RECOMP II USERS' PROGRAM NO. 1073

PROGRAM TITLE: AIRBORNE TELLUROMETER COMPUTATIONS LINE CROSSING METHOD

PROGRAM CLASSIFICATION: General

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PURPOSE: For obtaining the slant ranges for two sides of a triangle whereby a triangle solution may be accomplished in order to derive the position of the unknown station at the vertex of the triangle. The slant ranges are fitted to a parabola by the method of least squares.

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PROBLEM WRITE-UP

1. Task No: 59-050 Recomp II Computer Program

2. Date Rec'd: 1 July 1959

3. Submitted by: Mr. Mancini, Air & Gend Techniques Section, Surveying and Geod. Branch

4. Programmed by: L. A. Gambino

5. Description of Problem: Line cressing method using the airborne tellurometer for obtaining the slant ranges for two sides of a triangle whereby a triangle solution may be accomplished in order to derive the position of the unknown station at the vertex of the triangle. The slant ranges are fitted to a parabola by the method of least squares.

6. Mathematical Analysis: Crout's method was used in the solution of the resulting matrix.

7. Numerical Analysis: The final position of the unknown station can be obtained to ± 0.001 second.

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8. Block Diagram: Attached

9. Operational Notes: Input and Output

   A) Input via the electric typewriter.
   After reading in the tape, the location counter will be set at location 0001.0. Press the "Start 1" button. The computer will now wait for input data.

      1. Type ±. Type a + if the interior angle of the triangle is to be added to the azimuth of the eastmost base point or type a — if it is to be subtracted from the azimuth of the eastmost base point.

      2. XXXXX.XX Base length in meters

      3. XXXX.XXX Elevation of west base point in meters.

      4. XXXX.XXX Elevation of east base point in meters.

5. 0 Type a zero

6. XX:XX:XX.XXX Latitude of west base point

Note: In all angle input, the degrees, minutes and seconds must be separated from each other by a colon.

7. XX:XX:XX.XXX Latitude of east base point

8. XX:XX:XX.XXX Longitude of west base point

9. XX:XX:XX.XXX Longitude of east base point

10. XXX:XX:XX.XXX Azimuth from west to east base point

11. XXX:XX:XX.XXX Azimuth from east to west base point.

The computer will compute for a second and then wait for slant range values. A minimum of 3 sets of values must used in order to solve the system of equations.

12. X This is the frame number (K value or abscessos)

13. XXXXX.XXX D Slant range for one side of airplane

14. XXXXX.XXX D' Slant range for other side of airplane.

The primes designate either left or right side of airplane but once a connection is adopted it must be adhered to for that side of the triangle. For each K, there are associated two slant ranges, one for each side of the airplane. There will be a minimum of 3K values and no limit on the maximum number of K values.
At this point, these slant ranges zre for only one side of the triangle. When there are no more slant ranges, press the "Letter Shift" on the typewriter.
The computer goes into the computer mode and then prints the value of K at which the curve is at a minimum and also prints the minimum sum, SM.
The operator then picks up the meterological and elevation data corresponding to this minimum point; that is, at the instant the airplane, the known base station and the unknown station were coplanar. This data is typed in the following order:

15. XXXX.XXX Elevation of aircraft in meters

16. XXXX.XXX Elevation of vertex station in meters.

17. XX.XXX TDB$^{\circ}$F temperature of dry bulb in degrees fahrenheit for one side of airplane.

18. XX.XXX TDB'$^{\circ}$F for other side of airplane

19. XX.XXX TWB$^{\circ}$F wet bulb

20. XX.XXX TWB'$^{\circ}$F wet bulb

21. XXXX.XXX h altimeter reading in feet

22. XXXX.XXX h' altimeter reading in feet

23. XXXXX.XXX D Interpotated slant distance using the computed K value as argument.

24. XX:XX:XX.XXX ϕ_m mid lot

25. XX:XX:XX.XXX ϕ_m mide lot

26. XXX:XX:XX.XXX α approximate asimuth

27. XXX:XX:XX.XXX α' approximate asimuth

The computer goes into the compute mode and then prints out the following information for the first side of the triangle:

On the first line:

28. BP: Barometric pressure

29. VP: Vapor pressure

30. IR: Index of Refraction

On the second line:

31. BP'

32. VP'

33. IR'

On the third line:

34. D and D', the ray path distances. From here, steps 10a)12) to 10a)27) are repeated for the crossing of the second side of the triangle. When this data is completely typed in, the computer goes into the compute mode and then prints out information for the second side of the triangle simular to that printed for the first side. In addition, the information from the final solution of the triangle is also printed out as follows:

35. Sea level distance for first side of triangle.

36. Azimuth to the unknown station.

37. Sea level distance for the 2nd side of triangle.

38. Azimuth to the unknown station.

39. The geographic coordinates of the unknown station using the computed data from the first line crossing.

40. The geographic coordinates of the unknown station using the computed data from the second line crossing. Here, the computer waits for the input of the known geographic coordinates of the vertex station so that a delta N and delta E may be computed from both sides of the triangle. This was set up for latitude 38°36'26". Therefore, the constants for the meridonial arc and arc of parallel must be changed if the vertex station is at another latitude.

Type:

41. XX:XX:XX.XXX ϕ of vertex

42. XX:XX:XX.XXX λ of vertex

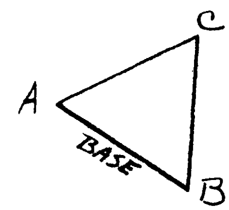
If this is not needed, press the error reset button on the console and set the location counter to 001.0 which sets the computer up for an entirely new problem. If these last two pieces of information are typed in and the final results computed, the computer will automatically set the location counter to 0001.0 upon completion of the problem.

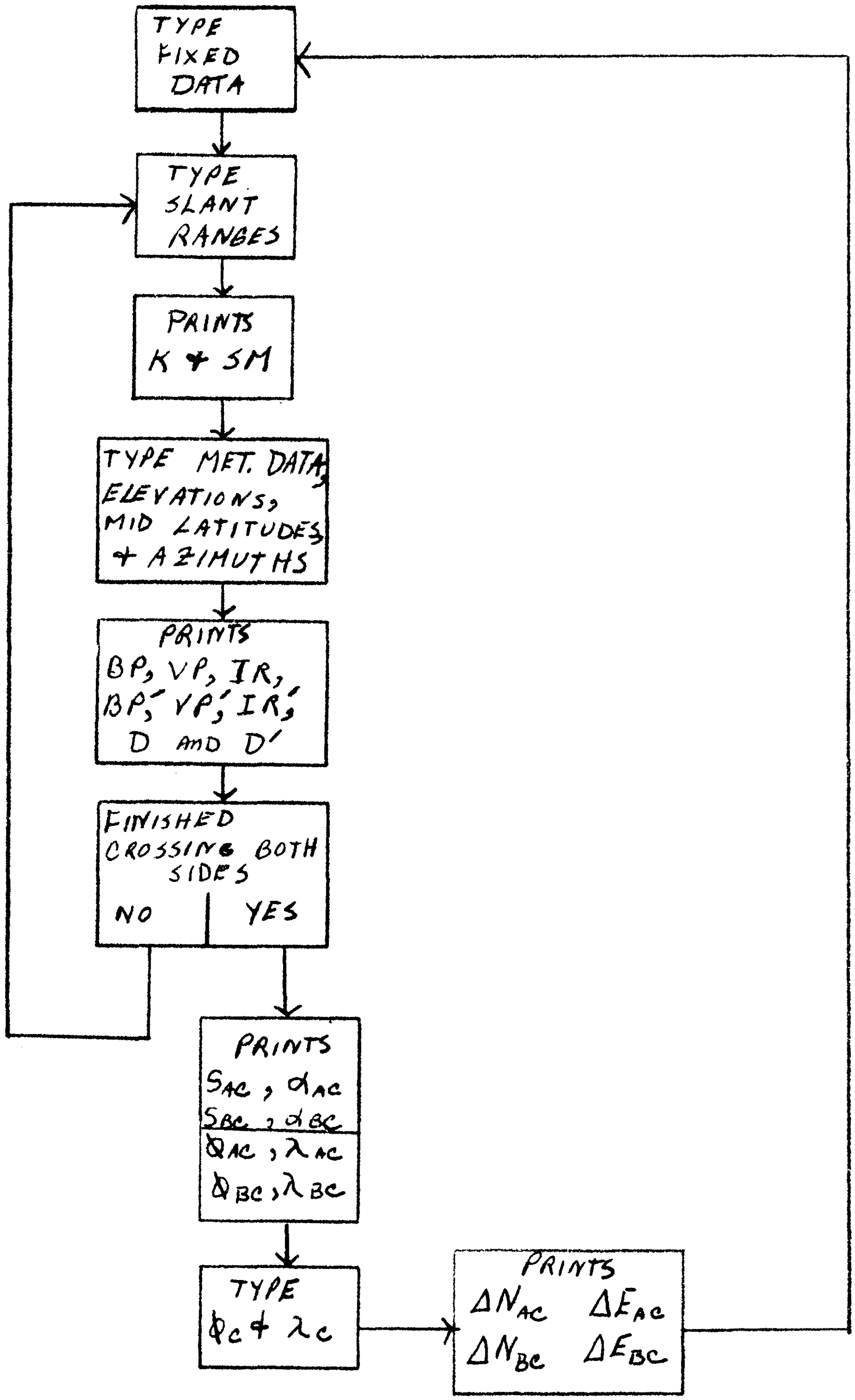
10b)

1. 1805 words or 3610 commands are utilized by this program.

2. Press the carriage return after typing in each number, press the "J" key on the typewriter, press the start button on the console and then retype the number. In typing the angles, the error must be caught before typing the colon. If an error is detected after entering a number, it is advisable to read the tape back into the computer so that modified commands and stepping constants will be reset, to their original values.

AIRBORNE TELLUROMETER LINE CROSSING METHOD 59-050





U. S. ARMY ENGINEER
GEODESY, INTELLIGENCE AND MAPPING RESEARCH AND DEVELOPMENT AGENCY
TOPOGRAPHIC ENGINEERING DEPARTMENT
SURVEYING AND GEODESY BRANCH 2 Feburary 1961

AIRBORNE TELLUROMETER COMPUTATIONS
LINE CROSSING METHOD
(WORKING EQUATIONS)

I. The solution of the Airborne Tellurometer Line Crossing Method involves the following steps:

A. Computations of mean index of refraction using meteorological data described under II A.

B. Calculation of minimum slant range from measured distances by least squares technique (parabola fit), Fig. 1.

C. Application of observed index of refraction during measurement instead of using standard η = 1.000330.

D. Computation of straight line slant range $\widetilde{D}$ (See Fig. 2).

E. Reduction of $\widetilde{D}$ to sea level distance S.

F. Computation of spherical angles (Fig. 3).

G. Position computation for the unknown station (Fig. 3).

II. Field Data Measured:

A. Meteorological data,

1. Temperature °F dry blub .....T_{DB_i}.

2. Temperature °F wet blub .....T_{WB_i}

3. Elevation, Altimeter rdgs....h_i

B. Equipment,

1. Slant ranges (k) compensated by an index of 1.000330 (incorporated in the equipment).

C. Other data (known),

1. Elevation of station A and station B........h_A, h_B(m)

2. Latitude and longitude of A and B...........ϕ_A, ϕ_B, λ_A, λ_B

3. Azimuth, geodetic, from A to B and B to A; α_{AB}, α_{BA} respectively from North.

III. Computations:

A. Index of refraction (mean),

1. Barometric Pressure $\widetilde{B}$ from altimeter radings;

$$\widetilde{B} = \left(\frac{288.0 - 0.00198h}{288} \right)^{5.256} . Po \quad ....(1)$$

where; Po = 29.921

h = mean altimeter reading expressed in feet.

