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NRL Report 5198

PROJECT VANGUARD REPORT NO. 32
MINITRACK REPORT NO. 5

MINITRACK DATA FOR THE ARTIFICIAL EARTH SATELLITES 1958 ALPHA AND 1958 BETA FROM 7 MAY 1958 TO 20 MAY 1958

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ERRATA SHEET
for
NRL Report 5198
(Project Vanguard Report No. 32)

Equation (4) on page 6 of subject report is in error. Please cut out the corrected Equation below, moisten and paste in the report, covering the erroneous equation.

$$b_c = C_o + C_1 a_o + C_2 b_o + C_3 a_o b_o + C_4 a_o^2$$

$$+ C_5 b_o^2 + C_6 b_o^3 + C_7 \sin "b_o" + C_8 \cos "b_o";$$

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ABSTRACT

The information necessary to permit satellite orbit computations from raw Minitrack data is given, and the Minitrack data on the satellites 1958 Alpha and 1958 Beta for the period 7 through 20 May 1958 are presented in appendixes. It is intended that the use of these data will encourage and facilitate the development of new computation techniques.

The basic Minitrack measurement and the data message itself are described, and a discussion is made of the handling and preparation of the data message for the Vanguard IBM 704 computer. The outputs of the computer are also briefly discussed. Residual data from the 704 computer's differential correction program, and meridian crossing times and elevation angles from the Burroughs E101 computer are given for each data message.

Two correction formulas are given for adjusting the raw data. One of these corrects for overall station factors only and may be used alone if an error of about 1 percent is tolerable; the other corrects for the 1 percent error introduced by antenna pattern distortion and system cross-talk. Station constants and other information required or useful in these calculations are included in the appendixes.

PROBLEM STATUS

This is a preliminary report on one phase of the problem; work is continuing.

AUTHORIZATION

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INTRODUCTION

The Minitrack system was developed as a part of Project Vanguard at the Naval Research Laboratory to provide acquisition and tracking of artificial earth satellites by radio techniques. In this system, a subminiature radio transmitter within the satellite illuminates the antennas at ground tracking stations. By phase-comparison techniques, these stations measure the angular position of the satellite as it passes through the antenna beam, recording its presence automatically without need for prior tracking. Analysis of these recordings provides the complete angular history of the satellite passage in the form of direction cosines and time coordinates. These data are quickly transmitted to a central computing facility for the computation and publication of ephemerides.

Orbit computation is a complex process that is made more so by the short periods of artificial satellites. With the advent of actual orbiting satellites this problem has become the subject of widespread interest. One result of this interest has been a desire that actual Minitrack satellite data be made available. This report is intended to meet that desire, as well as to encourage and facilitate the development of new techniques of orbit computation.

The Minitrack system will be discussed here only to the extent necessary to explain the nature and use of the data. The more general aspects of the Minitrack system have been discussed elsewhere,* and technical details have been covered in previous Project Vanguard Minitrack reports.†

The actual Minitrack data on the satellites 1958 Alpha and 1958 Beta are presented in Appendixes A and B. Data on the individual Minitrack stations is given in Appendix C, and other useful information will be found in subsequent appendixes.

BASIC MEASUREMENT OF THE MINITRACK SYSTEM

The satellite S radiates a 108-Mc signal which is received at two ground station antennas A_1 and A_2 (Fig. 1). Since the distance to the satellite is very large compared to the distance A_1A_2, it can be assumed that the signal wave front is the straight line A_1P; therefore the direction cosine of the satellite position is

$$\cos \alpha = \frac{a}{A_1A_2},$$

*Mengel, J.T., "Tracking the Earth Satellite, and Data Transmission, by Radio," Proc. I.R.E. 44(No. 6):755-760, June 1956

†See inside front cover

where a is the measured element in wavelengths and A_1A_2 is the distance between the antennas in wavelengths. The information from two pairs of antennas, one in the north-south and one in the east-west direction, will give the two direction cosines of the satellite. Other pairs of antennas at the Minitrack stations furnish the information necessary to resolve the east-west and north-south ambiguity. Additional information from other Minitrack stations is necessary to fully complement the above data in order to define completely the satellite's orbital position.

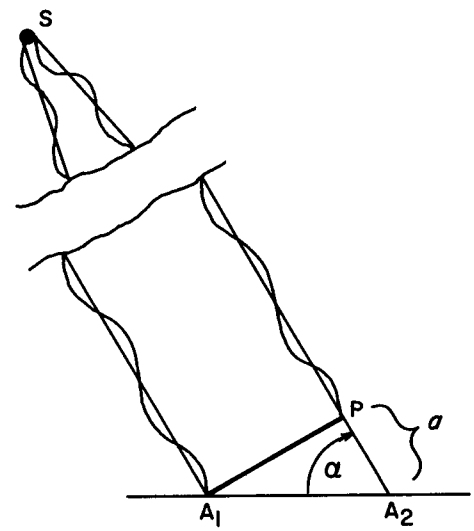

Fig. 1 - Basic geometry of Minitrack phase-measurement angle tracking system

THE MINITRACK DATA MESSAGE

Sample Message

The following is a typical Minitrack data message spaced and annotated for illustrative purposes.

Satellite Designation	1958 Beta		
Station	AGASTA	a b c 580609	Date: (a) Year (b) Month (c) Day
Time of first reading: (d) Hr (e) Min (f) Sec	d e f 222542	d e f 222552	Time of last reading: (d) Hr (e) Min (f) Sec
Internal electronic pre-calibration: (g) EW (h) NS	g h 153349	g h 153349	Internal electronic post-calibration: (g) EW (h) NS
Signal Level (j) EW (k) NS in dbm:	j k 125130	l m 666005	(l) Quality of signal (m) Satellite designation
East-West Minitrack phase readings: (n) Lobe (o) Fraction of a lobe	n o 048550	n o 056450	North-South Minitrack phase readings: (n) Lobe (o) Fraction of a lobe
	048830	056260	
	049090	056060	
	049360	055880	
	049650	055680	
	049890	055490	
	050170	055310	
	050440	055120	
	050720	054930	
	//////	//////	
	051260	054550	
Repetition of start time	d e f 222542	d e f 222552	Repetition of finish time.

Slant symbols indicate that part of all of a data point was not readable.

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Interpretation of the Message

The entire Minitrack data message is made up of six-digit "words" forming two vertical columns. The first part of the message presents general information concerning the particular satellite, the station designation, the date, and calibration information; while the latter part of the message is the actual Minitrack data.

Line one gives the station designation and the date. The first two digits of the date give the year, the middle two the month, and the last two the day of the month. The satellite designation is given above this line.

Line two gives the times of the first and last Minitrack reading in the observation being reported, and these start and finish times are repeated on the last line of the message format for checking purposes. In all time readings the first two digits give hours in the 24-hour system (Greenwich mean solar time), the middle two give minutes, and the last two give seconds. All Minitrack readings are taken at one-second intervals. Time is measured at all Minitrack stations to an accuracy of ± 1 millisecond.

Line three contains the pre-passage and post-passage internal electronic calibration data in the left and right columns respectively. The first three digits give the calibration figures for the east-west readings in thousandths of a wavelength while the last three digits give the same information for north-south readings. The pre-passage and post-passage calibration figures should agree, and if they do not the system has shifted during the satellite passage. In that event the mean of the two values will be taken as the calibration figure.

The left-hand word of the fourth line gives the maximum signal level of the main lobe in dbm. The first three digits give the reading for the east-west lobe and the last three for the north-south lobe. The first three digits of the right-hand word give the quality of the data as determined by Minitrack station personnel, ranging from 444 for very poor to 999 for excellent, and the last three digits designate the particular satellite "shoot;" a listing of the satellite shoots will be found on page 4. Examples are 666003 meaning poor data for 1958 Alpha, and 999005 meaning excellent data for 1958 Beta. There are some data messages which do not contain the three-digit satellite designator.

The fifth line through the next-to-last line list the actual Minitrack data. The left-hand word of the fifth line gives the phase reading of the east-west fine antennas at the start time, while the right-hand word gives the reading of the north-south fine antennas. The sixth line gives the same information for a time one second after the start time. The data continue in this manner until the next-to-last line which gives the east-west and north-south fine phase readings for the finish time. In each word the first three digits give the whole-cycle phase reading while the last three give the fraction of a wavelength in thousandths. The first east-west fine zero phase reading west of zenith is labelled EW 050.000 and the first north-south fine zero phase reading south of zenith is labelled NS 050.000. The east-west zero phase readings or lobes increase from EW 050.000 going east and the north-south lobes increase from NS 050.000 going north.

From the sample Minitrack message shown, it can easily be seen that the satellite is going from northwest to southeast, since the east-west phase readings are increasing and the north-south phase readings decreasing with time. The approximate time when the satellite crossed the station's meridian can be found by observing when the east-west phase reading is 050.000, then counting the number of seconds after the start time and adding this time to the start time. By observing the phase-difference readings from second to second, the rates of change of the phase differences can be determined for both east-west and north-south signals.

It is apparent from Fig. 1 that

$$a = A_1 A_2 \cos \alpha.$$

In the Minitrack system, A_1A_2 = 54.902 wavelengths at 108 Mc. The value of a when the satellite moves one degree of arc near zenith is obtained by setting α = 1 degree. Thus

$$a = 54.902 \times 0.01745 = 0.96 \text{ wavelengths.} \tag{1}$$

From this information the "space rate" or angular velocity of the satellite can be determined in both the east-west and north-south planes. For convenience, a table is given in Appendix D which converts degrees of arc from zenith into lobe numbers from 050.000.

