TYPE 1 PERTURBATION MATRIX J-11

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	C.99999999E-07	0.99999999E-07	0.99999999E-07	-0.99999999E-07
2	0.99999999E-07	0.99999999E-07	C.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	C.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	-0.99999999E-07	-C.99999999E-07	0.99999999E-07	-0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	C.99999999E-07	-C.99999999E-07	-0.99999999E-07	0.99999999E-07
6	-0.99999999E-07	0.99999999E-07	C.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	-0.99999999E-07	0.99999999E-07	-C.99999999E-07	-0.99999999E-07	0.99999999E-07	0.99999999E-07
8	-C.99999999E-07	-0.99999999E-07	-0.99999999E-07	C.99999999E-07	-0.99999999E-07	-0.99999999E-07
9	C.99999999E-07	-0.99999999E-07	C.99999999E-07	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07
10	-0.99999999E-07	0.99999999E-07	C.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

	7	8	9	10
1	-C.99999999E-07	-C.99999999E-07	C.99999999E-07	-0.99999999E-07
2	0.99999999E-07	-0.99999999E-07	-C.99999999E-07	0.99999999E-07
3	-0.99999999E-07	-0.99999999E-07	C.99999999E-07	0.99999999E-07
4	-C.99999999E-07	0.99999999E-07	-C.99999999E-07	0.99999999E-07
5	0.99999999E-07	-C.99999999E-07	-C.99999999E-07	0.99999999E-07
6	0.99999999E-07	-C.99999999E-07	-C.99999999E-07	0.99999999E-07
7	C.99999999E-07	-0.99999999E-07	C.99999999E-07	C.99999999E-07
8	-0.99999999E-07	-0.99999999E-07	-C.99999999E-07	0.99999999E-07
9	C.99999999E-07	-0.99999999E-07	-0.99999999E-07	-0.99999999E-07
10	0.99999999E-07	0.99999999E-07	-C.99999999E-07	-0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 1 PERTURBATION MATRIX J-12

	1	2	3	4	5	6
1	0.53523901D C7	0.320838400 07	C.12867466D 07	-0.156142330 11	-0.204950550 10	0.791914930 09
2	0.32C8384CD C7	0.568137640 07	0.34080163D 07	-C.113119480 11	0.306181830 10	0.356013790 10
3	0.12867466D C7	0.340801630 07	C.21592334D C7	-0.512202700 1C	0.251783850 10	0.235520850 10
4	-0.156142330 11	-0.113119480 11	-0.512202700 10	0.469433070 14	0.387490940 13	-0.388435260 13
5	-C.204950550 10	0.306181830 10	C.251783850 10	0.387490940 13	0.572216140 13	0.322758250 13
6	C.791914930 09	0.356013790 10	C.235520850 10	-0.388435260 13	0.322758250 13	0.265186700 13
7	-0.156025930 10	-0.395078310 10	-0.249073180 10	0.612438190 13	-0.284248200 13	-0.270576160 13
8	0.338903490 C7	-0.194103C30 10	-0.136243450 10	0.995753950 12	-0.222070190 13	-0.159500020 13
9	-0.320007590 10	0.150166450 11	0.111124670 11	0.652444380 12	0.206034760 14	0.134431840 14
10	-C.78CC3330D C9	0.647424900 10	C.468285670 10	-0.130467950 13	0.823254320 13	0.558604870 13

	7	8	9	10
1	-0.156025930 10	0.338903480 07	-0.320007590 10	-0.780033300 09
2	-0.395078310 10	-0.194103030 10	C.150166450 11	0.647424900 10
3	-0.249073180 10	-0.136243450 10	0.111124670 11	C.468285670 1C
4	0.612438190 13	0.995753950 12	0.652444380 12	-0.130467950 13
5	-C.284248200 13	-0.222070190 13	0.206034760 14	C.823254320 13
6	-0.270576160 13	-0.159500020 13	0.134431840 14	0.558604870 13
7	0.287435740 13	0.155802820 13	-C.126561510 14	-0.534239790 13
8	0.155802820 13	0.100466570 13	-C.875905070 13	-0.358984510 13
9	-0.126561510 14	-0.875905070 13	C.782247010 14	0.317528070 14
10	-0.534239790 13	-0.358984510 13	0.317528070 14	0.129377430 14