$\widetilde{B}$ = barometric pressure in inches of mercury (.Hg).

2. Vapor Pressure P_v,

$$P_v = e' - 0.000367\, \widetilde{B}\, (T_{DB} - T_{WB}) \left(\frac{1 + T_{WB} - 32}{1571} \right) ....(2)$$

where T_{DB}, T_{WB} are the average temperatures in °F of dry and wet bulb thermometer readings resulting from the ends of the slant ranges. (A to aircraft, B to aircraft and C to aircraft). B is in inches of Hg from (1) and e′ from the following:

$$\log e' = \log \beta - (a - b\bar{x} + c\bar{x}^{2} - d\bar{x}^{3} + e\bar{x}^{4}) \quad \frac{\theta - T}{T} \quad ....(3)$$

where $\theta = 643^\circ$

$\log \beta = 5.1959000$

$T = 273^\circ + T_{WB}$ (T_{WB} now in °C)

$\bar{X} = \frac{T - 453}{10}$

a = 3.14773172

b = 0.00295944

c = 0.0004 19 1398

d = 0.0000 0018 29924

e = 0.0000 0008 2435

e' = vapor pressure for a saturated atmosphere <u>in mm</u>.

Convert to inches by: e' (inches) = e' (millimeters)/25.40005 before using in (2).

3. Index of refraction η

$$(\eta - 1)\,10^6 = \frac{4730}{459.5 + T_{DB}}\,(B + E)\ldots\ldots\ldots\ldots(4)$$

where: $$E = \frac{8658}{459.5 + T_{DB}}\cdot P_v$$

B. Minimum Sum Computations: The distance(s) required is that which is measured when the known ground station A, the aircraft and unknown station C are coplaner. If the sum of the distances $k_3 + k'_3$, $k_2 + k'_2$, $k_1 + k'_1$, ...etc. are plotted with respect to time, one very nearly gets a parabola. The minimum of the parabola indicates the point and minimum distance when the aircraft crosses the vertical plane between the ground stations. To obtain this value we use a least squares method.

Each measured slant range satisfies the condition equation.

$$k = ax^2 - bx + c$$

or

$$-ax_1^2 + bx_1 - c + k_1 = o$$
$$-ax_2^2 + bx_2 - c + k_2 = o$$
$$-ax_3^2 + bx_3 - c + k_3 = o$$

$$ax_n^2 + bx_n - c + k_n = o$$

Solving this set by least squares for the coefficents a, b, c, we have

$$-[X^4]\,a + [X^3]\,b - [X^2]\,c + [X^2k] = 0$$
$$-[X^3]\,a + [X^2]\,b - [X]\,c + [Xk] = 0 \qquad \text{-------------} (5)$$
$$-[X^2]\,a + [X]\,b - nc + [k] = 0$$

Where the [ ] indicates the summation over X & k, and n=number of k measurements.

These three equations will yield a, b and c with the minimum frame occurring at $X = b/2a$ and the minimum sum $(k + k') = c - b^2/4a$..................(6)

C. Arc Distance Compensated for Index of Refraction (IR).

Since the minimum distances k & k′ incorporate $\eta = 1.000330$ we perform

$$D = \frac{k \cdot 1.000330}{\eta} \qquad \text{--------------} (7)$$

$$D' = \frac{k' \cdot 1.000330}{\eta'}$$

where η = I.R. of line AM (Fig 2)
η' = " " " MC (Fig 2)

and D & D′ are the distances reflecting η and η'.

D. Ray Path to Chord Distance: The distances D and D′ represent ray path distances as shown in Fig. 2. It is now required to reduce these distances to chord length by:

$$\tilde{D} = D - D^3/24r^2$$
$$\qquad\qquad ....(8)$$
$$\tilde{D}' = D' - D^3/24r^2$$

where:

$\tilde{D}$ = straight line slope distance A to M

$\tilde{D}'$ = straight line slope distance C to M

D, D′ = (as before)

r = 26.0×10^6 meters (radius of the radio wave)

E. Slope Distance $\tilde{D}$ and $\tilde{D}'$ spheroid chord distance K (Fig. 2)

$$K = \sqrt{\frac{\tilde{D}^2 - (h_m - h_A)^2}{(1 + \frac{h_A}{\rho'_\alpha})(1 + \frac{h_m}{\rho'_\alpha})}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

where: h_A = elevation of A

------------ in meters

h_M = height of the aircraft

$\tilde{D}$ = as obtained in (8)

ρ'_α = radius of curvature (mean) of spheroid.

defined as:

$$\rho'_\alpha = \rho\nu/(\nu \cos^2\alpha + \rho \sin^2\alpha)$$

$$\rho = \bar{a}(1 - \bar{e}^2) / (1 - \bar{e}^2 \sin^2 \phi m)^{3/2}$$

$$\nu = \bar{a} / (1 - \bar{e}^2 \sin^2 \phi m)^{1/2}$$

$\bar{a}$ = 6,378,206 m (semi-major axis of Clarke 1866 spheroid)

$\bar{e}^2$ = 0.006 768 658 (eccentricity squared of the spheroid)

ϕ_m = mid latitude of the line (this quantity will be known) to the nearest minute.

α = azimuth from north from A to M (this quantity will also be known to nearest 0.1 degree)

Similarly for K',

$$K' = \sqrt{\frac{(\tilde{D}')^2 - (h_m - h_c)^2}{(1 + \frac{h_c}{\rho''_\alpha})(1 + \frac{h_m}{\rho''_\alpha})}}$$

where: $\rho'' = f(\bar{a}, \bar{e}^2, \phi'_m, \alpha')$

$\bar{a}$, $\bar{e}^2$ = same as for (9)

$\phi'm$, α' = new values for line $\tilde{D}'$

F. Chord To Arc Correction: K and K′ need to be converted to spheroid arc distances by :

$$S = K + \frac{K^3}{24\rho_\alpha'^2} + \frac{3K^5}{640\rho_{\alpha_1}'^4} \quad \ldots\ldots\ldots\ldots\ldots (11)$$

$$S' = K' + \frac{K'^3}{24\rho_\alpha''^2} + \frac{3K^5}{640\rho_\alpha''^4} \quad \ldots\ldots\ldots\ldots\ldots (12)$$

where: S, S' = arc distances

K, K' = chord distances (obtained in (9) & (10).

ρ_α' = radius of curvature for K as obtained in (9).

ρ_α'' = radius of curvature associated with K' as obtained in (10).

G. Second line of Triangle ABC: The computations up to this point supply the sea-level distance from A to C, Fig. 3. The next step of the problem is to obtain the sea-level distance B to C in exactly the same manner as applied to length AC. This implies that the following quantities be known:

h_c = elevation of station C

ϕ_m = latitude for expression (9)

ϕ_m' = latitude for expression (10)

$\bar{a}, \bar{e}^2$ = as before

r = as before

$\alpha . \alpha'$ = aximuths for ρ' and ρ'' (from north)

After reducing arc length BC we compute the interior angles by normal cosine expressions involving the 3 known lengths. Assume the sides of triangle ABC to be plane lengths and compute:

$$a_1^2 = b_1^2 + c_1^2 - 2b_1c_1 \underline{\cos A}$$

$$b_1^2 = a_1^2 + c_1^2 - 2a_1c_1 \underline{\cos B} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

$$c_1^2 = a_1^2 + b_1^2 - 2a_1b_1 \underline{\cos C}$$

Now determine the spherical excess (ε) of triangle ABC by:

$$\varepsilon = a_1 \, b_1 \sin C \, . \, m \quad \text{.......... (14)}$$

a_1, b_1 = sides of triangle

C = included angle

and $$m = (1-\bar{e}^2 \sin^2 \phi_m)^2 / 2\bar{a}^2(1 - \bar{e}^2) \sin 1''$$

where $\bar{e}$, $\bar{a}$ = spheroid parameters as before

ϕ_m = mid latitude (mean of all four used in (9) & (10)).

H. Azimuth of line AC (α_{AC}) and azimuth of line BC (α_{BC}). To obtain α_{AC} α_{BC} perform:

$$A + B + C - (180^\circ + \varepsilon) = \bar{E} \quad \text{.......... (15)}$$

$$A' = A - \frac{\bar{E}}{3} \quad \text{.......... (16)}$$

$$B' = B - \frac{\bar{E}}{3} \quad \text{.......... (17)}$$

$$C' = C - \frac{\bar{E}}{3} \quad \text{.......... (18)}$$

In (16), (17), & (18) $\bar{E}$ carries the sign of (15)

check computation, $$A' + B' + C' = 180^\circ + \varepsilon \quad \text{.......... (19)}$$

Where:

A, B, C = spherical angles (uncorrected)

A′, B′, C′ = spherical angles (corrected for error closure)

ε = spherical excess

$\bar{E}$ = closure error

Now determine the azimuth (from the north) of lines AC and BC from the general equations:

$$\alpha_{AC} = \alpha_{BA} \pm 180^\circ - A' \quad \text{.......... (20)}$$

$$\alpha_{BC} = \alpha_{AB} \pm 180^\circ + B' \quad \text{.......... (21)}$$

α_{AC} and α_{BC} designate the geodetic azimuth of line AC and BC respectively. α_{BA} designates the back azimuth of line AB, and α_{AB} the forward azimuth.

These equations should be used in programming the azimuth computation in such a way that when viewing C from base line, A is always to the left and B to the right.

I. Computation of geographic coordinates of point C will be performed from both A and B. Resulting values in latitude and longitude separately computed will be meaned to give best set of coordinates for point C.

Helmert's Position Computation, involving a process of determining the geographic coordinates of a second point (C in our case) given the geodetic distance and azimuth from a known point (A or B).

A copy of Helmert's equations are included with this problem along with a sample computation.

J. The program will be developed for optional input and demanded output of the following basic geodetic and plane data. The problem operates in geodetic data; therefore plane and mil data must be programmed to convert to geodetic by subroutine which is to be an integral part of the program.