The abbreviations used in Minitrack messages to identify the reporting stations are as follows:

No.	Station	Abbreviation
1.	Blossom Point	BPOINT
2.	Fort Stewart	FTSTEW
3.	Havana	HAVANA
4.	Woomera	OOMERA
5.	Quito	QUITOE
6.	Lima	LIMAPU
7.	Antofagasta	AGASTA
8.	Santiago	SNTAGO
9.	Antigua	PANTIG
10.	San Diego	NELCAL
11.	Esselen Park	JOBURG

Any satellite which provides data for the downrange stations is assigned a satellite "shoot" number whether or not it actually goes into orbit. If the satellite goes into an orbit it is assigned a greek letter in addition to the satellite shoot number.

Satellite	Greek Letter Designation	Shoot Number	Launch Date
Sputnik I	1957 Alpha	001	4 Oct. 1957
Sputnik II	1957 Beta	002	3 Nov. 1957
Explorer I	1958 Alpha	003	1 Feb. 1958
Explorer II	—	004	5 Mar. 1958
Vanguard TV-4	1958 Beta	005	17 Mar. 1958
Explorer III	1958 Gamma	006	26 Mar. 1958
Vanguard TV-5	—	007	28 Apr. 1958
Sputnik III	1958 Delta	008	15 May 1958
Vanguard SLV-1	—	009	28 May 1958
Vanguard SLV-2	—	010	25 Jun. 1958
Explorer IV	1958 Epsilon	011	26 Jul. 1958

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Handling of the Message

Just prior to a satellite passage, station personnel perform an internal calibration which determines the internal electronic phase shift of the system at that time. After signal is lost another such calibration is made to detect any change in the phase shift of the system while the satellite passage was being recorded. After the pre-passage and post-passage calibration figures are noted, the data are studied for determination of meridian crossing time. The phase readings for the east-west and north-south directions are recorded at one-second intervals using the meridian crossing time as approximate center. All these data are sent from the particular tracking station to the Naval Research Laboratory via teletype for review, then forwarded to the Vanguard IBM 704 Computer for orbital computation. With the aid of the supplemental data messages which are sent to NRL with the basic Minitrack data messages, and knowing the calibration numbers for the Minitrack stations, the data reduction group checks the accuracy of the east-west and north-south data for possible ambiguity error as well as for any errors in the teletype communications.

ADJUSTING MINITRACK DATA FOR ORBITAL COMPUTATION

The raw Minitrack data (a_r, the phase reading in the east-west direction and b_r, in the north-south direction) must be corrected for certain factors before the computer can arrive at a solution to the basic equation $\cos \alpha = a/A_1A_2$, and these corrections must be ascertained for each station.

To obtain these corrections the Minitrack Calibration Section tracks the flight of an aircraft equipped with a Minitrack transmitter and a photoflash light located in the center of the transmitting antenna, by both Minitrack and an equatorially mounted camera.

Data from these two tracking systems result in an overall station calibration figure. Two formulas exist for adjusting the raw Minitrack data. The first of these yields "observed data" corrected for overall station factors but not for antenna pattern distortion and system crosstalk. The latter two factors introduce an error of about 1 percent in the data; thus the second formula, which corrects for them, may be omitted if that degree of error can be tolerated. The first formula gives a_o, the east-west observed data, or b_o, the north-south observed data, from the raw data a_r or b_r:

$$a_o = a_r - (K_c - K_{s_1}) - K_{s_2} + \dot{a}_r \, (K_f - .002\underline{a} - \Delta T). \tag{2}$$

where

K_c = the station calibration figure;

K_{s_1} = the internal electronic calibration figure at the time of station calibration;

K_{s_2} = the internal electronic calibration figure at the time of satellite passage (line three in the data message);

$\dot{a}_r$ = the time rate of change of a_r;

K_f = a correction for phase shift in a filter due to frequency shift in the Minitrack system;

$.002\underline{a}$ = the delay in the phase meter circuitry, $\underline{a}$ being decimal part of a_r;

ΔT = the transmission delay time from the Bureau of Standards, Station WWV, to the particular station.

The values of the constants for each station are given in Appendix C.

It will be noted upon inspection of any Minitrack data message from the Santiago (SNTAGO) station, that the east-west fine data from that station decrease with time, indicating a satellite passage from east to west although the passage is actually from west to east. This results from the fact that the east-fine and west-fine antennas at SNTAGO are reversed. To read these data properly, reverse the sign of a_o in Eq. (2) if only that correction is to be employed. If the correction for antenna pattern distortion and system crosstalk is also to be employed, do not reverse the sign of a_o.

The second formula, which is based on a least-square fit of a large number of data points taken over the complete antenna pattern, is used to correct for the antenna pattern distortion and the system crosstalk. The corrected east-west data, a_c, or north-south data, b_c, are given from the observed data, a_o; b_o:

$$a_c = C_o + C_1 a_o + C_2 b_o + C_3 a_o b_o + C_4 a_o^2 + C_5 b_o^2 + C_6 b_o^3 + C_7 \sin "a_o" + C_8 \cos "a_o"; \tag{3}$$

$$b_c = C_o + C_1 b_o + C_2 a_o + C_3 b_o a_o + C_4 b_o^2 + C_5 a_o^2 + C_6 a_o^3 + C_7 \sin "b_o" + C_8 \cos "b_o"; \tag{4}$$

where C_o through C_8 are the antenna correction constants obtained from the least-square fit, and $"a_o"$, $"b_o"$ are the decimal parts of a_o, b_o from Eq. (2). In Eqs. (3) and (4) the sine and cosine terms correct for the system crosstalk while the other terms correct for the antenna pattern distortion. The constants are given in Appendix C.

OUTPUTS OF IBM 704 AND BURROUGHS E101 COMPUTERS

The Minitrack input program used by the IBM 704 computer determines a "best" parabola from the data points in a Minitrack data message. The east-west and north-south direction cosines of points on this "best" parabola are computed at one-second intervals corresponding in time to the data points in the Minitrack message. The program determines to the nearest whole second the mid-time of the Minitrack Data Message, t_o, and prints this as well as the constants L_1, L_2, L_3, and M_1, M_2, M_3 for the following direction cosine formulas:

$$L = L_1 + L_2 \Delta t + L_3 \Delta t^2, \tag{5}$$

$$M = M_1 + M_2 \Delta t + L_3 \Delta t^2, \tag{6}$$

where L and M are the direction cosines of points on the "best" parabola in the east-west and north-south directions, respectively, at times $t_o \pm \Delta t$.

The meridian crossing time is found with the Burroughs E101 computer by setting L equal to zero in Eq. (5), solving for Δt and algebraically adding this value of Δt, called Δt_1 to t_o. Also, by substituting Δt_1 for Δt in Eq. (6), the E101 computes the north-south direction cosine at the time $t_o \pm \Delta t_1$, the time of meridian crossing.

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These data, the meridian crossing times and the elevation angles at the meridian crossing times, are given after the Minitrack data messages in Appendixes A and B. Then N or S following the elevation angle indicate that it is measured from the horizontal in the north or south direction.

The six parameters which define a satellite's elliptical orbit are determined by the differential correction program from past data messages and these parameters are changed to fit new data messages. As stated previously the one-second data points in a Minitrack data message are fitted to a "best" parabola (Curve A, Fig. 2) and the direction cosines of points on the parabola are computed for the time t_o. These direction cosines are then compared, at t_o, to the direction cosines of the orbit as defined by the latest set of orbital parameters (Curve B). The angular differences, in radians, noted for both the north-south and east-west directions are called "residuals" (R_i) for the particular data message. A positive residual indicates that the direction cosine of the mid-point of the "best" parabola should be higher.

Residuals for each data message are found in Appendixes A and B. A root-mean-sqaure averaging process was performed on these residuals and the results, in minutes of arc, are as follows:

	EW	NS
1958 Alpha	11.2′	8.5′
1958 Beta	8.0′	4.4′

The Minitrack data placed into the differential correction program are the data accumulated over a period of approximately six days, with the result that the program determines one set of orbital parameters for this six-day period. In the case of 1958 Alpha which is subject to considerable air drag, the orbital parameters change noticeably during a six-day period, resulting in larger residuals.

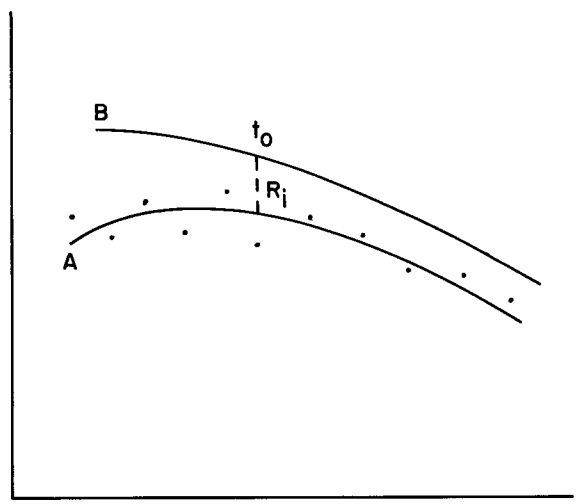

Fig. 2 - Comparison of previously computed orbit to "best" parabola from a Minitrack data message

The above root-mean-square residual figures are given here to indicate the approximate accuracy of the orbit determination.

The orbital elements issued by the Vanguard Computing Center on 28 May 1958 for 1958 Alpha and 1958 Beta are given in Appendix E.

ACKNOWLEDGMENTS

The material in this report is the result of the work and suggestions of the Time Measurement Section, Radio Tracking Branch, Project Vanguard. Special acknowledgment is made to Jerome J. Madden, and Paul J. Kushmeider.