F MATRIX AS INPUT

TYPE 2 PERTURBATION

MATRIX J-13

	1	2	3	4	5	6
1	0.C9999999E-C5	0.C9999999E-05	C.C9999999E-05	C.09999999E-05	0.09999999E-05	-0.C9999999E-05
2	0.C9999999E-C5	0.C9999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
3	C.C9999999E-C5	0.09999999E-05	C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.C9999999E-C5	-0.09999999E-05	-C.C9999999E-05	C.09999999E-05	-0.09999999E-05	0.09999999E-05
5	0.C9999999E-C5	C.C9999999E-05	C.C9999999E-05	-C.09999999E-05	-0.09999999E-05	0.09999999E-05
6	-0.C9999999E-C5	0.C9999999E-05	C.C9999999E-05	C.09999999E-05	0.09999999E-05	0.09999999E-05
7	-0.C9999999E-C5	0.C9999999E-05	-C.C9999999E-05	-0.09999999E-05	0.09999999E-05	0.09999999E-05
8	-0.C9999999E-C5	-0.C9999999E-05	-C.C9999999E-05	C.09999999E-05	-0.09999999E-05	-0.09999999E-05
9	C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	-C.09999999E-05	-0.09999999E-05	-0.09999999E-05
10	-C.C9999999E-C5	0.C9999999E-05	C.C9999999E-05	C.09999999E-05	0.09999999E-05	0.09999999E-05

	7	8	9	10
1	-C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	-0.09999999E-05
2	C.C9999999E-C5	-C.C9999999E-05	-C.C9999999E-05	C.09999999E-05
3	-C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	C.09999999E-05
4	-C.C9999999E-C5	0.C9999999E-05	-C.C9999999E-05	C.09999999E-05
5	C.C9999999E-C5	-0.C9999999E-05	-C.C9999999E-05	0.09999999E-05
6	C.C9999999E-C5	-0.C9999999E-05	-C.C9999999E-05	C.09999999E-05
7	C.C9999999E-C5	-0.C9999999E-05	C.C9999999E-05	C.09999999E-05
8	-C.C9999999E-C5	-0.C9999999E-05	-C.C9999999E-05	C.09999999E-05
9	C.C9999999E-C5	-0.C9999999E-05	-C.C9999999E-05	-C.09999999E-05
10	0.C9999999E-C5	C.C9999999E-05	-C.C9999999E-05	-C.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 2 PERTURBATION MATRIX J-14

	1	2	3	4	5	6
1	0.698901860 07	0.244015930 07	0.454774330 06	-0.189929220 11	-0.450575670 10	-0.360950380 09
2	0.244015930 07	0.384192450 07	0.225689970 07	-0.808445470 10	0.187550240 10	0.233771070 10
3	0.454774330 06	0.225689970 07	0.150192780 07	-0.224460500 10	0.213046290 10	0.170621910 10
4	-0.189929220 11	-0.808445470 10	-0.224460500 10	0.552259390 14	0.115291180 14	0.566991490 10
5	-0.450575670 10	0.187550240 10	0.213046290 10	0.115291180 14	0.718364860 13	0.313780260 13
6	-0.360950380 09	0.233771070 10	0.170621910 10	0.566991490 10	0.313780260 13	0.205962290 13
7	-0.628059650 09	-0.261757880 10	-0.172363170 10	0.291962560 13	-0.234014440 13	-0.193675940 13
8	0.903878150 09	-0.123136220 10	-0.102681740 10	-0.173299970 13	-0.237603690 13	-0.132331310 13
9	-0.119449610 11	0.932193510 10	0.866385070 10	0.267723290 14	0.236255580 14	0.118469270 14
10	-0.421845850 10	0.405620370 10	0.366060730 10	0.897378400 13	0.916708080 13	0.479193400 13

	7	8	9	10
1	-0.628059650 09	0.903878150 09	-0.119449610 11	-0.421845850 10
2	-0.261757880 10	-0.123136220 10	0.932193510 10	0.405620370 10
3	-0.172363170 10	-0.102681740 10	0.866385070 10	0.366060730 10
4	0.291962560 13	-0.173299970 13	0.267723290 14	0.897378400 13
5	-0.234014440 13	-0.237603690 13	0.236255580 14	0.916708080 13
6	-0.193675940 13	-0.132331310 13	0.118469270 14	0.479193400 13
7	0.197906240 13	0.115901830 13	-0.976004360 13	-0.405435120 13
8	0.115901830 13	0.917529020 12	-0.853571560 13	-0.340824340 13
9	-0.976004360 13	-0.853571560 13	0.812217420 14	0.321960820 14
10	-0.405435120 13	-0.340824340 13	0.321960820 14	0.127824270 14

F MATRIX AS INPUT TYPE 3 PERTURBATION MATRIX J-15

	1	2	3	4	5	6
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
8	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
9	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
10	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

	7	8	9	10
1	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
2	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
3	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
4	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
5	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
6	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
7	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
8	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
9	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07
10	0.99999999E-07	0.99999999E-07	0.99999999E-07	0.99999999E-07