1. Input:
   - a. Geodetic
     - (1). Geographic Coordinates (° ′ ″)
     - (2). Azimuth (° ′ ″)
   - b. UTM
     - (1). Coordinates (meters)
     - (2). Azimuth (° ′ ″ or mil values)
2. Output:
   - a. Geodetic
     - (1). Geographic Coordinates (° ′ ″)
     - (2). Azimuth (° ′ ″)
   - b. UTM
     - (1). Coordinates (meters)
     - (2). Azimuth (° ′ ″ and mil values)

k. Utilise the formulae developed for Engineer Problem No. 12, UTM Coordinates to Geodgraphic Coordinates to convert UTM coordinate input (optional entry) to geographic coordinates. From other existing formulae (convergence of meridians), convert UTM azimuth to geodetic azimuth. The mil azimuth can be converted to UTM sexagesimal first and then to geodetic.

l. Engineer Problem No. 11, Geographic Coordinates to UTM Coordinates formulae can serve as subroutine for converting geographic coordinates to UTM coordinates for output. Convergence formulae will allow geodetic azimuth conversion to UTM azimuth. Mil azimuth can be worked out from the simple relationship of 6400 mils = 360°.

m. Entire program will contain all subroutines as integral part.

n. Program shall be designed to work only west of Greenwich and north of the equator.

o. Program shall be developed so that after entering Baseline data, the operator can re-enter as many times as desired at Field Data for computing several unknown points (C's).

Note: Refer to Format as guidance.

AIRBORNE TELLUROMETER COMPUTATIONS
(LINE CROSSING METHOD)

PROGRAM WRITE-UP

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHABETIC CODE	REMARKS
0001	+57	3730.0	TRA	Push Start 1
	+40	0000.0	NOP	
1350	+72	0033.0	A TYC	Type Figs
	+00	0614.0	A1 CLA	L (B)
1351	+57	3000.0	TRA	AN 002
	+77	1350.1	HTR	A 1
1352	+43	0000.0	XAR	
	+00	0614.0	CLA	L (B)
1353	+43	0000.0	XAR	
	+45	0000.0	FNM	
1354	+35	[2014].0	B1 F ST	[2014]
	+00	0617.0	CLA	FOUR (Fxd.pt) @ b38
1355	+03	0616.0	SUB	ONE (Fxd.pt) @ b38
	+50	1360.0	TZE	C 1
1356	+60	0617.0	STO	FOUR
	+00	1354.0	CLA	B 1
1357	+01	0623.0	ADD	TWØ (Fxd.pt) @ b18
	+57	0766.0	TRA	0766.0
1360	+00	0620.0	C1 CLA	(K FOUR) Reset 3 @ b38
	+60	0617.0	STO	FOUR @ b38
1361	+00	0624.0	CLA	(K B1) Reset Loc B1
	+60	1354.0	STO	B1
1362	+57	1362.1	TRA	BEGIN
	+72	0033.0	TYC	Type Figs (Deg.,Min,Sec.)
1363	+57	6715.0	E.0 TRA	6715 Type from Rad. to (Deg, Min, Sec.)
	+40	[2024.0]	E.1 PZE	[2024]
1364	+00	0621.0	CLA	SIX(Fxd.pt) @ b38
	+03	0616.0	SUB	ØNE(Fxd.pt) @ b38
1365	+50	1367.1	TZE	F
	+60	0621.0	STO	

	COMMAND			
LOCATION	OPERATION CODE	ADDRESS	ALPHABETIC CODE	REMARKS
1366	+00	1363.0	CLA	E.0 Step E
	+01	0625.0	ADD	TWØ @ b_{38}
1367	+57	0767.0	TRA	E.0
	+00	0622.0	F.1 CLA	K3 Reset @ b38
1370	+60	0621.0	STØ	
	+00	0626.0	CLA	K4 Reset E.1
1371	+60	1363.0	STO	E
	+30	0600.0	F1.1 FCA	ZERØ
1372	+35	0100.0	FST	SUM D_i
	+35	0102.0	FST	SUM+2 a_{11}
1373	+35	0104.0	FST	SUM+4 a_{12}
	+35	0106.0	FST	SUM+6 a_{13}
1374.	+35	0110.0	FST	SUM+10 b_1
	+35	0112.0	FST	SUM+12 a_{21}
1375	+35	0114.0	FST	SUM+14 a_{22}
	+35	0116.0	FST	SUM+16 a_{23}
1376	+35	0120.0	FST	SUM+20 b_2
	+35	0122.0	FST	SUM+22 a_{31}
1377	+35	0124.0	FST	SUM+24 a_{32}
	+35	0126.0	FST	SUM+26 a_{33}
1400	+35	0130.0	FST	SUM+30 b_3
	+35	0132.0	FST	COUNT
1401	+00	0614.0	CLA	L (B)
	+57	3000.0	TRA	AD 0002
1402	+77	1401.0	HTR	1401.0 Error Return
	+57	1403.1	TRA	B2.1 Normal Return
1403	+57	1437.1	TRA	J.1 End of File (operator hits LTRS SHIFT when Prog. comes back to wait for more data. This will TRA. prog. to Least Sq. solution.)
	-43	0000.0	B2.1 XAR	

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHABETIC CODE	REMARKS
1404	+00	0614.0	CLA	L (B)
	+43	0000.0	XAR	
1405	+45	0000.0	1B.0 FNM	
	+35	[2000.0]	1B.1 FST	[2000.0]
1406	+00	0627.0	CLA	THREE
	+03	0616.0	SUB	ONE
1407	+50	1411.1	TZE	(C.1) Reset
	+60	0627.0	STO	THREE
1410	+00	1405.0	CLA	B.0 Step B.1
	+01	0625.0	ADD	TWØ @ b38
1411	+57	0770.0	TRA	START
	+00	0630.0	C.1 CLA	K 3 Reset 4
1412	+60	0627.0	STO	FOUR
	+57	0773.0	TRA	K 2 Reset L(B.1)
1413	+30	2002.0	FCA	2002
	+04	2004.0	FAD	2004 $(D_i - D'_i)$
1414	+35	0100.0	FST	SUM
	+04	0130.0	FAD	SUM $(D_i + D_i^1)$
1415	+35	0130.0	FST	SUM + 30 D_i = b3
	+30	0132.0	FCA	COUNT
1416	+04	0544.0	FAD	ONE
	+35	0132.0	FST	COUNT = 1
1417	+30	2000.0	FCA	2000
	+07	2000.0	FMP	2000 $(k_1)^2 = 4$
1420	+35	0134.0	FST	COM
	+07	2000.0	FMP	2000 $(k_1)^3 = 8$
1421	+35	0136.0	FST	COM +2
	+07	2000.0	FMP	2000
1422	+35	0140.0	FST	COM +4 $(k_1)^4 = 16$
	+34	0140.0	FCS	COM +4
1423	+04	0102.0	FAD	SUM +2
	+35	0102.0	FST	SUM +2 $-\Sigma K_i^4 = a_{11}$
1424	+30	0136.0	FAD	SUM +2
	+04	0104.0	FST	SUM +4

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHABETIC CODE	REMARKS
1425	+35	0104.0	FST	SUM +4 $\Sigma K_i^3 = a_{12}$
	+34	0104.0	FCS	SUM +4
1426	+35	0112.0	FST	SUM +12 $-\Sigma K_i^3 = a_{21}$
	+34	0134.0	FCS	COM $-K^2$
1427	+04	0106.0	FAD	SUM +6 K^2
	+35	0106.0	FST	SUM +6 $-\Sigma K_i^2 = a_{13}$
1430	+35	0122.0	FST	SUM +22 $-\Sigma K_i^2 = a_{31}$
	+34	0122.0	FCS	SUM +22
1431	+35	0114.0	FST	SUM +14 $\Sigma K_i^2 = a_{22}$
	+57	0775.0	FMP	SUM
1432	+35	0110.0	FST	SUM +10 $\Sigma K_i^2 D_i = b_1$
	+30	2000.0	FCA	2000 $= k_i$
1433	+04	0124.0	FAD	SUM +24
	+35	0124.0	FST	SUM +24 $\Sigma k_i = a_{32}$
1434	+34	0124.0	FCS	SUM+24
	+35	0116.0	FST	SUM +16 $-\Sigma k_i = a_{23}$
1435	+30	2000.0	FCA	k_2
	+07	0100.0	FMP	SUM k_i
1436	+04	0120.0	FAD	SUM +20
	+35	0120.0	FST	SUM +20 $\Sigma k_i \cdot D_i = b_2$
1437	+57	1401.0	TRA	START
	+34	0132.0	J.1 FCS	COUNT
1440	+04	0126.0	FAD	SUM +26
	+35	0126.0	FST	SUM +26 $-n = a_{33}$
1441	+30	0104.0	FCA	SUM +4,5
	+05	0102.0	FDV	SUM +2,3
1442	+35	0104.0	FST	SUM +4,5 $= a_{12}^{(1)}$
	+30	0106.0	FCA	SUM +6,7
1443	+05	0102.0	FDV	SUM +2,3
	+35	0106.0	FST	SUM +6,7 $= a_{13}^{(1)}$
1444	+34	0112.0	FCS	SUM +12,13
	+07	0104.0	FMP	SUM +4,5

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
1445	+04	0114.0	FAD	SUM +14,15
	+35	0114.0	FST	SUM +14,15 = $a_{22}^{(1)}$
1446	+34	0122.0	FCS	SUM +22
	+07	0104.0	FMP	SUM +4.5
1447	+04	0124.0	FAD	SUM +24.25
	+35	0124.0	FST	SUM +24 25 = $a_{32}^{(1)}$
1450	+34	0112.0	FCS	SUM +12,13
	+07	0106.0	FMP	SUM +6,7
1451	+04	0116.0	FAD	SUM +16,17
	+05	0114.0	FDV	SUM +14,15
1452	+35	0116.0	FST	SUM +16.17 = $a_{23}^{(1)}$
	+30	0122.0	FCA	SUM +22,23
1453	+07	0106.0	FMP	SUM +6,7
	+35	0134.0	FST	COM, COM+1
1454	+30	0124.0	FCA	SUM +24,25
	+07	0116.0	FMP	SUM +16,17
1455	+04	0134.0	FAD	COM, COM+1
	+35	0134.0	FST	COM, COM+1
1456	+34	0134.0	FCS	COM, COM+1
	+04	0126.0	FAD	SUM +26,27
1457	+35	0126.0	FST	SUM +26.27 = $a_{33}^{(1)}$
	+34	0110.0	FCS	SUM +10.11
1460	+05	0102.0	FDV	SUM +2,3
	+35	0110.0	FST	SUM +10.11 = $b_{1}^{(1)}$
1461	+34	0112.0	FCS	SUM +12,13
	+07	0110.0	FMP	SUM +10,11
1462	+06	0120.0	FSB	SUM +20.21
	+05	0114.0	FDV	SUM +14,15
1463	+35	0120.0	FST	SUM +20 21 = $b_{2}^{(1)}$
	+30	0122.0	FCA	SUM +22,23
1464	+07	0110.0	FMP	SUM +10.11
	+35	0134.0	FST	COM
1465	+30	0124.0	FCA	SUM +24,25
	+07	0120.0	FMP	SUM +20,21