Suggestions were also offered by Edmund J. Habib of the Minitrack Calibration Section, Radio Tracking Branch, Project Vanguard, and by Campbell H. Chrisman, Jr. of the Operational Research Branch, Applications Research Division.

* * *

Appendix A

MINITRACK DATA MESSAGES FOR 1958 ALPHA

The following are the data messages for 1958 Alpha during the period 7 May through 20 May 1958. Message numbers located immediately above each message will be used to correlate that message with the appropriate meridian crossing time, elevation angle, and residuals given at the end of this appendix.

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1

1958 ALPHA	
SNTAGO	580507
035759	035813
194361	195361
115115	999999
052438	049515
052156	049519
051871	049537
051593	049559
051313	049563
051023	049582
050741	049591
050443	049598
050173	049620
049892	049632
049607	049648
049318	049666
049029	049674
048743	049684
048454	049708
035759	035813

2

1958 ALPHA	
NELCAL	580507
180020	180034
925988	925988
105104	999003
047720	053964
048100	053990
048478	054019
048864	054050
049244	054075
049623	054100
049998	054123
050386	054161
050761	054182
051132	054216
051512	054234
//////	//////
052266	054287
052644	054310
053015	054332
180020	180034

3

1958 ALPHA	
NELCAL	580507
200221	200233
925987	925987
109109	999003
048661	043889
048885	043839
049138	043783
049373	043733
049617	043683
049852	043630
050089	043573
050324	043523
050569	043468
050800	043423
051040	043371
051276	043320
051513	043260
200221	200233

4

1958 ALPHA	
SNTAGO	580508
024245	024259
195363	195363
105105	777003
051670	050920
051440	050905
051240	050890
//////	//////
050805	050840
050580	050820
050380	050790
//////	//////
049964	050762
049742	050737
049535	050719
//////	//////
049094	050684
048872	050663
048659	050650
024245	024259

5

1958 ALPHA	
SNTAGO	580508
044500	044514
194362	194362
110110	888003
054035	060149
053725	060234
053413	060303
053113	060381
052789	060459
052477	060534
052170	060610
//////	//////
051544	060765
051227	060839
050912	060919
050580	061004
050284	061064
049963	061140
049658	061217
044500	044514

6

1958 ALPHA	
OOMERA	580508
121008	121042
262354	263354
112115	777777
047191	047074
047275	047040
047483	047000
047668	046970
047864	046938
048000	046900
048177	046859
048402	046825
048585	046792
048832	046745
048974	046709
049162	046684
049343	046634
049500	046620
049710	046576
049894	046537
050074	046503
050220	046479
050419	046437
050592	046406
050797	046371
050960	046325
051171	046303
051327	046260
051530	046228
051700	046180
051948	046157
052157	046125
052358	046070
052510	046025
052742	046000
052940	045981
053123	045943
053270	045920
053343	045861
121008	121042

7

1958 ALPHA	
OOMERA	580508
141253	141327
262354	261354
112116	777777
045885	041901
046138	041919
046420	041935
046670	041975
046935	042005
047195	042041
047460	042065
047715	042106
047999	042138
048282	042166
048515	042190
048807	042237
049050	042268
049330	042298
049610	042325
049932	042362
050149	042392
050418	042420
//////	042438
050936	042492
051230	042513
051502	042557
051787	042578
052044	042620
052348	042652
052661	042682
052915	042727
053181	042775
053482	042796
053729	042820
053991	042850
054271	042900
054520	042950
054829	042980
055080	042995
141253	141327

8

1958 ALPHA	
NELCAL	580508
164552	164606
927990	928991
108108	999003
048221	040232
048737	040342
049260	040460
049786	040575
050295	040695
050812	040809
051329	040924
051877	041037
052363	041158
052874	041284
053384	041405
053897	041525
054398	041658
054914	041773
055420	041893
164552	164606

9

1958 ALPHA

NELCAL	580508
184717	184733
926989	926989
110110	999003
050153	053198
050502	053158
050815	053135
051145	053094
051470	053061
051799	053015
052124	052995
052453	052962
052779	052933
053092	052851
053420	052863
053747	052826
054063	052798
//////	//////
054702	052734
055024	052698
055345	052653
184717	184733

10

1958 ALPHA

HAVANA	580508
185802	185815
142365	141364
110115	777003
049460	057540
049630	057460
049810	057370
049990	057280
050150	057200
050350	057120
050530	057040
050710	056960
050390	056880
051070	056790
051230	056700
051400	056610
051580	056520
051750	056440
185802	185815

11

1958 ALPHA

PANTIG	580508
190702	190718
121264	121263
117117	666003
049112	035364
049231	035290
049351	035186
049476	035123
049602	035059
049723	034987
049838	034914
049954	034842
050086	034764
050204	034691
050326	034620
050447	034550
050562	034479
050690	034403
050808	034331
050926	034259
051057	034187
190702	190718

12

1958 ALPHA

QUITOE	580508
210718	210730
080365	080365
125126	888003
049710	068565
049810	068490
049910	068420
050015	068350
050130	068280
050230	068200
050340	068130
050440	068060
050540	067990
050640	067920
050750	067850
050850	067770
050960	067700
210718	210730

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1958 ALPHA

LIMAPU	580508
231743	231757
130370	130370
110110	888003
049200	034240
049310	034180
049420	034120
049520	034060
049630	033990
049740	033920
049840	033860
049950	033800
050060	033730
050160	033670
050270	033600
050370	033540
050480	033480
050580	033420
050690	033360
231743	231757

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1958 ALPHA

SNTAGO	580509
032948	033000
194362	194362
110110	999003
052874	050440
052635	050461
052307	050468
052145	050490
051914	050518
051665	050531
051402	050568
051187	050584
050950	050603
050701	050621
050481	050646
050220	050661
049971	050690
032948	033000

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1958 ALPHA

OOMERA	580509
105338	105412
264354	264354
118122	777003
047918	058593
048070	058568
048240	058514
048387	058480
048525	058426
048646	058379
048753	058344
048895	058281
049045	058231
049187	058190
049313	058160
049465	058123
049600	058085
049750	058040
049895	058005
050020	057940
050185	057880
050343	057840
050510	057800
050643	057760
050801	057700
050957	057660
051115	057610
051265	057560
051405	057520
051545	057480
051680	057420
051826	057375
051963	057300
052106	057260
052243	057225
052400	057200
052545	057160
052685	057105
052722	057060
105338	105412

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1958 ALPHA

OOMERA	580509
125723	125757
264354	263354
112115	777003
046918	040597
047120	040590
047310	040585
047493	040577
047702	040566
047900	040560
048100	040555
048293	040550
048467	040540
048623	040535
048846	040535
049020	040530
049265	040525
049448	040525
049760	040515
049867	040514
050070	040514
050285	040508
050505	040490
050725	040480
050934	040475
051169	040470
051400	040470
051611	040465
051812	040463
052055	040463
052245	040459
052475	040440
052684	040440
052908	040435
053145	040430
053327	040425
053534	040420
053763	040415
053964	040415
125723	125757

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1958 ALPHA

FTSTEW	580509
154001	154020
019318	019318
110110	888003
046357	060314
046763	060289
047154	060263
047570	060253
047976	060241
048384	060221
048779	060197
049186	060191
049586	060174
049987	060155
050385	060138
050781	06012.
051182	060097
051577	060074
051975	060058
052361	060032
052761	060019
053152	059991
053585	059976
053930	059948
154001	154020

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1958 ALPHA

NELCAL	580509
173228	173240
927989	926988
104100	999003
048127	056030
048572	056047
049045	056064
049502	056080
049996	056094
050442	056106
050880	056125
051335	056139
051788	056153
052236	056169
052696	056175
053143	056190
053593	056202
173228	173240

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1958 ALPHA

NELCAL	580509
193409	193423
926988	926988
109106	999003
049040	039320
049316	039245
049591	039171
049875	039108
050143	039053
050409	038994
050688	038930
051084	038873
051223	038795
051495	038736
051770	038662
052033	038624
052301	038557
052571	038492
052842	038423
193409	193423

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1958 ALPHA

LIMAPU	580509
215830	215854
120370	120370
115112	888003
049030	063320
049140	063250
049240	063200
049340	063120
049440	063060
049550	062970
049640	062900
049750	062840
049850	062760
049960	062690
050060	062630
050160	062550
050260	062480
050360	062410
050460	062350
050560	062270
050650	062210
050760	062140
050850	062070
050970	061990
051060	061920
051170	061850
051270	061780
051370	061700
051480	061630
215830	215854

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1958 ALPHA

SNTAGO	580510
021400	021414
193362	193361
115115	999003
052580	050120
052385	050117
052219	050102
052018	050081
051827	050076
051636	050068
051451	050053
051263	050042
051075	050031
050887	050018
050696	050006
050501	049992
050315	049982
050134	049977
049942	049963
021400	021414

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1958 ALPHA

NELCAL	580510
161756	161808
927989	927989
100100	999003
046564	044223
047199	044336
047838	044451
048476	044574
049113	044688
049755	044807
050387	044926
051019	045056
051660	045164
052293	045286
052925	045311
053553	045426
054152	045547
161756	161808

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1958 ALPHA

NELCAL	580510
181859	181911
927989	927989
108108	999003
048555	051711
048951	051660
049349	051601
049748	051551
050143	051501
050516	051442
050955	051391
051332	051345
051723	051290
052090	051243
052499	051184
052894	051132
053276	051082
181859	181911

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1958 ALPHA

QUITOE	580510
203824	203836
075345	075345
122122	777003
049795	061995
049915	061900
050010	061820
050120	061735
050240	061650
050345	061575
050455	061495
050580	061400
050715	061305
050825	061230
050940	061140
051030	061055
051125	060955
203824	203836