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 3 PERTURBATION MATRIX J-16

	1	2	3	4	5	6
1	0.113531880 06	0.174552810 06	0.102542600 06	-0.238427630 09	0.116502890 09	0.109174910 09
2	0.174552810 06	-0.105315910 07	-0.771603420 06	-0.255436580 09	-0.147995590 10	-0.937040990 09
3	0.102542600 06	-0.771603420 06	-0.560811250 06	-0.137255750 09	-0.106140140 10	-0.678323430 09
4	-0.238427630 09	-0.255436580 09	-0.137255750 09	0.473496610 12	-0.109762990 12	-0.136953160 12
5	0.116502890 09	-0.147995590 10	-0.106140140 10	-0.109762990 12	-0.196442320 13	-0.127519450 13
6	0.109174910 09	-0.937040990 09	-0.678323430 09	-0.136953160 12	-0.127519450 13	-0.818785370 12
7	-0.112365810 09	0.864094520 09	0.627593020 09	0.148011790 12	0.118616110 13	0.758792640 12
8	-0.560828250 08	0.601362830 09	0.432838000 09	0.600718140 11	0.805691130 12	0.520946040 12
9	0.506465760 09	-0.553688380 10	-0.398351190 10	-0.544108270 12	-0.741227590 13	-0.479380720 13
10	0.193088840 09	-0.219413630 10	-0.157720700 10	-0.197536470 12	-0.292952860 13	-0.189704280 13

	7	8	9	10
1	-0.112365810 09	-0.560828250 08	0.506465760 09	0.193088840 09
2	0.864094520 09	0.601362830 09	-0.553688380 10	-0.219413630 10
3	0.627593020 09	0.432838000 09	-0.398351190 10	-0.157720700 10
4	0.148011790 12	0.600718140 11	-0.544108270 12	-0.197536470 12
5	0.118616110 13	0.805691130 12	-0.741227590 13	-0.292952860 13
6	0.758792640 12	0.520946040 12	-0.479380720 13	-0.189704280 13
7	-0.702314500 12	-0.483959970 12	0.445345480 13	0.176324370 13
8	-0.483959970 12	-0.330047560 12	0.303587750 13	0.120069260 13
9	0.445345480 13	0.303587750 13	-0.279286790 14	-0.110440140 14
10	0.176324370 13	0.120069260 13	-0.110440140 14	-0.436713060 13

F MATRIX AS INPUT TYPE 4 PERTURBATION MATRIX J-17

	1	2	3	4	5	6
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
8	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
9	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
10	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

	7	8	9	10
1	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
2	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
3	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
4	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
5	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
6	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
7	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
8	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
9	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05
10	0.09999999E-05	0.09999999E-05	0.09999999E-05	0.09999999E-05

ERROR MATRIX (E-EHAT) EFFECT OF TYPE 4 PERTURBATION MATRIX J-18

	1	2	3	4	5	6
1	0.223590550 06	-0.137078640 06	-0.136436960 06	-0.504645910 09	-0.397399870 09	-0.191714180 09
2	-0.137078640 06	0.387885160 06	0.297114770 06	0.238691970 09	0.612574250 09	0.369601590 09
3	-0.136436960 06	0.297114770 06	0.233228150 06	0.258219010 09	0.501680900 09	0.294073500 09
4	-0.504645910 09	0.238691970 09	0.258219010 09	0.114013390 13	0.806871560 12	0.373384600 12
5	-0.397399870 09	0.612574250 09	0.501680900 09	0.806871560 12	0.115308890 13	0.646600970 12
6	-0.191714180 09	0.369601590 09	0.294073500 09	0.373384600 12	0.646600970 12	0.373448990 12
7	0.154103880 09	-0.133437890 09	-0.262581220 09	-0.292552440 12	-0.565330490 12	-0.331167980 12
8	0.140401030 09	-0.243753530 09	-0.196450180 09	-0.280083900 12	-0.440964160 12	-0.251184990 12
9	-0.133158860 10	0.224435530 10	0.181575860 10	0.266452090 13	0.409841310 13	0.232612530 13
10	-0.531669270 09	0.894818270 09	0.724083130 09	0.106637550 13	0.163535930 13	0.927743900 12

	7	8	9	10
1	0.154103880 09	0.140401030 09	-0.133158860 10	-0.531669270 09
2	-0.133437890 09	-0.243753530 09	0.224435530 10	0.894818270 09
3	-0.262581220 09	-0.196450180 09	0.181575860 10	0.724083130 09
4	-0.292552440 12	-0.280083900 12	0.266452090 13	0.106637550 13
5	-0.565330490 12	-0.440964160 12	0.409841310 13	0.163535930 13
6	-0.331167980 12	-0.251184990 12	0.232612530 13	0.927743900 12
7	0.295600340 12	0.221264950 12	-0.204561290 13	-0.815634050 12
8	0.221264950 12	0.169986530 12	-0.157713290 13	-0.629050700 12
9	-0.204561290 13	-0.157713290 13	0.146355860 14	0.583908630 13
10	-0.815634050 12	-0.629050700 12	0.583908630 13	0.232916910 13