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1466	+04	0134.0	FAD	COM
	+35	0134.0	FST	COM
1467	+34	0130.0	FCS	SUM +30,31
	+06	0134.0	FSB	COM
1470	+05	0126.0	FDV	SUM +26,27
	+35	0130.0	FST	SUM +30,31 = $b_3^{(1)}$ = R
1471	+34	0116.0	FCS	SUM +16 $-a_{23}^{(1)}$
	+07	0130.0	FMP	SUM +30 $xb_3^{(1)}$
1472	+04	0120.0	FAD	SUM +20
	+35	0120.0	FST	SUM +20 = Q
1473	+34	0104.0	FCS	SUM +4 $- a_{12}^{(1)}$
	+07	0120.0	FMP	SUM +20 x a_2
1474	+35	0134.0	FST	COM
	+34	0106.0	FCS	SUM +6 $- a_{13}^{(1)}$
1475	+07	0130.0	FMP	SUM +30 x a_3
	+04	0110.0	FAD	SUM +10 $-b_1$
1476	+04	0134.0	FAD	COM
	+35	0110.0	FST	SUM +10 = P
1477	+30	0110.0	FCA	P = SUM +10
	+07	0556.0	FMP	TWØ
1500	-35	0134.0	FST	COM
	+30	0120.0	FCA	Q
1501	+05	0134.0	FDV	COM
	+35	2100.0	FST	(2100) =K=Q/2P
1502	+30	0120.0	FCA	Q
	+07	0120.0	FMP	Q = Q^2 This is the value which makes D_i a minimum.
1503	+35	0134.0	FST	COM
	+30	0562.0	FCA	4
1504	+07	0110.0	FMP	P
	+35	0136.0	FST	COM +2 4P

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1505	+34	0134.0	FCS	COM
	+05	0136.0	FDV	COM +2 R= $Q^2/4P$
1506	+40	0000.0	NOP	
	+04	0130.0	FAD	R
1507	+35	2102.0	FST	2102 = $D_m = (D_i + D_i^1)$
	+72	0037.0	TYC	Type Letters
1510	+72	0017.0	TYC	K
	+40	0000.0	G1 SLL	
1511	+57	0244.0	TRA	0244
	+40	2100.0	PZE	(2100)
1512	+00	2005.0		
	-11	0201.1		
1513	+77	1510.1	HTR	G1
	+72	0037.0	TYC	
1514	+72	0005.0	TYC	S
	+40	0000.0	ARS	
1515	+72	0034.0	TYC	M
	+40	0000.0	G2 SLL	
1516	+57	0244.0	TRA	0244
	+40	2102.0	PZE	(2102)
1517	+00	2005.0		
	-31	0220.1		
1520	+77	1515.1	HTR	G2
	+72	0033.0	TYC	Type Figs
1521	+00	0614.0	CLA	L(B) Loc of Binary Scale
	+57	3000.0	TRA	3000
1522	+77	1521.0	HTR	G3
	+43	0000.0	XAR	
1523	+00	0614.0	CLA	L(B)
	+40	0000.0	NOP	
1524	+43	0000.0	XAR	
	+45	0000.0	FNM	

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1525	+35	[2040.0]	G4 FST	(2040) Step to 2060
	+00	0632.0	CLA	NINE @ b38
1526	+03	0616.0	SUB	ONE @ b38
	+50	1531.0	TZE	G5 Reset TEN
1527	+60	0632.0	STO	NINE
	+00	1525.0	CLA	G4
1530	+01	0623.0	ADD	TWØ.0 @ b18
	+57	0771.0	TRA	PATCH
1531	+00	0633.0	G5 CLA	K (NINE) Reset 9
	+60	0632.0	STO	NINE
1532	+00	0634.0	CLA	K (G4) Reset G4
	+60	1525.0	STO	G4
1533	+40	0000.0	NOP	PATCH
	+72	0033.0	G6 TYC	Type Figs
1534	+57	6715.0	G7.0 TRA	Deg., Min., Sec. to Radians
	+40	[2064.0]	G7.1 PZE	[2064]
1535	+00	0617.0	CLA	FOUR
	+03	0616.0	SUB	ONE
1536	+50	1540.1	TZE	G7A.0
	+60	0617.0	STO	FOUR
1537	+00	1534.0	CLA	G7.0
	+01	0625.0	ADD	TWØ @ b38
1540	+57	0772.0	TRA	PATCH
	+00	0620.0	G7A CLA	K(FOUR) Reset 4
1541	+60	0617.0	STO	FOUR
	+00	0635.0	CLA	K(G7) Reset G7.1
1542	+60	1534.0	STO	G7.0and G7.1
	+30	0502.0	G8 FCA	.00198
1543	+07	[2054.0]	X1 FMP	[2054]
	+35	0134.0	FST	COM
1544	+30	0500.0	FCA	288
	+06	0134.0	FSB	COM

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
1545	+05	0500.0	FDV	288
	+57	5400.0	TRA	ln $\left[\frac{288 - .00198h_i}{288}\right]$
1546	+40	7774.0	PZE	
	+77	1542.1	HTR	G8
1547	+07	0504.0	FMP	5.256
	+35	0134.0	FST	COM
1550.0	+30	0506.0	Y1 FCA	29.921= Po
	+57	5400.0	TRA	
1551	+40	7774.0	PZE	7774.0
	+77	1550.0	HTR	Y1
1552	+04	0134.0	FAD	COM 5.25 ln[ ]+lnP$_o$
	+57	5500.0	TRA	5500 e^x
1553	+40	7774.0	PZE	7774.0
	+77	1542.1	HTR	G8 Go over whole sequence again if it stops.
1554	+35	2110.0	FST	(B_i, B_i+1) 2110
	+30	[2050.0]	FCA	(2050) T_wB_i
1555	+06	0512.0	FSB	32^o
	+07	0636.0	FMP	5 5/9(TwBi-32)
1556	+05	0640.0	FDV	9
	+04	0522.0	FAD	273^o T_i= TWB+273
1557	+35	0134.0	FST	COM,COM+1 = T_i
	+06	0524.0	FSB	453 T_i-453
1560	+05	0526.0	FDV	10 $x = \frac{Ti-453}{10}$
	+35	0136.0	FST	COM+2, COM+3 X
1561	+30	0516.0	FCA	θ
	+06	0134.0	FSB	COM $\theta - T_i$
1562	+05	0134.0	FDV	COM $(\theta - T_i)/T_i$
	+35	0134.0	FST	COM, COM-1
1563	+34	0136.0	FCS	COM 2 -x
	+07	0532.0	FMP	b -xb

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1564	+04	0530.0	FAD	a
	+35	0140.0	FST	COM+4, COM+5 a-xb
1565	+30	0136.0	FCA	COM2
	+07	0136.0	FMP	COM2
1566	+35	0142.0	FST	COM+6, COM+7 x^2
	+40	0000.0	NOP	
1567	+30	0142.0	FCA	COM+6
	+07	0136.0	FMP	COM+2
1570	+35	0144.0	FST	COM 10, COM+11 X^3
	+07	0136.0	FMP	COM+2
1571	+35	0146.0	FST	COM+12, COM+13 X^4
	+30	0534.0	FCA	C
1572	+07	0142.0	FMP	COM+6 $-CX^2$
	+04	0140.0	FAD	COM+4 $a-bx+cx^2$
1573	+35	0136.0	FST	COM+2
	+34	0144.0	FCS	COM+10 $-d\ x^3$
1574	+07	0536.0	FMP	d
	+04	0136.0	FAD	COM+2
1575	+35	0136.0	FST	COM+2 $a-bx+cx^2-dx^3$
	+30	0146.0	FCA	COM+12
1576	+07	0540.0	FMP	e
	+04	0136.0	FAD	COM+2
1577	+07	0134.0	FMP	COM $(a-bx+cx^2-dx^3+ex^4)$
	+35	0134.0	FST	COM $x(\theta - T_i)/T_i$
1600	+30	0520.0	FCA	logβ
	+06	0134.0	FSB	COM logβ -[ ]( )
1601	+40	0000.0	SLR	
	+57	5500.0	TRA	5500
1602	+40	7774.0	PZE	7770.0 (7770=10^x)
	+77	1554.1	HTR	X2 Recompute log e_i'
1603	+35	0136.0	FST	e_i' (COM-2)
	+30	0510.0	FCA	-.000367

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1604	+40	0000.0	NOP	
	+07	2110.0	FMP	$\hat{B}_i$
1605	+35	0134.0	X3.0 FST	COM, COM+1
	+30	[2044.0]	X3 FCA	T_D B_i
1606	+06	[2050.0]	X4 FSB	$T_D B - T_W B$
	+07	0134.0	FMP	COM
1607	+35	0134.0	X5.0 FST	COM
	+30	[2050.0]	X5 FCA	$T_w B_i$
1610	+06	0512.0	FSB	32 (TwB-32)/1571
	+05	0514.0	FDV	1571
1611	+04	0544.0	FAD	1
	+07	0134	FMP	COM
1612	+35	0134.0	FST	COM e'=10.2798/25.40005
	+30	0136.0	FCA	e'_i COM+2
1613	+05	0542.0	FDV	25.40005
	+06	0134.0	FSB	COM
1614	+35	2112.0	FST	(Pv_i)
	+30	0552.0	FCA	459.5
1615	+04	[2044.0]	X6 FAD	(2044) $T_D B$+459.5
	+35	0134.0	FST	COM COM+1
1616	+30	0554.0	FCA	8658
	+05	0134.0	FDV	COM
1617	+07	2112.0	FMP	Pv_i 2112 $E_i = Pv_i(8658)/459.5+T_D B$
	+04	2110.0	FAD	$\hat{B}_i$ 2110 (B_i+E_i) 4730/ 459.5-$T_D B$
1620	+07	0550.0	FMP	4730
	+05	0134.0	FDV	COM
1621	+05	0546.0	FDV	10^6
	+40	0000.0	NOP	
1622	+04	0544.0	X7.0 FAD	ONE
	+35	[2104.0]	X7 FST	Index of Ref
1623	+57	1626.0	TRA	

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
1626	+72	0037.0	TYC	Ltrs
	+72	0031.0	TYC	B
1627	+72	0026.0	TYC	P
	+40	0000.0	G2 SLL	
1630	+57	0244.0	TRA	
	+40	2110.0	PZE	L(BP)
1631	+00	2005.0		
	-11	0201.1		
1632	+77	1627.0	HTR G2	
	+72	0037.0	TYC	Type letters
1633	+72	0036.0	TYC	V
	+72	0026.0	TYC	P
1634	+57	0244.0	G3 TRA	
	+40	2112.0	PZE L(PV_1)	
1635	+00	2005.0	CLA	
	-15	0201.1	SAX	
1636	+77	1634.0	HTR G3	
	+72	0037.0	TYC	Type letters
1637	+72	0006.0	TYC	I
	+72	0012.0	TYC	R
1640	+57	0244.0	G4 TRA	0244
	+40	2104.0	X10 PZE	(2104) = L(N_m)
1641	+00	2005.0	CLA	
	-05	0460.1	FDV	
1642	+77	1640.0	HTR G4	
	+57	1646.0	TRA	
1646	+40	0000.0	NOP	
	+00	0642.0	CLA	TWØ1 @b38
1647	+03	0616.0	SUB	ONE
	+50	1672.0	TZE	RESET
1650	+60	0642.0	STO	TWØ1
	+00	1543.0	CLA	X1.0 Step X1
1651	+01	0623.0	ADD	TWØ @ b_{18}
	+60	1543.0	STO	X1