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1958 ALPHA

SNTAGO	580511
030104	030119
154391	154391
115115	888003
052304	051705
052089	051731
051881	051752
//////	//////
051477	051805
051261	051832
051052	051858
050829	051875
050615	051904
050426	051932
050219	051960
050023	051978
049791	052011
049588	052033
049380	052052
049172	052078
030104	030119

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1958 ALPHA

FTSTEW	580511
131058	131112
014319	015319
105108	888003
044537	035842
045289	036021
046046	036201
046811	036379
047569	036563
048232	036748
049095	036929
049858	037128
050518	037323
051366	037508
052141	037721
052899	037916
053616	038124
054371	038338
055162	038524
131058	131112

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1958 ALPHA

FTSTEW	580511
151146	151201
014319	014319
105110	888003
046496	060979
046987	060952
047401	060919
047984	060868
048468	060837
048952	060790
049421	060764
049923	060717
050411	060671
050898	060624
051375	060593
051851	060559
052329	060518
052793	060480
053243	060431
053732	060393
151146	151201

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1958 ALPHA

NELCAL	580511
170412	170428
924987	924987
105105	999003
046053	057742
046617	057741
047202	057734
047732	057750
048292	057744
048846	057745
049404	057747
049957	057742
050513	057738
051061	057737
051612	057732
052165	057729
052715	057729
053258	057723
053799	057717
054350	057711
054891	057703
170412	170428

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1958 ALPHA

NELCAL	580512
154944	154956
927989	926988
103100	999003
046750	049062
047529	049176
048304	049288
049082	049404
049862	049514
050634	049632
051410	049748
052182	049860
052950	049974
053719	050087
054480	050199
055241	050315
055993	050427
154944	154956

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1958 ALPHA

FTSTEW	580512
155808	155822
014318	014318
108108	888003
047053	045230
047467	045122
047899	045053
048279	044955
048707	044865
049115	044770
049511	044675
049937	044598
050344	044508
050754	044405
051157	044330
051559	044235
051976	044157
052376	044074
052768	043985
155808	155822

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1958 ALPHA

NELCAL	580512
175029	175041
926989	926989
115115	999003
047970	048350
048465	048776
048917	048681
049389	048614
049859	048533
050343	048460
050817	048388
051294	048288
051769	048236
052238	048168
052694	048097
053168	048019
053614	047942
175029	175041

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1958 ALPHA

HAVANA	580512
180038	180051
118345	118345
100110	999003
048940	044480
049150	044350
049400	044240
049600	044120
049860	044020
050090	043900
050300	043750
050500	043670
050770	043560
051020	043430
051230	043300
051420	043200
051690	043100
051900	042980
180038	180051

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1958 ALPHA

AGASTA	580512
222208	222228
203318	200316
114115	999003
049073	051226
049178	051193
049305	051121
049425	051063
049529	051005
049602	050930
049759	050892
049873	050844
049990	050780
050082	050758
050205	050663
050326	050605
050437	050547
050512	050498
050666	050437
050774	050386
050892	050324
051021	050283
051118	050211
051232	050158
051341	050098
222208	222228

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1958 ALPHA

AGASTA	580513
043519	043544
200315	200315
110112	888003
047127	044742
047393	044857
047626	044971
047877	045096
048126	045191
048395	045338
048625	045412
048873	045528
049124	045644
049384	045753
049633	045873
049842	045983
050132	046100
050367	046280
050649	046327
050891	046447
051150	046558
051477	046673
051658	046795
051898	046916
052165	047010
052442	047154
052663	047259
052943	047369
053198	047481
053458	047600
043519	043544

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1958 ALPHA

LIMAPU	580513
063648	063712
120370	120370
100100	999003
045470	041770
045830	042300
046160	042200
046540	042420
046880	042650
047220	042870
047590	043080
047900	043320
048300	043540
048670	043770
049020	044000
049390	044230
049780	044450
050100	044680
050500	044930
050880	045140
051220	045370
051620	045620
051990	045870
052340	046080
052730	046300
053080	046570
053480	046800
053880	047040
054220	047230
063648	063712

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1958 ALPHA

QOMERA	580513
095427	095501
266351	266351
114117	555003
048199	052838
048318	052799
048470	052775
048575	052755
048705	052704
048829	052665
048959	052633
049075	052594
049207	052569
049346	052537
049488	052485
049578	052454
049740	052428
049867	052398
049988	052361
050110	052320
050240	052280
050376	052257
050505	052205
050645	052165
050756	052159
050894	052116
051026	052082
051147	052055
051261	052011
051413	051975
051550	051937
051670	051911
051795	051869
051934	051836
052061	051810
052180	051765
052315	051735
052449	051695
052559	051676
095427	095501

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1958 ALPHA

QOMERA	580513
115847	115921
264350	266351
113115	666003
047357	042356
047519	042369
047690	042380
047870	042390
048024	042390
048169	042397
048359	042410
048492	042416
048647	042416
048823	042426
048935	042435
049134	042447
049281	042450
049463	042455
049608	042463
049791	042470
049951	042483
050123	042486
050260	042495
050421	042502
050594	042309
050743	042518
050927	042525
051073	042533
051233	042541
051378	042544
051550	042552
051716	042571
051888	042579
052053	042585
052225	042595
052393	042602
052568	042619
052739	042622
052915	042630
115847	115921

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1958 ALPHA

FTSTEW	580513
124238	124255
019319	019319
100100	999003
041865	042394
042780	042555
043705	042728
044629	042923
045547	043102
046476	043295
047403	043489
048333	043688
049261	043889
050190	044091
051118	044294
052042	044496
052964	044711
053884	044923
054800	045132
055716	045339
056622	045568
057552	045799
124238	124255

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1958 ALPHA

FTSTEW	580513
144310	144332
019319	019319
105105	999003
044239	061108
044865	061053
045454	060992
046038	060939
046629	060878
047227	060822
047812	060758
048401	060695
048960	060635
049575	060570
050135	060502
050711	060437
051333	060371
051916	060305
052494	060241
053082	060163
053656	060105
054229	060040
054802	059967
055379	059875
055949	059822
056529	059763
057065	059684
144310	144332

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1958 ALPHA

NELCAL	580513
163544	163556
927988	927989
102106	999003
046901	058968
047573	058947
048244	058920
048917	058893
049588	058871
050257	058852
050928	058824
051595	058803
052261	058775
052929	058746
053590	058718
054232	058697
054905	058659
163544	163556

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1958 ALPHA

HAVANA	580513
164427	164439
124347	123348
118110	999003
048340	076750
048620	076640
048940	076540
049250	076430
049560	076320
049870	076220
050120	076120
050440	076000
050790	075890
051080	075770
051380	075660
051680	075540
051970	075440
164427	164439

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1958 ALPHA

LIMAPU	580513
205936	205948
100360	100360
115115	888003
049460	050290
049580	050220
049690	050140
049820	050070
049940	049990
050060	049910
050150	049830
050260	049760
050380	049680
050490	049600
050600	049530
050700	049460
050830	049380
205936	205948

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1958 ALPHA

SNTAGO	580514
011505	011516
180347	180347
115115	999003
050856	049691
050709	049691
050548	049691
050400	049692
050248	049692
050095	049692
049945	049693
049792	049693
049545	049694
049483	049694
049333	049695
049195	049695
011505	011516

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1958 ALPHA

OOMERA	580514
104143	104217
266351	266351
114117	555003
047783	043973
047918	043955
048062	043940
048205	043930
048349	043904
048478	043897
048611	043877
048775	043870
048907	043850
049053	043840
049177	043820
049315	043805
049453	043799
049603	043784
049741	043775
049865	043360
050022	043732
050144	043728
050299	043718
050421	043755
050554	043685
050694	043674
050837	043663
050970	043650
051107	043640
051280	043634
051420	043618
051539	043601
051670	043590
051824	043579
051969	043566
052093	043550
052231	043543
052401	043532
052536	043512
104143	104217

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1958 ALPHA

OOMERA	580514
124544	124617
266351	266351
115114	666003
047223	049687
047400	049731
047581	049764
047746	049808
047928	049856
048070	049900
048238	049933
048444	049969
048611	050015
048784	050045
048983	050099
049149	050135
049310	050178
049475	050206
049637	050281
049819	550299
050007	050340
050189	050377
050379	050432
050561	050467
050761	050512
050942	050560
051105	050590
051285	050693
051431	050687
051615	050724
051774	050764
051952	050811
052145	050847
052320	050901
052508	050932
052687	050977
052860	051031
053023	051047
124544	124617

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1958 ALPHA

NELCAL	580514
152110	152122
929990	928989
105105	999003
045263	053929
046173	054029
047097	054128
048023	054228
048948	054330
049867	054436
050793	054531
051714	054630
052634	054724
053541	054837
054457	054924
055365	055014
056269	055108
152110	152122

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1958 ALPHA

ETSTEW	580514
152915	152939
018316	018316
105105	999003
044240	039516
044754	039401
045249	039280
045734	039149
046210	039033
046679	038923
047193	038805
047610	038674
048120	038556
048681	038452
049169	038345
049629	038230
050129	038118
050609	038002
051075	037901
051532	037708
052052	037680
052497	037571
053003	037453
053458	037368
053908	037273
054390	037170
054813	037063
055318	036982
055752	036883
152915	152939

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1958 ALPHA

NELCAL	580514
172143	172155
928989	929990
105105	999003
047427	044216
048005	044106
048573	043988
049147	043884
049722	043782
050291	043679
050856	043570
051424	043469
051990	043369
052550	043271
053113	043172
053666	043067
054230	042974
172143	172155

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1958 ALPHA

HAVANA	580514
173136	173149
124350	124350
120120	777003
048800	035500
049030	035380
049300	035240
049550	035100
049820	034960
050060	034860
050320	034720
050560	034640
050830	034480
051060	034360
051320	034260
051590	034140
051850	034020
052040	033900
173136	173149

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1958 ALPHA

QUITOE	580514
193941	193953
070350	080350
120115	777003
049730	046800
049870	046700
050010	046600
050140	046500
050270	046400
050410	046300
050550	046200
050680	046100
050810	046000
050990	045910
051080	045820
051230	045720
051360	045620
193941	193953

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1958 ALPHA

ACASTA	580514
215155	215214
202316	202318
115115	999003
048925	047320
049047	047258
049164	047216
049290	047161
049395	047106
049503	047063
049620	047005
049747	046945
049862	046892
049977	046838
050075	046789
050188	046725
050290	046683
050408	046614
050530	046566
050653	046500
050760	046441
050877	046408
050989	046355
051107	046308
215155	215214

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1958 ALPHA

SNTAGO	580514
235743	235801
170340	180350
120125	999003
051046	052485
050912	052468
050897	052436
//////	//////
050623	052409
050485	052389
//////	//////
//////	//////
049986	052337
049850	052305
049712	052289
//////	//////
049440	052254
049319	052233
049281	052213
//////	//////
048923	052170
048786	052162
048657	052137
235743	235801

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1958 ALPHA

LIMAPU	580515
060804	060828
120370	120370
105105	888003
046560	056270
046850	056490
047160	056690
047480	056900
047760	057100
048050	057310
048360	057520
048670	057730
048970	057960
049260	058160
049540	058370
049850	058590
050150	058800
050460	059000
050800	059200
051130	059400
051430	059610
051730	059830
052040	060020
052340	060230
052640	060440
052940	060640
053260	060870
053580	061080
053880	061280
060804	060828

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1958 ALPHA

OOMERA	580515
092403	092436
266351	265351
113117	555003
048021	050831
048140	050800
048256	050783
048401	050732
048522	050716
048645	050680
048778	050653
048896	050626
049030	050600
049150	050565
049274	050533
049384	050520
049496	050474
049640	050440
049755	050419
049891	050383
050013	050351
050136	050320
050240	050295
050382	050269
050509	050242
050646	050203
050748	050173
050876	050152
050995	050113
051154	050080
051256	050040
051367	050030
051510	049995
051636	049975
051757	049944
051883	049910
052019	049889
052152	049854
092403	092436

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1958 ALPHA

HAVANA	580515
101257	101310
124348	124345
090110	999003
043880	050170
044900	050720
045890	051220
046900	051730
047900	052230
048900	052740
049910	053240
050950	053750
051990	054260
052990	054760
054000	055260
055020	055760
056010	056240
057010	056740
101257	101310

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1958 ALPHA

OOMERA	580515
112841	112914
265352	266351
113118	555003
047813	043394
047953	043413
048092	043426
048240	043425
048384	043454
048521	043458
048671	043475
048820	043460
048986	043490
049111	043513
049259	043515
049380	043520
049543	043534
049721	043559
049857	043569
049995	043580
050144	043599
050279	043605
050424	043616
050570	043630
050740	043641
050886	043644
051012	043663
051181	043678
051072	043789
051451	043702
051614	043715
051762	043728
051910	043730
052092	043756
052220	043767
052355	043781
052535	043785
052686	043798
112841	112914

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1958 ALPHA

FTSTEW	580515
121400	121414
018316	018315
102104	888003
041669	050416
042751	050605
043785	050781
044871	050985
045975	051166
046998	051355
048107	051560
049185	051759
050259	051955
051331	052145
052395	052340
053472	052534
054530	052719
055593	052914
056666	053114
121400	121414

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1958 ALPHA

FTSTEW	580515
141419	141439
016313	016313
102105	999003
042647	060013
043431	059925
044110	059838
044817	059749
045536	059662
046290	059572
046937	059483
047640	059398
048439	059305
049121	059208
049795	059107
050517	059018
051257	058918
052002	058812
052677	058704
053377	058615
054077	058502
054742	058405
055467	058299
056189	058173
056859	058089
141419	141439

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1958 ALPHA

NELCAL	580515
160655	160707
926987	928988
105103	999003
045785	059281
046597	059247
047412	059189
048226	059147
049032	059090
049846	059030
050653	058984
051453	058920
052262	058879
053070	058816
053871	058759
054664	058691
055463	058639
160655	160707

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1958 ALPHA

LIMAPU	580515
202933	202947
100370	100370
110110	888003
049180	044100
049300	044030
049420	043960
049540	043880
049660	043810
049790	043730
049910	043650
050020	043570
050140	043500
050260	043420
050390	043340
050500	043260
050630	043180
050750	043110
050870	043030
202933	202947

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1958 ALPHA

QUITOE	580516
065524	065536
050355	050355
115117	888003
047700	050310
048040	050550
048440	050860
048800	051125
049180	051380
049570	051670
049970	051950
050330	052210
050735	052430
051120	052780
051480	053080
051830	053340
052160	053590
065524	065536

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1958 ALPHA

QOMERA	580516
101110	101143
268353	268353
114118	555003
048999	043570
049126	043563
049246	043546
049360	043535
049500	043525
049620	043522
049750	043514
049890	043495
050030	043494
050160	043486
050287	043479
050420	043460
050553	043475
050700	043452
050812	043445
050960	043420
051087	043428
051217	043418
051341	043406
051480	043380
051620	043387
051740	043380
051876	043375
052000	043355
052121	043357
052263	043362
052405	043346
052530	043351
052660	043327
052800	043317
052928	043315
053055	043300
053181	043298
053310	043294
101110	101143

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1958 ALPHA

AGASTA	580517
033626	033636
201316	201316
111115	999003
049323	058372
049501	058451
049676	058572
049858	058679
050044	058769
050232	058878
050416	058967
050501	059048
050787	059170
050951	059268
051157	059367
033626	033636

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1958 ALPHA

FTSTEW	580517
114459	114515
019316	019315
100100	888003
040665	057899
041669	058129
042841	058311
043977	058500
045121	058685
046212	058858
047420	059036
048578	059213
049729	059378
050878	059540
052029	059702
053176	059850
054321	060004
055459	060143
056616	060265
057791	060408
059350	060551
114459	114515

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1958 ALPHA

NELCAL	580517
153746	153800
927989	927989
100095	999003
043268	058365
044210	058275
045153	058183
046095	058099
047041	058009
047996	057928
048969	057848
049906	057739
050868	057665
051824	057570
052779	057482
053720	057369
054666	057292
055620	057197
056558	057089
153746	153800

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1958 ALPHA

LIMAPU	580517
195918	195932
110370	110370
115115	777003
049600	037480
049730	037400
049860	037330
049990	037250
050120	037180
050250	037100
050380	037020
050510	036950
050640	036880
050760	036800
050890	036730
051020	036650
051150	036580
051270	036500
051400	036440
195918	195932

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1958 ALPHA

QOMERA	580518
073453	073527
268352	267352
112116	666003
048196	060677
048311	060630
048447	060579
048555	060549
048676	060503
048795	060468
048922	060409
049044	060380
049161	060337
049273	060253
049373	060269
049517	060202
049635	060162
049767	060118
049892	060080
050009	060039
050130	059995
050243	059948
050343	059922
050485	059867
050607	059808
050726	059777
050832	059752
050965	059683
051088	059644
051201	059596
051304	059561
051448	059507
051571	059465
051695	059421
051837	059386
051947	059339
052066	059294
052192	059247
052290	059210
073453	073527

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1958 ALPHA

AGASTA	580518
205024	205049
202316	203317
117118	888003
048747	040336
048863	040280
048996	040231
049096	040200
049241	040138
049352	040095
049481	040043
049654	039928
049722	039946
049852	039892
049980	039851
050050	039820
050228	039741
050345	039700
050466	039662
050521	039632
050713	039561
050837	039503
050958	039474
051058	039440
051198	039374
051312	039327
051450	039287
051598	039238
051695	039198
051808	039131
205024	205049

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1958 ALPHA

SNTAGO	580518
225548	225600
177338	177338
115115	888003
051442	050729
051303	050682
051216	050678
051076	050674
050965	050670
050811	050665
050708	050640
050578	050632
050431	050613
050328	050602
050200	050590
050076	050585
049966	050576
225548	225600

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1958 ALPHA

FTSTEW	580519
111541	111554
019317	019314
100105	888003
042230	064073
043350	064245
044490	064396
045630	064538
046770	064685
047920	064829
049060	064956
050210	065088
051350	065211
052490	065328
053630	065434
054770	065538
055910	065635
057050	065739
111541	111554

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1958 ALPHA

NELCAL	580519
130816	130828
928988	928988
100100	999003
043864	039016
044952	039197
046059	039343
047159	039523
048274	039708
049381	039906
050503	040091
051622	040293
052747	040492
053874	040689
054984	040911
056103	041126
057215	041344
130816	130828

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1958 ALPHA

FTSTEW	580519
131550	131603
020318	020318
102102	888003
042901	051121
043896	050937
044801	050748
045904	050557
046908	050368
047902	050162
048908	049988
049904	049792
050875	049605
051928	049420
052872	049231
053810	049045
054895	048854
055864	048675
131550	131603

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1958 ALPHA

HAVANA	580519
151641	151654
124350	124350
100100	555003
047360	059620
047840	059380
048420	059110
049040	058810
049610	058540
050190	058260
050760	057990
051340	057700
051900	057420
052500	057160
053040	056860
053610	056600
054200	056300
054760	056020
151641	151654