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1652	+00	1554.0	CLA	X2.0
	+01	0625.0	ADD	TWO @ b_{38}
1653	+60	1554.0	STO	X2 Step X2
	+00	1605.0	CLA	X3.0
1654	+01	0625.0	ADD	TWØ
	+60	1605.0	STO	X3 Step X3
1655	+00	1606.0	CLA	X4.0
	+01	0623.0	ADD	TWO
1656	+60	1606.0	STO	X4 Step X4
	+00	1607.0	CLA	X5.0
1657	+01	0625.0	ADD	TWØ
	+60	1607.0	STO	X5 Step X5
1660	+00	1615.0	CLA	Step X6
	+01	0623.0	ADD	TWØ
1661	+60	1615.0	STO	X6
	+00	1622.0	CLA	X7.0
1662	+01	0625.0	ADD	TWØ
	+60	1622.0	STO	X7 Step X7
1663	+57	1666.1	TRA	
	+40	0000.0	NOP	
1666	+00	1640.0	CLA	X10
1667	+01	0625.0	ADD	TWØ
	+60	1640.0	STO	X10
1670	+57	1671.1	TRA	
	+57	1542.1	TRA G8	
1672	+00	0643.0	CLA	K(TWØ)
	+60	0642.0	STO	TWO
1673	+00	0644.0	CLA	K(X1)
	+60	1543.0	STO	X1

LOCATION	COMMAND OPERATION CODE	ADDRESS		ALPHEBETIC CODE	REMARKS
1674	+00	0645.0		CLA	K(X2)
	+60	1554.0		STO	X2
1675	+00	0646.0		CLA	K(X3)
	+60	1605.0		STO	X3
1676	+00	0647 0		CLA	K(X4)
	+60	1606.0		STO	X4
1677	+00	0650.0		CLA	K(X5.)0
	+60	1607.0		STO	X5
1700	+00	0651.0		CLA	K(X6)
	+60	1615.0		STO	X6
1701	+40	0000.0		NOP	
	+00	0652.0		P1 CLA	K(X7.)0
1702	+60	1622.0		STO	X7.0
	+40	0000.0		NOP	K(X8)
1703	+40	0000.0		NOP	X8
	+40	0000.0		NOP	K(X9.)0
1704	+40	0000.0		NOP	X9.0
	+00	0656.0		CLA	K(X10).0
1705	+60	1640.0		STO	X10
	+40	0000.0		CLA	K(X11)
1706	+57	0750.0		TRA	PATCHWORK
	+57	7004.0		1.1 TRA	SUB.R
1707	+40	2114.0		2.0 PZE	L(D)
	+40	2016.0	X12A	2.1 PZE	L(h_a)
1710	+40	2040.0		3.0 PZE	L(h_m)
	+40	2064.0		3.1 PZE	L(ϕ_m)
1711	+40	2070.0		4.0 PZE	L(α)
	+40	2600.0	X12	4.1 PZE	L(ANS.) COM + 20

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
7004	+15	0140.0	SUB.R SAX	COM+4 Contents of X, which contains
	+01	0615.0	ADD	1 b_{39} Loc of TRA INST. goes into the right half of A
7005	+42	7010.1	STA.1	B
	+01	0616.0	ADD	1 b_{38}
7006	+42	7012.1	STA.1	C
	+01	0616.0	ADD	1 b_{38}
7007	+42	7014.1	STA.1	D
	+01	0616.0	ADD	1 b_{38}
7010	+42	7100.1	STA.1	E
	+00	[0000.0]	B CLA	[ ]
7011	+42	7016.0	STA.0	Z1
	+42	7024.1	STA.1	Z2
7012	+42	7062.1	STA.1	Z3
	+00	[0000.0]	C CLA	3.0 [1710.0]
7013	+42	7025.0	STA.0	Z4 L(h_m)
	+42	7065.0	STA.0	Z5 L(h_a)
7014	+42	7033.1	STA.1	Z6 L(ϕ_m)
	+00	[0000.0]	D CLA	[1711.0]
7015	+42	7036.0	STA.0	Z7 L( )
	+42	7077.1	STA.1	Z8 L(Ans)
7016	+30	[0000.0]	Z1 FCA	[2114.0]
	+35	0142.0	D FST	COM+6
7017	+07	0142.0	D^2 FMP	COM+6
	+07	0142.0	FMP	COM+6
7020	+35	0144.0	D^3 FST	COM+10
	+30	0564.0	FCA	24
7021	+07	0566.0	FMP	r(5096,700)
	+07	0566.0	FMP	r
7022	+35	0146.0 $24r^2$	FCS	COM+12
	+34	0144.0	FCS	COM+10
7023	+05	0146.0	FDV	COM+12
	+04	0142.0	FAD	COM+6

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE		REMARKS
7024	+35	0142.0	D^2	FST	COM+6
	+30	0000.0	Z2	FCA	[ ]
7025	+06	0000.0	Z4	FSB	[ ] h_a-h_m
	+35	0144.0		FST	COM+10
7026	+30	0144.0		FCA	COM+10
	+07	0144.0		FMP	COM+10
7027	+35	0144.0		FST	COM+10 $(h_a-h_m)^2$
	+30	0142.0		FCA	COM+6
7030	+07	0142.0		FMP	COM+6
	+35	0146.0		FST	COM+12 $\tilde{D}^2$
7031	+30	0144.0		FCA	COM+10
	+05	0146.0		FDV	COM+12 $(h-h_m)^2/\tilde{D}^2$
7032	+35	0146.0		FST	COM+12
	+40	0000.0		SLL	
7033	+40	0000.0		NOP	[ ]
	+30	0000.0	Z6	FCA	[ ]
7034	+57	1100.0		TRA	AN017 1100-1220
	+40	0150.0		PZE	(COM+14) $=\sin \phi_m$
7035	+77	7033.0		HTR	Z6
	+40	0000.0		SLL	
7036	+30	0000.0	Z7	FCA	[ ]
	+57	1005.0		TRA	ATCP
7037	+57	1100.0	Q	TRA	AN017 1100-1220
	+40	0152.0		PZE	(COM+16) $= \sin\alpha$
					(COM+18) $= \cos\alpha$
7040	+77	7036.0		HTR	Z7
	+30	0150.0		FCA	COM+14
7041	+07	0150.0		FMP	COM+14 $\sin^2\phi_m$
	+07	0572.0		FMP	0.006768658 $= \bar{e}^2$
7042	+35	0150.0		FST	COM+14 $\bar{e}^2 \sin^2\phi_m$
	+30	0544.0		FCA	ONE

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
7043	+06	0150.0	FSB	COM+14
	+35	0150.0	FST	COM+14 $1-\bar{e}^2\sin^2\phi_m$
7044	+44	0150.0	FSQ	COM+14 $\sqrt{1-\bar{e}^2\sin^2\phi_m}$
	+35	0150.0	FST	COM+14
7045	+30	0570.0	FCA	6378206 = $\bar{a}$
	+05	0150.0	FDV	COM+14
7046	+35	0144.0	FST	COM+10 = ν
	+30	0150.0	FCA	COM+14
7047	+07	0150.0	FMP	COM+14
	+07	0150.0	FMP	COM+14
7050	+35	0150.0	FST	COM+14 $(1-\bar{e}^2\sin^2\phi_m)^{3/2}$
	+30	0544.0	FCA	ONE
7051	+06	0572.0	FSB	$\bar{e}^2$
	+07	0570.0	FMP	$\bar{a}$ $\bar{a}(1-\bar{e}^2)$
7052	+05	0150.0	FDV	COM+14
	+35	0150.0	FST	COM+14 = ρ
7053	+30	0152.0	FCA	COM+16
	+07	0152.0	FMP	COM+16
7054	+35	0152.0	FST	COM+16 $\sin^2\alpha$
	+30	0154.0	FCA	COM+20
7055	+07	0154.0	FMP	COM+20 $\cos^2\alpha$
	+07	0144.0	FMP	COM+10 $2\cos^2\alpha$
7056	+35	0154.0	FST	COM+20 $\nu\cos^2\alpha$
	+30	0152.0	FCA	COM+16
7057	+07	0150.0	FMP	COM+14 $\rho\sin^2\alpha$
	+04	0154.0	FAD	COM+20
7060	+35	0154.0	FST	COM+18 $\nu\cos^2\alpha-\rho\sin^2\alpha$
	+30	0150.0	FCA	COM+14
7061	+07	0144.0	FMP	COM+10
	+05	0154.0	FDV	COM+20 $(\nu\cos^2\alpha-\rho\sin^2\alpha)$
7062	+35	0154.0	FST	COM+20 = ρ'_α
	+30	[0000.0]	Z3 FCA	[h_a]

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
7063	+40	0000.0	NOP	
	+05	0154.0	FDV	COM+20 h_a/ρ'_α
7064	+04	0146.0	FAD	COM+12 $+(h_a-h_m)2/\tilde{D}^2$
	+35	0146.0	FST	COM+12
7065	+30	[0000.0]	Z5 FCA	[ ]
	+40	0000.0	NOP	[h_m]
7066	+05	0154.0	FDV	COM+20
	+04	0146.0	FAD	COM+12
7067	+05	0556.0	FDV	TWØ
	+35	0146.0	FST	COM+12
7070	+30	0544.0	FCA	ONE $1-\frac{1}{2}[\ \ ]$
	+06	0146.0	FSB	COM+12
7071	+07	0142.0	FMP	COM+6
	+35	0142.0	FST	COM+6 = K
7072	+30	0142.0	FCA	COM+6
	+07	0142.0	FMP	COM+6 K^2
7073	+07	0142.0	FMP	COM+6
	+35	0144.0	FST	COM+10 = K^3
7074	+30	0564.0	FCA	(24)
	+07	0154.0	FMP	COM+20 $24\rho'$
7075	+07	0154.0	FMP	COM+20
	+35	0154.0	FST	COM+20 $24(\rho'_\alpha)^2$
7076	+30	0144.0	FCA	COM+10
	+05	0154.0	FDV	COM+20
7077	+04	0142.0	FAD	COM+6
	+35	0000.0	Z8 FST	[ ]
7100	+40	0000.0	SLR	
	+57	[0000.0]	E TRA	[ ]
1712	+72	0033.0	SLR	
	+57	7004.0	TRA	SUB.R
1713	+40	2116.0	PZE	L(D')
	+40	2040.0	PZE	L(h_m)
1714	+40	2042.0	PZE	L(h)
	+40	2066.0	PZE	L(ϕ^c_m)