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1958 ALPHA

ACASTA	580519
193142	193207
201317	201318
120121	666003
048360	062181
048501	062095
048615	061975
048777	061941
048910	061869
049060	061783
049134	061674
049318	061631
049456	061548
049587	061485
049718	061395
049818	061319
049993	061254
050135	061182
050292	061094
050400	061027
050540	060956
050678	060877
050821	060797
050934	060723
051083	060658
051219	060575
051362	060495
051455	060424
051634	060394
051777	060261
193142	193207

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1958 ALPHA

LIMAPU	580520
035100	035114
070370	070370
110110	888003
049070	034500
049220	034590
049380	034680
049540	034760
049700	034850
049860	034940
049010	035020
050170	035110
050330	035200
050490	035280
050650	035300
050810	035470
050960	035560
050120	035640
050290	035730
035100	035114

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1958 ALPHA

OOMERA	580520
070340	070414
281349	281348
120121	666003
048060	058394
048200	058345
048335	058300
048475	058260
048610	058215
048735	058180
048860	058140
048975	058100
049110	058060
049240	058020
049370	057975
049500	057930
049625	057880
049750	057840
049880	057800
050000	057760
050120	057720
050260	057675
050395	057625
050530	057580
050660	057535
050795	057485
050925	057435
051030	057395
051170	057360
051300	057315
051435	057260
051560	057220
051690	057180
051805	057135
051940	057085
052055	057040
052195	057005
052325	056965
052460	056925
070340	070414

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1958 ALPHA

OOMERA	580520
090846	090920
281349	281349
116116	555003
048268	043224
048394	043205
048520	043200
048645	043195
048753	043195
048884	043190
049007	043190
049135	043185
049263	043185
049377	043185
049505	043180
049635	043180
049766	043180
049888	043180
050016	043180
050135	043180
050272	043185
050383	043185
050505	043190
050645	043195
050750	043200
050794	043200
051010	043200
051130	043200
051249	043200
051389	043200
051500	043200
051633	043200
051755	043195
051880	043195
052020	043190
052140	043190
052260	043190
052370	043195
052500	043195
090846	090920

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1958 ALPHA

FTSTEW	580520
100042	100056
019316	022313
104106	888003
042343	030741
043234	030868
044119	030995
045045	031192
045964	031359
046893	031537
047823	031728
048750	031912
049695	032119
050642	032325
051587	032545
052539	032769
053492	032990
054444	033219
055396	033464
100042	100056

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1958 ALPHA

OOMERA	580520
111349	111423
281349	281349
118119	444003
048295	056480
048415	056515
048545	056560
048570	056615
048790	056660
048932	056700
049050	056740
049160	056785
049322	056830
049437	056880
049559	056915
049695	056955
049815	057000
049941	057055
050115	057080
050245	057125
050365	057165
050483	057200
050594	057240
050735	057285
050869	057335
050995	057380
051130	057420
051255	057470
051386	057515
051511	057560
051626	057600
051749	057645
051881	057690
052042	057725
052140	057775
052285	057825
052426	057870
052548	057915
052680	057960
111349	111423

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1958 ALPHA

FTSTEW	580520
120055	120108
020316	019312
105105	888003
040174	071975
043248	071925
044318	071908
045415	071897
046508	071875
047605	071835
048699	071792
049749	071745
050904	071690
052002	071627
053074	071546
054196	071478
055282	071395
056383	071307
120055	120108

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1958 ALPHA

PANTIG	580520
140636	140654
182296	182296
110109	777003
045758	076923
046230	076714
046696	076497
047167	076281
047636	076051
048117	075839
048592	075611
049071	075372
049551	075128
050030	074919
050505	074671
050989	074434
051469	074190
051954	073943
052445	073668
052918	073442
053408	073187
053894	072917
054373	072666
140636	140654

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1958 ALPHA

QUITOE	580520
180936	180947
080360	080360
125127	666003
049235	021415
049425	021320
049595	021240
049765	021155
049940	021070
050125	020995
050290	020910
050450	020835
050620	020760
050785	020680
051145	020520
051300	020445
180936	180947

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1958 ALPHA

LIMAPU	580520
181010	181034
080380	080380
110110	888003
048560	067880
048740	067760
048930	067640
049120	067500
049300	067380
049480	067240
049680	067120
049860	067000
050060	066870
050230	066740
050420	066600
050580	066490
050770	066360
050960	066220
051160	066080
051340	065960
051540	065840
051700	065720
051900	065600
052080	065470
052260	065340
052450	065210
052620	065080
052800	064960
053000	064820
181010	181034

The following are additional data for the 1958 ALPHA messages:

Message Number	Meridian Crossing Time			Elevation Angle		Residuals* (Radians)	
	Hr	Min	Sec	Deg	Min	East-West	North-South
1	03	58	04.37	89	15S	-1.7713652,-03	9.2905038,-04
2	18	00	28.43	86	01N	7.9299232,-03	3.4896144,-04
3	20	02	30.52	82	41S	6.7409385,-03	-4.6772269,-03
4	02	42	48.48	89	26N	-2.8358841,-03	-2.0532088,-04
5	04	45	09.97	78	51N	-1.1703605,-03	1.7587176,-04
6	12	10	24.64	85	28S	-1.6559963,-03	-6.5175234,-05
7	14	13	09.10	81	10S	-2.5502007,-04	-4.0064251,-04
8	16	45	57.20	79	59S	4.8996583,-03	2.7666396,-03
9	18	47	19.33	87	09N	3.7971466,-03	6.6711450,-04
10	18	58	09.29	83	11N	1.1964892,-03	6.0955644,-05
11	19	07	09.26	73	55S	-3.2828656,-03	1.1459503,-03
12	21	07	26.71	71	53N	-1.2901911,-03	1.4659321,-03
13	23	17	55.48	71	23S	-2.4457754,-03	9.2206260,-04
14	03	29	56.09	89	41N	-6.9401663,-05	-1.2218798,-03
15	10	53	53.83	82	36N	-8.8596587,-04	4.5070890,-05
16	12	57	39.40	79	11S	-7.6945544,-04	-4.5927125,-04
17	15	40	08.99	79	42N	5.1662008,-03	1.5847291,-04
18	17	32	34.09	84	00N	2.7676987,-03	8.8490918,-04
19	19	34	15.82	77	54S	-1.6315422,-03	2.9299978,-04
20	21	58	44.62	78	06N	-3.0790930,-03	1.2153105,-03
21	02	14	08.82	89	43S	-2.1893797,-03	-1.3204948,-03
22	16	18	02.83	84	24S	-5.9375684,-04	1.8725835,-03
23	18	19	04.98	88	57N	-1.3248910,-03	2.8463301.-04
24	20	38	31.25	78	56N	-2.5607382,-03	5.5822846,-04
25	03	01	10.81	88	23N	-2.1443756,-03	-2.2365681,-03
26	13	11	04.65	76	00S	-1.4938579,-03	2.5221919,-03
27	15	11	52.28	79	06N	-6.8254781,-03	5.5725278,-04
28	17	04	20.74	82	18N	-9.6252430,-05	3.3400626,-04
29	15	49	49.36	89	16S	3.0559127,-03	-3.7373362,-03
30	15	58	14.12	84	03S	8.0003074,-05	3.5106088,-04
31	17	50	35.22	87	54S	2.9312942,-04	1.5251128,-04
32	18	00	45.55	82	54S	-2.1856838,-04	3.2443921,-03
33	22	22	16.62	89	57S	-1.0960694,-03	3.5539054,-03
34	04	35	30.64	85	03S	-1.5137052,-03	-1.5903779,-03
35	06	37	02.07	83	41S	-4.0520769,-04	-3.7091363,-03
36	09	54	42.48	88	26N	-1.9223853,-03	1.5831372,-03
37	11	59	04.31	81	17S	-2.8863948,-03	2.9773928,-04
38	12	42	46.32	83	10S	1.6200178,-03	-1.8316186,-03
39	14	43	19.01	79	17N	6.3293075,-05	-7.2335288,-04
40	16	35	49.98	81	09N	-1.9630503,-04	-1.3551106,-03
41	16	44	34.65	62	18N	-5.5354172,-04	2.1620360,-03
42	20	59	45.06	88	35S	-9.3016595,-04	1.8141579,-03
43	01	15	04.79	89	23S	-1.7867973,-03	-2.7368556,-03
44	10	42	00.22	82	35S	-1.2374862,-03	9.9839654,-04
45	12	46	00.93	89	33S	-1.4888698,-03	-3.4374248,-04
46	15	21	16.13	85	39N	-5.3299544,-04	-2.5015654,-03
47	15	29	25.88	77	15S	8.5432635,-05	9.5703871,-06
48	17	21	49.13	82	52S	-7.4176469,-04	-8.0612534,-04

(Cont'd)

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Message Number	Meridian Crossing Time			Elevation Angle		Residuals* (Radians)	
	Hr	Min	Sec	Deg	Min	East-West	North-South
49	17	31	43.38	73	14S	3.5941589,-04	1.3870641,-03
50	19	39	47.45	85	06S	3.0984827,-03	5.5562028,-04
51	21	52	04.81	85	31S	-1.6252508,-04	7.0041352,-03
52	23	57	44.47	87	44N	1.5356476,-05	-1.4046730,-03
53	06	08	17.10	81	34N	-9.1479264,-04	-6.1755094,-04
54	09	24	20.35	89	30S	3.9331328,-04	3.8736971,-04
55	10	13	03.70	86	38N	-8.4183388,-04	-2.0746020,-03
56	11	28	57.37	82	28S	6.7454012,-04	3.0355411,-05
57	12	14	07.36	88	28N	5.3375656,-04	-2.2256118,-03
58	14	14	28.64	80	47N	7.9864896,-04	-1.7589344,-03
59	16	07	01.32	81	00N	1.7362184,-04	-1.6375819,-03
60	20	29	43.93	81	57S	7.5831618,-04	-4.6947640,-04
61	06	55	31.64	88	23N	4.7733369,-03	5.5735800,-03
62	10	11	26.88	82	17S	8.9913195,-04	4.2261416,-04
63	03	36	30.11	81	39N	-4.4165807,-03	-6.7988492,-03
64	11	45	06.89	80	33N	1.8903305,-03	-7.2436200,-03
65	15	37	54.05	82	23N	-2.9905830,-03	4.7879052,-04
66	19	59	24.99	75	12S	-5.1931636,-03	7.7742090,-03
67	07	35	09.38	80	22N	-6.8649490,-03	4.1521635,-03
68	20	50	34.65	78	27S	-4.3908421,-03	3.1300011,-03
69	22	55	52.38	89	36N	2.1823089,-03	-4.9336144,-05
70	11	15	47.44	74	30N	9.6745789,-03	-2.0085222,-03
71	13	08	22.37	79	17S	9.1036072,-03	-2.7703372,-03
72	13	15	56.97	89	25S	6.1421382,-03	1.8163563,-04
73	15	16	46.82	82	01N	7.3655173,-04	2.7839596,-03
74	19	31	54.43	79	04N	-3.1282482,-03	4.8587174,-03
75	03	51	10.70	73	33S	-2.4815486,-03	-2.4232288,-03
76	07	03	56.45	82	47N	-7.1368709,-03	2.0844677,-03
77	09	09	01.53	82	02S	-5.1531147,-03	3.2418767,-04
78	10	00	49.86	70	35S	-7.4227293,-04	-2.4922722,-03
79	11	14	03.85	83	23N	-5.1526268,-03	-1.2744429,-03
80	12	01	01.79	67	04N	-1.5616600,-03	-9.3294638,-04
81	14	06	45.24	63	11N	-2.4018757,-03	1.8616972,-03
82	18	09	43.74	56	45S	-3.8591941,-03	2.2048314,-03
83	18	10	20.32	73	30N	-4.3124200,-03	3.2866427,-03

*The last two numbers following the comma in each residual indicate the power of ten by which the residual should be multiplied.

Appendix B

MINITRACK DATA MESSAGES FOR 1958 BETA

The following are thd data messages for 1958 Beta during the period 7 May through 20 May 1958. Message numbers located immediately above each message will be used to correlate that message with the appropriate meridian crossing time, elevation angle, and residuals given at the end of this appendix.

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1

1958 BETA

HAVANA	580507
000020	000034
140363	139364
122122	777777
050080	052980
050160	052940
050220	052900
050300	052860
050380	052820
050440	052780
050500	052740
050550	052700
050620	052660
050700	052620
050780	052580
050850	052550
050920	052510
050980	052460
051050	052420
000020	000034

2

1958 BETA

QUITOE	580507
024112	024124
070340	070350
125125	555555
050230	044910
050280	044860
050340	044820
050400	044780
050460	044730
050510	044690
050570	044650
050620	044600
050680	044560
050740	044520
050790	044470
050850	044420
050920	044380
024112	024124

3

1958 BETA

HAVANA	580507
172030	172043
144364	142364
115115	777005
048160	062160
048440	062300
048730	062430
049060	062560
049350	062600
049660	062840
049980	062990
050280	063080
050540	063220
050850	063340
051190	063490
051460	063620
051740	063750
052040	063880
172030	172043

4

1958 BETA

QOMERA	580507
190152	190226
287353	286353
112119	777777
047562	040453
047880	040463
048096	040514
048274	040535
048567	040592
048819	040633
049122	040676
049307	040720
049571	040775
049801	040785
050065	040818
050320	040869
050541	040896
050795	040933
051074	040984
051318	041027
051510	041039
051828	041092
052060	041145
052345	041152
052582	041228
052829	041241
053150	041304
053331	041358
053627	041423
053870	041444
054128	041473
054380	041520
054613	041572
054838	041605
055158	041648
055392	041710
055607	041727
055891	041751
056215	041836
190152	190226

5

1958 BETA

NELCAL	580507
215856	215909
928988	928988
124124	888005
049681	055647
//////	//////
049926	055664
050238	055682
050500	055703
050685	055774
050820	//////
050972	//////
051150	055782
051370	055792
051503	055810
051794	055835
051938	//////
052065	055868
215856	215909

6

1958 BETA

NELCAL	580508
002452	002505
928987	926989
121118	888005
050209	047546
050345	047496
//////	//////
050529	047433
050684	047421
050792	047407
050885	047355
051022	047322
051115	047281
051233	047254
//////	//////
051423	047224
051565	047188
051646	047085
002452	002505

7

1958 BETA

HAVANA	580508
004300	004314
141364	141364
125125	777005
050100	034080
050160	034040
050220	033900
050280	033950
050340	033920
050400	033880
050460	033840
050500	033800
050570	033760
050620	033730
050680	033700
050740	033660
050800	033620
050860	033580
050920	033550
004300	004314

8

1958 BETA

SNTAGO	580508
082547	082601
175339	174338
125125	555005
050750	048040
050520	048070
050300	048100
050060	048130
049830	048160
049600	048200
049370	048230
049130	048260
048950	048290
048680	048320
048450	048350
048220	048390
047999	048420
047740	048460
047520	048480
082547	082601

9

1958 BFTA

AGASTA	580508
104935	105000
196310	196310
110112	888005
045538	048727
045955	048984
046337	049129
046739	049385
047072	049553
047449	049765
047821	049967
048185	050144
048508	050347
048941	050528
049315	050721
049717	050966
050076	051124
050455	051201
050869	051493
051211	051684
051577	051890
051979	052103
052350	052300
052709	052487
053104	052686
054483	052886
054878	053089
055264	053282
055648	053477
056097	053693
104935	105000

10

1958 BETA

FTSTEW	580508
180025	180038
017320	016319
115115	555005
047630	039890
047910	039990
048170	040060
048420	040160
048700	040250
048970	040350
049250	040450
049500	040540
049780	040640
050050	040730
050300	040830
050550	040930
050810	041010
051040	041090
180025	180038

11

1958 BETA	
QOMERA	580508
194106	194139
262354	262354
108111	777005
045270	054270
045520	054360
045760	054455
046030	054550
046320	054645
046600	054740
046895	054840
047190	054230
047460	055010
047730	055100
048040	055200
048320	055285
048590	055380
048870	055480
049170	055590
049425	055700
049685	055800
049950	055900
050260	056000
050530	056090
050820	056180
051115	056260
051400	056360
051675	056460
051950	056560
052220	056660
052500	056760
052760	056860
053050	056260
053335	057050
053635	057140
053920	057240
054220	057340
054580	057425
194106	194139

12

QOTI BETA	
NELCAL	580508
201409	201422
928988	927988
114114	888005
049681	034347
049960	034446
050243	034506
050624	034666
050755	034747
050987	034850
051287	034936
051554	035029
051836	035131
052082	035232
052422	035290
052595	//////
052865	035537
053142	035630
201409	201422

13

1958 BETA	
FTSTEW	580508
202450	202508
017321	017321
120122	555005
408570	059080
048750	059070
048890	059055
049050	059040
049210	059035
049380	059020
049540	059015
049710	059010
049860	059005
050030	058995
050170	058980
050340	058970
050490	058960
050660	058945
050820	058930
050970	058920
051130	058910
051280	058890
051430	058880
202450	202508

14

1958 BETA	
NELCAL	580508
223826	223841
929989	928988
121121	999005
049766	057174
049032	057168
050083	057165
050273	057147
050450	057136
050597	057154
050783	857124
050944	057163
051073	057123
051297	057099
051412	057089
051582	057094
051747	057086
051936	057092
052059	057065
052261	057035
233826	233841

15

1958 BETA	
HAVANA	580508
225143	225156
140362	140362
120120	777005
049950	063790
050050	063750
050110	063710
050200	063670
050300	063630
050390	063580
050480	063540
050580	063500
050680	063460
050760	063430
050860	063380
050950	063340
051050	063300
051160	063250
225143	225156

16

1958 BETA	
FTSTEW	580508
225217	225236
017320	017320
120122	777005
049221	036201
049329	036187
049430	036122
049501	036088
049580	036060
049672	036048
049754	035972
049843	035950
049942	035920
050011	035875
050080	035850
050160	035820
050279	035780
050351	035753
050443	035709
050507	035680
050610	035650
050692	035592
050769	035550
050880	035568
225217	225236

17

1958 BETA	
NELCAL	580509
010532	010546
926988	927988
122122	777005
050258	036261
050232	036232
050384	036188
050588	036168
050538	036125
050643	036070
050831	036065
050785	036015
050916	035977
051091	035965
051070	035923
051174	035888
051317	035851
051337	035818
051469	035754
010532	010546

18

1958. BETA	
QUITOE	580509
012954	013006
065350	065350
131132	666005
050360	061675
050420	061630
050460	061600
050525	061540
050575	061500
050625	061460
050680	061420
050735	061375
050785	061330
050840	061290
050895	061250
050945	061200
050995	061160
012954	013006

19

1958 BETA	
SNTAGO	580509
090503	090514
194365	194365
110110	999005
052302	059599
052027	059677
051788	059691
051556	059837
051315	059919
051027	059988
050808	060060
050555	060017
050288	060225
050050	060292
049798	060377
049643	060446
090503	090514

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20

1958 BETA

HAVANA	580509
161532	161545
124349	125349
110115	777005
048030	036400
048360	036600
048760	036800
049150	037030
049540	037240
049940	037460
050330	037670
050740	037900
051120	038120
051460	038320
051900	038550
052300	038800
052700	039000
053080	039230
161532	161545