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
1715	+40	2072.0	PZE	L(α')
	+40	2602.0	X13 PZE	L(Ans.) COM+22
1716	+00	1711.0	CLA	X12
	+01	0620.0	ADD	FOUR 4b38
1717	+60	1711.0	STO	X12
	+00	1715.0	CLA	X13
1720	+01	0620.0	ADD	FOUR 4b38
	+60	1715.0	STO	X13
1721	+00	0660.0	CLA	TWØ.3
	+03	0616.0	SUB	ØNE
1722	+50	1723.1	TZE	Reset
	+60	0660.0	STO	TWØ.3
1723	+57	3754.0	TRA	F1
	+00	0662.0	Reset CLA	K(X12)
1724	+60	1711.0	STO	X12
	+00	0663.0	CLA	K(X13)
1725	+60	1715.0	STO	X13
	+00	0661.0	CLA	K(TWØ.3)
1726	+60	0660.0	STO	TWØ.3
	+57	3756.0	NOP	
1727	+30	2014.0	A18 FCA	2014
	+07	2014.0	FMP	2014
1730	+35	0134.0	FST	COM c_1^2
	+30	2600.0	FCA	COM+20
1731	+04	2602.0	FAD	COM+22 $S_{ac}+S'_{ac}=b_1$
	+35	0154.0	FST	COM+20 = b_1
1732	+30	0154.0	FCA	COM+20
	+07	0154.0	FMP	COM+20
1733	+35	0156.0	FST	COM+22 b_1^2
	+30	2604.0	FCA	COM+24
1734	+04	2606.0	FAD	COM+26
	+35	0162.0	FST	COM+26 $S_{bc}+S'_{bc}=a_1$

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
1735	+30	0162.0	FCA	COM+26
	+07	0162.0	FMP	COM+26
1736	+35	0160.0	FST	COM+24 a_1^2
	+30	0154.0	FCA	COM+20
1737	+07	2014.0	FMP	2014
	+07	0556.0	FMP	(TWO) $2b_1c_1$
1740	+35	0136.0	FST	COM+2
	+30	0156.0	FCA	COM+22 b_1^2
1741	+04	0134.0	FAD	COM $+ c_1^2$
	+06	0160.0	FSB	COM+24 $- a_1^2$
1742	+05	0136.0	FDV	COM -2 $b_1^2-c_1^2-a_1^2/2b_1c_1$ /
	+40	0000.0	SLL	
1743	+57	1230.0	TRA	
	+40	0136.0	PZE	L(arc sin) COM+2
1744	+77	1727.0	HTR	A18
	+35	0136.0	FST	COM+2 Angle A
1745	+30	0556.0	A19 FCA	TWØ
	+07	0162.0	FMP	COM+26
1746	+07	2014.0	FMP	2014
	+35	0140.0	FST	COM+4 $2a_1 c_1$
1747	+30	0160.0	FCA	COM+24
	+04	0134.0	FAD	COM
1750	+06	0156.0	FSB	COM+22
	+05	0140.0	FDV	COM+4 $a_1^2 + c_1^2 - b_1^2/2a_1c_1$
1751	+57	1230.0	TRA	1230.0
	+40	0140.0	PZE	L(arc sin) COM+4
1752	+77	1745.0	HTR	A19
	+35	0140.0	FST	COM+4 Angle B
1753	+30	0556.0	A20 FCA	TWØ
	+07	0162.0	FMP	COM+26

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1754	+07	0154.0	FMP	COM+22 $2a_1b_1$
	+35	0142.0	FST	COM+6
1755	+30	0160.0	FCA	COM+24
	+04	0156.0	FAD	COM+22
1756	+06	0134.0	FSB	COM
	+40	0000.0	NOP	
1757	+05	0142.0	FDV	COM+6 $a_1^2+b_1^2-c_1^2/2a_1b_1$
	+40	0000.0	SLL	
1760	+57	1230.0	TRA	1230.0
	+40	0142.0	PZE	L(arcsine) COM+6
1761	+77	1753.0	HTR	A20
	+35	0142.0	FST	COM+6 Angle c
1762	+30	0142.0	A21 FCA	COM+6
	+40	0000.0	SLL	
1763	+57	1100.0	TRA	AH017 - 1100
	+40	0100.0	PZE	COM = Sin C
1764	+77	1762.0	HTR	A21
	+30	2064.0	A22 FCA	2064 ϕ_m
1765	+57	1100.0	TRA	AN017 - 1100
	+40	0146.0	PZE	COM+12 = Sin ϕ_m
1766	+77	1764.1	HTR	A22
	+30	0146.0	FCA	COM+12
1767	+07	0146.0	FMP	COM+12 $\sin^2 \phi_m$
	+07	0572.0	FMP	$\bar{e}^2$
1770	+35	0146.0	FST	COM+12 $\bar{e}^2\sin^2 \phi_m$
	+30	0544.0	FCA	ONE
1771	+06	0146.0	FSB	COM+12
	+35	0146.0	FST	COM+12 $1-\bar{e}^2\sin^2\phi_m$
1772	+30	0146.0	FCA	COM+12
	+07	0146.0	FMP	COM+12
1773	+35	0146.0	FST	COM+12 $(1-\bar{e}^2\sin^2\phi_m)^2$
	+57	2120.0	TRA	2120 Transfer around data input.

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
2120	+30	0570.0	FCA	$\bar{a}$
	+07	0570.0	FMP	$\bar{a} = \bar{a}^2$
2121	+07	0556.0	FMP	2
	+35	0144.0	FST	COM+10
2122	+30	0544.0	FCA	ONE
	+06	0572.0	FSB	$\bar{e}^2$
2123	+07	0144.0	FMP	COM+10
	+40	0000.0	ARS	
2124	+35	0144.0	FST	COM+10 $2\bar{a}^2(1-\bar{e}^2)$
	+30	0146.0	FCA	COM+12 Angle A
2125	+05	0144.0	FDV	COM+10 = M
	+07	0100.0	FMP	COM Sm C.M
2126	+07	0154.0	FMP	COM+20 $b_1 x$
	+07	0162.0	FMP	COM+26 $a_1 x = \epsilon$
2127	+04	0574.0	FAD	180° (180°
	+35	0150.0	FST	COM+14 $+ \epsilon$)
2130	+30	0136.0	FCA	COM+2 Angle A
	+04	0140.0	FAD	COM+4 Angle B
2131	+04	0142.0	FAD	COM+6 Angle C
	+06	0150.0	FSB	COM+14 $= \bar{E}$
2132	+05	0664.0	FDV	(THREE)
	+35	0134.0	FST	COM $= \bar{E}/_3$
2133	+30	0136.0	FCA	COM+2 $A + \bar{E}/_3$
	+04	0134.0	FAD	COM
2134	+35	0136.0	FST	COM+2 $A' = A + \bar{E}/_3$
	+40	0000.0	NOP	
2135	+30	0140.0	FCA	COM+4
	+04	0134.0	FAD	COM
2136	+35	0140.0	FST	COM+4 B'
	+30	0142.0	FCA	COM+6
2137	+04	0134.0	FAD	COM
	+35	0142.0	FST	COM+6 C'

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
2140	+57	3737.0	TRA	PATCH
	+40	0000.0	ARS	COM+2
2141	+35	2600.0	FST	2600 = α_{AC}
	+30	2036.0	FCA	2036
2142	+04	0140.0	FAD	COM+4
	+35	2602.0	FST	2602 = α_{BC}
2143	+57	1003.1	TRA	PATCH 2
	+72	0037.0	A24A TYC	Type ltrs.
2144	+72	0003.0	TYC	A
	+72	0016.0	TYC	C
2145	+57	0244.0	A24 TRA	
	+40	2604.0	PZE	(COM+20) L(b_1)
2146	+00	2005.0	CLA	
	-31	0201.1		
2147	+77	2145.0	HTR	A24
	+72	0037.0	TYC	Type ltrs.
2150	+40	0000.0	NOP	
	+72	0037.0	TYC	
2151	+72	0003.0	TYC	A
	+72	0021.0	TYC	Z
2152	+72	0004.0	TYC	Space
	+72	0003.0	TYC	A
2153	+72	0016.0	TYC	C
	+57	1012.0	TRA	Rad. to Deg., Min., Sec. (& print)
2154	+57	2700.0	TRA	FB010
	+40	2600.0	PZE	L(Y) Rad.
2155	+57	1016.0	TYC	B
	+72	0016.0	TYC	C
2156	+57	0244.0	A25 TRA	
	+40	2606.0	PZE	COM+26 = a_1

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
2157	+00	2005.0	CLA	
	-31	0201.1		Operation code
2160	+77	2156.0	HTR	A25
	+72	0037.0	TYC	
2161	+72	0003.0	TYC	A
	+72	0021.0	TYC	Z
2162	+72	0004.0	TYC	Space
	+72	0031.0	TYC	B
2163	+72	0016.0	TYC	C
	+57	1020.0	SLL	
2164	+57	2700.0	TRA	FB010 Rad. to Deg.,Min, Sec.
	+40	2602.0	PZE	L(Y) Rad.
2165	+72	0010.0	TYC	CR
	+40	0000.0	SLL	
2166	+57	4600.0	TRA	FB023
	+40	0556.0	PZE	L(FLAG) Floating Pt.2
2167	+40	2024.0	PZE	L(ϕ_a)
	+40	2030.0	PZE	L(a)
2170	+40	2024.0	PZE	L(ϕ_a)
	+40	2030.0	PZE	L(λ_a)
2171	+40	0604.0	PZE	L(a) Semi Major Axis
	+40	0606.0	PZE	L(b) Semi Minor Axis
2172	+40	2600.0	PZE	L($\alpha_{a\phi}$)
	+40	0612.0	PZE	L(e'^2) Minor Ecc. Sq.
2173	+40	2604.0	PZE	L(S) b_1
	+40	0610.0	PZE	L(e^2) *Major Ecc. Sq.*
2174	+40	2610.0	PZE	L(B_2) ϕ_c from A
	+40	2612.0	PZE	L(L_2) 2612 = λ_c from A
2175	+72	0037.0	TYC	Type Ltrs.
	+72	0003.0	TYC	A
2176	+72	0016.0	TYC	C
	+72	0004.0	TYC	Space

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
2177	+72	0004.0	TYC	SPACE
	+40	0000.0	SLL	
2200	+57	2700.0	TRA	FB010 Rad. to Deg. min., Sec. & Print
	+40	2610.0	PZE	L(Y) = 2610 - ϕ_c
2201	+72	0037.0	TYC	Type ltrs.
	+72	0014.0	TYC	N
2202	+72	0004.0	TYC	Space
	+72	0004.0	TYC	Space
2203	+57	2700.0	TRA	FB 010 Rad. to De[illegible]., Min. Sec.
	+40	2612.0	PZE	L(Y) = λ_c
2204	+72	0037.0	TYC	Type ltrs.
	+72	0023.0	TYC	W
2205	+72	0010.0	TYC	Carriage Return
	+40	0000.0	SLL	
2206	+57	4600.0	TRA	FB 023
	+40	0556.0	PZE	L(FLAG) F.P. two
2207	+40	2026.0	PZE	L(ϕ_B)
	+40	2032.0	PZE	L(λ_B)
2210	+40	2026 0	PZE	L(ϕ_B)
	+40	2032.0	PZE	L(λ_B)
2211	+40	0604.0	PZE	L(a) Semi Major Axis
	+40	0606.0	PZE	L(b) Semi Minor Axis
2212	+40	2602.0	PZE	L(α_{BC})
	+40	0612.0	PZE	L(e'^2) Minor Ecc. Sq.
2213	+40	2606.0	PZE	L(S) = a_1
	+40	0610.0	PZE	L(e^2) Major Ecc. Sq.
2214	+40	2614.0	PZE	L(B_2) = ϕ_c from B
	+40	2616.0	PZE	L(L_2) = λ_c from B
2215	+72	0037.0	TYC	Type ltrs.
	+72	0031.0	TYC	B

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
2216	+72	0016.0	TYC	C
	+72	0004.0	TYC	Space
2217	+72	0004.0	TYC	Space
	+40	0000.0	SLL	
2220	+57	2700.0	TRA	FB010 Rad. to Deg., Min., Sec. & Print
	+40	2614.0	PZE	L(Y) = $\emptyset_c$ from B
2221	+72	0037.0	TYC	+72 0037 Type ltrs.
	+72	0014.0	TYC	N
2222	+72	0004.0	TYC	Space
	+72	0004.0	TYC	Space
2223	+57	2700.0	TRA	FB010 Rad. to Deg., Min., & Sec.
	+40	2616.0	PZE	L(Y) =λ_c from B
2224	+72	0037.0	TYC	Type ltrs.
	+72	0023.0	TYC	W
2225	+72	0010.0	TYC	Carriage Return
	-77	0000.0	HTR	
2226	+72	0033.0	TYC	Type Fig. Deg., Min., Sec.
	+40	0000.0	SLL	
2227	+57	6715.0	TRA	
	+40	[2620].0	TZE	[2620] Given $\emptyset$ of Vertex
2230	+72	0033.0	TYC	Fig
	+40	0000.0	SLL	
2231	+57	6715.0	TRA	
	+40	2622.0	PZE	Given λ of Vertex
2232	+30	2620.0	FCA	$\emptyset_G$ Given
	+06	2610.0	FSB	$\emptyset_G$ Computed
2233	+07	0701.0	FMP	$\Delta\emptyset$ X 30 m
	+57	2274.0	TRA	2624 ΔN_{RG}
2234	+30	2622.0	FCA	2622 λ_G Given
	+06	2612.0	FSB	2612 $-\lambda_G$ Computed

LOCATION	COMMAND OPERATION CODE	ADDRESS		ALPHEBETIC CODE	REMARKS
2235	+07	0703.0		FMP	0703.0
	+57	2276.0		TRA	2626 $\Delta E_{R \to G}$
2236	+30	2620.0		FCA	2620 ϕ_G Given
	+06	2614.0		FSB	2614 $\phi_{C \to G}$ Computed
2237	+07	0701.0		FMP	0701.1
	+57	2300.0		TRA	2630 ΔN From Clarke Ellipsoid
2240	+30	2622.0		FCA	2622 λ_G Given
	+06	2616.0		FSB	2616 $-\lambda_{C \to G}$ Computed
2241	+07	0703.0		FMP	0703.0
	+57	2302.0		TRA	2632 ΔE From Clarke Ellipsoid
2242	+72	0037.0		TYC	Letters DN AC DE AC
	+72	0003.0		TYC	A
2243	+72	0016.0		TYC	C
	+72	0004.0		TYC	Space
2244	+72	0011.0		TYC	D
	+72	0014.0		TYC	N
2245	+72	0004.0		TYS	Space
	+40	0000.0		SLL	
2246	+57	0244.0	A	TRA	
	+40	[2624]		PZE	[2624] ΔN
2247	+00	2215.0		OCTAL	
	-21	0221.0		CODE	Type CR
2250	+77	2246.0		HTR	A
	+72	0037.0		TYC	Ltrs.
2251	+72	0003.0		TYC	AC
	+72	0016.0		TYC	C
2252	+72	0004.0		TYC	Space
	+72	0011.0		TYC	D
2253	+72	0001.0		TYC	E
	+72	0004.0		TYS	Space
2254	+57	0244.0	B	TRA	0244
	+40	[2626].0		PZE	[2626]

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
2255	+00	2215.0	OCTAL	
	-21	0221.0	CODE	Type CR
2256	-77	2254.0	HTR	B
	+72	0037.0	TYC	Ltrs.
2257	+72	0031.0	TYC	B
	+72	0016.0	TYC	C
2260	+72	0004.0	TYC	Space
	+72	0011.0	TYC	D
2261	+72	0014.0	TYC	N
	+72	0004.0	TYC	Space
2262	+57	0244.0	C TRA	0244
	+40	[2630].0	PZE	[2630]
2263	+00	2215.0	OCTAL	
	-21	0221.0	CODE	CR
2264	+77	2262.0	HTR	C
	+72	0037.0	TYC	Ltrs.
2265	+72	0031.0	TYC	B
	+72	0016.0	TYC	C
2266	+72	0004.0	TYC	Space
	+72	0011.0	TYC	D
2267	+72	0001.0	TYC	E
	+72	0004.0	TYC	Space
2270	+57	0244.0	D TRA	0244
	+40	[2632.0]	PZE	[2632]
2271	+00	2215.0	OCTAL	
	-21	0221.0	CODE	
2272	+77	2270.0	HTR	D
	+40	0000.0	NOP	
2273	+77	0001.0	HTR	0001
	+40	0000.0	NOP	
2274	+05	0602.0	FDV	
	+35	2624.0	FST	

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
2275	+57	2234.0	TRA	
	+40	0000.0	ARS	
2276	+05	0602.0	FDV	
	+35	2626.0	FST	
2277	+57	2236.0	TRA	
	+40	0000.0	ARS	
2300	+05	0602.0	FDV	
	+35	2630.0	FST	
2301	+57	2240.0	TRA	
	+40	0000.0	ARS	
2302	+05	0602.0	FDV	
	+35	2632.0	FST	
2303	+57	2242.0	TRA	
	+40	0000.0	ARS	

PATCHWORK FROM LOC. 0750 to 1025

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
0750	+30	2060.0	FCA	2060 D From graph
	+07	(0666.0)	FMP	1.000325
0751	+05	2104.0	FDV	n (2104)
	+35	2114.0	FST	
0752	+30	2102.0	FCA	2102 = S_m
	+06	2114.0	FSB	2114 -D
0753	+05	2106.0	FDV	n^1 (2106)
	+57	1000.0	TRA	PATCH
0754	+72	0037.0	TYC	LTRS
	+72	0011.0	TYC	D
0755	+57	0244.0	TRA	0244
	+40	2114.0	PZE	(2114) L (D)
0756	+00	0201.1		
	-31	0755.0		
0757	+77	0755.0	HTR	
	+57	1002.0	TRA	
0760	+72	0033.0	TYC	FIG
	+72	0027.0	TYC	1
0761	+57	0244.0	TRA	0244
	+40	2116.0	PZE	(2116) L (D')
0762	+00	2005.0		
	-31	0220.1		
0763	+77	0761.0	HTR	
	+57	1706.1	TRA	
0764	+35	2604.0	FST	2604
	+30	0162.0	FCA	COM+26= a_1
0765	+35	2606.0	FST	2606
	+57	2143.1	TRA	A24A
0766	+60	1354.0	STO	B1
	+57	1350.1	TRA	A1
0767	+60	1363.0	STO	E.O
	+57	1363.0	TRA	E.O

PATCHWORK CON'T

LOCATION	COMMAND OPERATION CODE	COMMAND ADDRESS	ALPHEBETIC CODE	REMARKS
0770	-60	1405.0	STO	B.0
	-57	1401.0	TRA	START
0771	-60	1525.0	STO	G4
	-57	1521.0	TRA	G3
0772	-60	1534.0	STO	G7
	-57	1533.1	TRA	G6
0773	-00	0631.0	CLA	K2 Reset L(R.1)
	-60	1405.0	STO	B.0
0774	-57	1413.0	TRA	
	-40	0000.0	NOP	
0775	-30	0134.0	FCA	COM
	-07	0100.0	FMP	SUM
0776	-04	0110.0	FAD	SUM-10
	-35	0110.0	FST	SUM-10
0777	-57	1432.0	TRA	
	-40	0000.0	NOP	
1000	-07	0666.0	FMP	1.000325
	-35	2116.0	FST	2116
1001	-57	0754.0	TRA	0754.0
	-40	0000.0	NOP	
1002	-72	0037.0	TYC	Ltrs
	-72	0011.0	TYC	D
1003	-57	0760.0	TRA	
	-30	0154.0	FCA	
1004	-57	0764.0	TRA	-180
	-40	0000.0	NOP	
1005	-35	0156.0	FST	COM-22
	-06	0574.0	FST	
1006	-51	1007.1	TMI	
	-06	0574.0	FST	θ -180
1007	-35	0156.0	FST	COM-22
	-30	0156.0	FCA	COM-22

PATCHWORK CON'T

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
1010	-57	7037.0	TRA	Q
	-40	0000.0	NOP	
1012	-72	0004.0	TYC	Space
	-30	2600.0	TPL	2154.0
1013	-52	2154.0	FAD	
	-04	0574.0	FAD	
1014	-04	0574.0	FST	
	-35	2600.0	FST	
1015	-57	2154.0	TRA	
	-40	0000.0	NOP	
1016	-72	0010.0	TYC	CR
	-57	1024.0	TRA	
1017	-57	2155.1	TRA	
	-40	0000.0	NOP	
1020	-72	0004.0	TYC	Space
	-30	2602.0	FCA	
1021	-52	2164.0	TPL	
	-04	0574.0	FAD	
1022	-04	0574.0	FAD	
	-35	2602.0	FST	
1023	-57	2164.0	TRA	
	-40	0000.0	NOP	
1024	-72	0037.0	TYC	Ltrs.
	-72	0031.0	TYC	B
1025	-57	1017.0	TRA	
	-40	0000.0		
3730	-72	0033.0	TYC	figs.
	-30	0670.0	FCA	-1
3731	-35	0672.0	FST	CONST 1
	-35	0674.0	FST	CONST 2
3732	-00	0676.0	CLA	
	-71	7761.0	RDY - or -	

PATCHWORK CON'T

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
3733	-03	0677.0		
	-50	3735.1	TZE	
3734	-34	0672.0	FCS	CONST 1 - Float 2
	-35	0672.0	FST	CONST 1
3735	-57	3753.0	TRA	
	-34	0674.0	FCS	CONST 2 - Float 1
3736	-35	0674.0	FST	CONST 2
	-57	3753.0	TRA	
3737	-30	0136.0	FCA	A'
	-07	0674.0	FMP	CONST 2
3740	-35	0136.0	FST	A'
	-30	0140.0	FCA	Angle B'
3741	-07	0672.0	FMP	CONST 1
	-35	0140.0	FST	Angle B'
3742	-30	2034.0	FCA	AB
	-04	0136.0	FAD	A'
3743	-51	3744.1	TMI	
	-35	2600.0	FST	AC
3744	-57	3746.0	TRA	Out
	-04	0574.0	FAD	
3745	-04	0574.0	FAD	
	-35	2600.0	FST	AC
3746	-30	2036.0	FCA	BA
	-04	0140.0	FAD	B'
3747	-51	3750.1	TMI	
	-35	2602.0	FST	
3750	-57	2143.0	TRA	Out 1
	-04	0574.0	FAD	
3751	-04	0574.0	FAD	
	-35	2602.0	FST	2602
3752	-57	2143.0	TRA	2143.0
	-40	0000.0	NOP	

PATCHWORK CON'T

LOCATION	COMMAND OPERATION CODE	ADDRESS	ALPHEBETIC CODE	REMARKS
3753	-72	0010.0	TYC	CR
	-57	1350.0	TRA	1350
3754	-00	1707.0	CLA	X12A
	-01	0625.0	ADD	$TWO.b_{38}$
3755	-60	1707.0	STØ	X12A
	-57	1371.1	TRA	F'l (compute line BC)
3756	-00	0700.0	CLA	K(X12A)
	-60	1707.0	STO	X12A
3757	-57	1727.0	TRA	1727.0
	-40	0000.0	NOP	

CONSTANTS

0500	-44	0000.0	288
	-00	0000.0	
0501	-00	0000.0	
	-00	0004.1	
0502	-40	3413.1	
	-14	7700.0	0.00198
0503	-00	0000.0	
	-00	0004.0	
0504	-52	0304.1	
	-33	5136.0	5.256
0505	-00	0000.0	
	-00	0001.1	
0506	-73	6570.1	
	-24	7737.0	
			P_o=29$_D$921
0507	-00	0000.0	
	-00	0002.1	
0510	-60	0647.1	
	-37	7311.1	0.000367
0511	-00	0000.0	
	-00	0005.1	
0512	-40	0000.0	
	-00	0000.0	32
0513	-00	0000.0	
	-00	0003.0	
0514	-61	0600.0	
	-00	0000.0	1571
0515	-00	0000.0	
	-00	0005.1	
0516	-50	1400.0	
	-00	0000.0	θ = 643
0517	-00	0000.0	
	-00	0005.0	

CONSTANTS

0520	-51	4423.0	
	-00	2352.1	log = 5.5 1959
0521	-00	0000.0	
	-00	0001.1	
0522	-42	1000.0	
	-00	0000.0	273
0523	-00	0000.0	
	-00	0004.1	
0524	-70	5000.0	
	-00	0000.0	453
0525	-00	0000.0	
	-00	0004.1	
0526	-50	0000.0	
	-00	0000.0	10
0527	-00	0000.0	
	-00	0002.0	
0530	-62	2666.1	
	-24	3702.0	a = 3.1473172
0531	-00	0000.0	
	-00	0001.0	
0532	-60	3714.1	
	-50	0355.0	b = 0.00295944
0533	-00	0000.0	
	-00	0004.0	
0534	-66	7377.1	
	-67	3607.0	R = 0.000491398
0535	-00	0000.0	
	-00	0005.1	
0536	-61	0762.0	
	-05	4163.1	d = 0.000 000 182 992
0537	-00	0000.0	
	-00	0013.0	

CONSTANTS

0540	-54	2034.0	
	-73	3220.1	e = 0.000 000 082 435
0541	-00	0000.0	
	-00	0013.1	
0542	-62	6315.0	
	-65	5205.1	25.40005
0543	-00	0000.0	
	-00	0002.1	
0544	-40	0000.0	
	-00	0000.0	
0545	-00	0000.0	
	-00	0000.1	
0546	-75	0220.0	
	-00	0000.0	10^6 = 1,000,000
0547	-00	0000.0	
	-00	0012.0	
0550	-44	7500.0	
	-00	0000.0	4730
0551	-00	0000.0	
	-00	0006.1	
0352	-71	3400.0	
	-00	0000.0	459.5
0553	-00	0000.0	
	-00	0004.1	
0554	-41	6440.0	
	-00	0000.0	8658
0555	-00	0000.0	
	-00	0007.0	
0556	-40	0000.0	
	-00	0000.0	2
0557	-00	0000.0	
	-00	0001.0	

CONSTANTS

0560	-44 -00	4610.1 0000.0	V = 299793
0561	-00 -00	0000.0 0011.1	
0562	-40 -00	0000.0 0000.0	4
0563	-00 -00	0000.0 0001.1	
0564	-60 -00	0000.0 0000.0	24
0565	-00 -00	0000.0 0002.1	
0566	-72 -66	2500.0 3146.1	3822,599.4 = r
0567	-00 -00	0000.0 0013.0	
0570	-60 -60	5226.1 0000.0	$\bar{a}$ = 6,378,206
0571	-00 -00	0000.0 0013.1	
0572	-67 -71	3456.0 3756.0	$\bar{e}^2$ = 0.006 768 658
0573	-00 -00	0000.0 0003.1	
0574	-62 -52	2077.0 4244.1	180° = to 8 decimal places
0575	-00 -00	0000.0 0001.0	
0576	-44 -67	6566.0 3553.0	Base 10 to Base e = 2.3025850930
0577	-00 -00	0000.0 0001.0	
0600	-00 -00	0000.0 0000.0	

CONSTANTS

0601	-00	0000.0	ZERO
	-00	0000.0	
0602	-50	5263.0	
	-62	4513.1	Sin 1" to 10 decimal places
0603	-00	0000.0	
	-00	0010.1	
0604	-60	5226.1	
	-63	1463.0	
			a = 6,378,206.4 Semi major axis
0605	-00	0000.0	
	-00	0013.1	
0606	-60	3763.0	b = 6,356,583.8 Semi minor axis
	-76	3146.1	
0607	-00	0000.0	
	-00	0013.1	
0610	-67	3456.0	
	-71	3616.1	e^2 = 0.006 768 6580
0611	-00	0000.0	
	-00	0003.1	
0612	-67	6472.0	e'^2 = 0.006814 7849
	-74	4313.0	
0613	-00	0000.0	
	-00	0003.1	
0614	-00	0000.0	
	-00	0016.1	Binary Scale of 29 ($b29_{10}$ = $b35_8$ Use this for all input
0615	-00	0000.0	
	-00	0000.1	1 at a binary scale of 39
0616	-00	0000.0	
	-00	0001.0	1 at a binary scale of 38
0617	-00	0000.0	
	-00	0004.0	Variable 4 @b38
0620	-00	0000.0	
	-00	0004.0	Reset 5 @ b38
0621	-00	0000.0	
	-00	0006.0	Variable 7 @ b38

CONSTANTS

0622	-00	0000.0	
	-00	0006.0	Reset 6 @b38
0623	-00	0002.0	
	-00	0000.0	Stepping 2 @b18
0624	-35	2014.0	
	-00	0617.0	K(B1) Reset Command at Loc. B1
0625	-00	0000.0	
	-00	0002.0	Stepping by 2 @b38
0626	-57	6715.0	
	-40	2024.0	K(E.1) Reset Command at Loc E.0 & E.1
0627	-00	0000.0	
	-00	0003.0	Variable 3 @b38
0630	-00	0000.0	
	-00	0003.0	Reset @ b38
0631	-45	0000.0	
	-35	2000.0	K(1B.0 & 1B.1) Reset Command at Loc 1B.1
0632	-00	0000.0	
	-00	0011.0	Variable 9 @ b38
0633	-00	0000.0	
	-00	0011.0	Reset 9 @b38
0634	-35	2040.0	
	-00	0632.0	K(G4.0) Reset Command at Loc. G4. or G4.1
0635	-57	6715.0	
	-40	2064.0	K(G7.1) Reset Command at Loc. G.7. or G7.1
0636	-50	0000.0	
	-00	0000.0	5
0637	-00	0000.0	
	-00	0001.1	

CONSTANTS

0640	-44	0000.0	
	-00	0000.0	9
0641	-00	0000.0	
	-00	0002.0	
0642	-00	0000.0	
	-00	0002.0	Variable 2 @b38
0643	-00	0000.0	
	-00	0002.0	Reset 2 @b38
0644	-07	2054.0	
	-35	0134.0	K(X1.0) Reset Command at Loc X1.0 &11
0645	-35	2110.0	
	-30	2050.0	K(X2.0) " X2.0 & X2.1
0646	-35	0134.0	
	-30	2044.0	K(X3.0) " X3.0 & .1
0647	-06	2050.0	K(X4.0) " X4.0 & .1
	-07	0134.0	
0650	-35	0134.0	K(X5.0) " X5.0 & .1
	-30	2050.0	
0651	-04	2044.0	K(X6.0) " X6.0 & .1
	-35	0134.0	
0652	-04	0544.0	K(X7.0) " X7.0 & .1
	-35	2104.0	
0653	-07	2060.0	K(X8.0) " X8.0
	-05	2104.0	
0654	-04	2022.0	K(X9.0) " X9.0
	-35	2114.0	
0655	-00	0002.0	Stepping 2 @ b18 & b38
	-00	0002.0	
0656	-57	0244.0	K(X10.0) Reset Command at Loc. X10. or .1
	-40	2104.0	
0657	-57	0244.0	K(X11) " Loc X11
	-40	2106.0	
0660	-00	0000.0	Variable 2 TWO.3 for Big Loop @b38
	-00	0002.0	

CONSTANT

0661	-00	0000.0	
	-00	0002.0	Reset 2 for Big Loop @ b38
0662	-40	2070.0	
	-40	2600.0	K(X12) Reset Command at Loc X12
0663	-40	2072.0	
	-40	2602.0	K(X13) " X13
0664	-60	0000.0	
	-00	0000.0	3
0665	-00	0000.0	
	-00	0001.0	
0666	-40	0052.1	
	-31	1414.0	1.000325 Index of Refraction constant for the Union of South Africa
0667	-00	0000.0	
	-00	0000.1	
0670	-40	0000.0	
	-00	0000.0	FP. 1 for configuration
0671	-00	0000.0	
	-00	0000.1	
0672	-00	0000.0	
	-00	0000.0	CONST 1
0673	-00	0000.0	
	-00	0000.0	
0674	-00	0000.0	
	-00	0000.0	CONST 2
0675	-00	0000.0	
	-00	0000.0	
0676	-02	0000.0	
	-00	0000.0	Fixed 2
0677	-00	0000.0	
	-00	0010.1	Code Word
0700	-40	2114.0	
	-40	2016.0	

CONSTANTS

0701	-75	5217.0
	-34	1217.1
0702	-00	0000.0
	-00	0002.1
0703	-60	3024.0
	-72	7024.1
0704	-00	0000.1
	-00	0002.1