21

1958 BETA

FTSTEW	580509
183947	184009
017317	017318
118118	888005
047630	055240
047895	055334
047900	055347
048249	055405
048582	055430
048833	055471
048969	055494
049214	055579
049453	055584
049795	055689
049922	055683
050166	055721
050400	055772
050754	055891
050878	055854
051107	055891
051346	055927
051684	055958
051823	056002
052075	056033
052302	056092
052617	056104
052788	056139
183947	184009

22

1958 BETA

BPOINT	580509
184106	184121
360325	360325
121121	777005
049710	029600
049920	029630
050130	029670
050340	029700
050560	029740
050770	029770
050980	029805
051190	029840
051400	029870
051610	029910
051820	029940
052030	029970
052235	030025
052440	030065
052650	030100
052860	030140
184106	184121

23

1958 BETA

NELCAL	580509
205327	205341
927988	927989
112112	999005
048356	050977
048633	051017
048842	051056
049094	051122
049377	051129
049587	051231
049861	051281
050129	051327
050334	051383
050599	051433
050863	051469
051091	051541
051346	051575
051611	051619
051904	051695
205327	205341

24

1958 BETA

FTSTEW	580509
210433	210453
017317	017317
118120	777005
048642	053943
048815	053920
048980	053893
049098	053858
049244	053819
049398	053805
049475	053790
049658	053749
049808	053725
049919	053693
050083	053659
050218	053645
050335	053600
050496	053562
050622	053520
050772	053492
050915	053476
051056	053453
051105	053400
051324	053395
051467	053342
210433	210453

25

1958 BETA

FTSTEW	580509
233403	233416
017318	017318
125125	777005
049480	022260
049560	022220
049640	022200
049700	022170
049780	022140
049840	022100
049920	022070
049980	022040
050060	021999
050120	021980
050180	021960
050240	021920
050300	021900
050360	021860
233403	233416

26

1958 BETA

QUITOE	580510
021418	021430
050350	050350
120130	666005
050180	036470
050230	036430
050310	036390
050370	036350
050420	036310
050470	036270
050520	036230
050580	036190
050640	036150
050690	036110
050740	036070
050810	036030
050870	035990
021418	021430

27

1958 BETA

LIMAPU	580510
021512	021548
130380	130380
122122	333005
049520	061640
049570	061600
049620	061560
049680	061520
049730	061480
049780	061440
049840	061400
049890	061360
049950	061320
050000	061280
050050	061240
050100	061200
050160	061160
050210	061100
050260	061080
050320	061030
050380	060990
050430	060950
050480	060900
050540	060860
050590	060820
050650	060780
050700	060740
050760	060700
050810	060660
050860	060620
050910	060580
051030	060480
051080	060450
051130	060400
051180	060360
051230	060320
051280	060280
051330	060240
051380	060200
051440	060150
021512	021548

28

1958 BETA	
AGASTA	580510
094435	094500
209323	207322
120122	888005
046885	031108
047100	031203
047362	031223
047580	031387
047859	031474
048132	031559
048400	031620
048676	031746
048951	031879
049203	031924
049512	032036
049751	032116
050038	032195
050313	032336
050531	032379
050826	032496
051104	032593
051234	032684
051677	032784
051931	032864
052240	032982
052578	033110
052796	033203
053076	033284
053350	033394
053559	033484
094435	094500

29

1958 BETA	
LIMAPU	580510
120716	120730
120370	120370
100105	888005
047040	042600
047460	042900
047870	043160
048260	043410
048720	043700
049160	043020
049590	044280
050020	044560
050460	044850
050860	045140
051280	045400
051740	045720
052180	046020
052620	046280
053040	046580
120716	120730

30

1958 BETA	
FTSTEW	580510
191911	191923
018316	017316
120120	666005
048850	060695
049095	060697
049325	060699
049555	060701
049770	060704
049990	060706
050180	060708
050395	060711
050600	060713
050835	060715
051015	060717
051175	060721
051445	060725
191911	191923

31

1958 BETA	
BPOINT	580510
192025	192039
365335	365335
120120	666005
049520	033895
049700	033900
049880	033905
050080	033910
050260	033915
050450	033920
050640	033925
050830	033935
051010	033940
051200	033945
051390	033950
051590	033955
051780	033960
051970	033970
052160	033975
192025	192039

32

1958 BETA	
NELCAL	580510
213249	213301
925989	925988
118118	777005
049600	057950
049810	057960
049990	057960
050250	057970
050460	057980
050670	057980
050910	057990
051150	057990
051340	058000
051570	058020
051800	058030
051990	058040
052200	058050
213249	213301

33

1958 BETA	
FTSTEW	580510
214443	214459
014316	014315
120120	888005
049096	043546
049183	043549
049311	043542
049432	043506
049550	043496
049684	043453
049791	043410
049814	043373
050034	043332
050158	043282
050272	043248
050368	043208
050525	043167
050610	043118
050709	043081
050824	043020
050964	043045
214443	214459

34

1958 BETA	
BPOINT	580510
214630	214644
360330	360330
125125	666005
050200	022385
050300	022360
050400	022340
050500	022310
050600	022290
050700	022260
050800	022235
050900	022215
051000	022190
051100	022160
051200	022140
051300	022115
051400	022090
051500	022060
051600	022040
214630	214644

35

1958 BETA	
NELCAL	580510
235808	235826
930990	930989
122120	888005
049951	043244
050106	043212
//////	//////
050338	043148
050466	043096
050644	043042
050701	043050
050818	042990
050962	042932
051148	042891
051170	042872
051386	042793
051452	042791
051526	042776
051671	042728
051826	042692
051993	//////
052031	042614
052250	042570
235808	235826

36

1958 BETA	
NELCAL	580511
194836	194848
926987	926987
112114	555005
050840	041430
051160	041520
051481	041620
051820	041720
052120	041820
052440	041920
052770	042030
053080	042140
053400	042240
053720	042330
054050	042430
054370	042540
054690	042640
194836	194848

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1958 BETA

FTSTEW	580511
195831	195847
013317	013318
118120	666005
048561	058695
048736	058684
048905	058636
049080	058605
049300	058586
049451	058580
049648	058551
049861	058529
050026	058516
050205	058468
050389	058455
050531	058430
050759	058404
050937	058388
051121	058351
051300	058296
051501	058226
195831	195847

38

1958 BETA

BPOINT	580511
195948	200007
366325	366325
119119	666005
048980	032180
049160	032160
049310	032140
049490	032120
049640	032100
049840	032080
050000	032070
050180	032050
050340	032040
050500	032020
050660	032000
050840	031990
050990	031980
051160	031960
051320	031940
051480	031930
051640	031910
051810	031900
051990	031880
052140	031860
195948	200007

39

1958 BETA

NELCAL	580511
221212	221224
926986	927987
120212	999005
050234	056848
050432	056811
050588	056831
050798	056787
051000	056766
051274	056769
051353	056723
051589	056679
051750	056669
051967	056699
052125	056648
052342	056622
052569	056581
221212	221224

40

1958 BETA

QUITOE	580512
010252	010304
060360	060360
135132	666005
049950	053360
050000	053320
050050	053280
050100	053230
050150	053190
050210	053150
050260	053100
050320	053050
050380	052990
050420	052950
050480	052910
050540	052860
050580	052820
010252	010304

41

1958 BETA

LIMAPU	580512
010354	010424
120370	120370
122125	555005
049710	076560
049760	076520
049820	076490
049870	076460
049920	076420
049970	076380
050040	076350
050090	076320
050140	076280
050200	076240
050250	076210
050300	076170
050350	076140
050400	076100
050450	076070
050500	076040
050550	076000
050600	075970
050650	075930
050700	075890
050750	075850
050800	075820
050850	075780
050900	075740
050950	075710
051010	075670
051060	075630
051120	075600
051170	075550
051220	075520
051270	075480
010354	010424

42

1958 BETA

JOBURG	580512
015546	015615
902249	902250
120120	777005
048258	030073
048474	030266
048624	030184
048820	030219
049020	030224
049203	030309
049410	030356
049613	030394
049778	030354
049972	030474
050212	030520
050339	030482
050576	030599
050792	030649
051001	030705
051167	030640
051378	030762
051590	030825
051788	030769
051976	030906
052194	030968
052404	031018
052667	//////
052765	031093
053019	031159
053197	031104
053421	031222
053619	031297
054832	031350
054041	031363
015546	015615

43

1958 BETA

SNTAGO	580512
083914	083924
152320	152320
115115	999005
051881	064912
051615	064955
051404	065055
051262	065132
051047	065230
050834	065296
050673	065322
050415	065459
050201	065507
049846	065631
049694	065716
083914	083924

44

1958 BETA

FTSTEW	580512
181357	181414
014316	014316
125125	777005
047792	059695
048087	059729
048358	059788
048658	059802
048939	059815
049223	059850
049520	059875
049771	059899
050054	059924
050323	059931
050623	059985
050896	060001
051178	060035
051446	060067
051755	060096
051989	060111
052258	060127
052521	060149
181357	181414

45

1958 BETA

BPOINT	580512
181506	181525
370325	365323
118119	666005
048840	029560
049100	029580
049340	029610
049600	029640
049850	029670
050090	029700
050340	029730
050590	029760
050830	029780
051100	029820
051350	029840
051600	029870
051840	029900
052090	029930
052340	029960
052590	029980
052830	030020
053070	030050
053310	030080
053560	030120
181506	181525

46

1958 BETA

NELCAL	580512
225145	225157
929988	928987
122121	777005
050275	049548
//////	//////
050623	049494
050742	049448
050954	049401
051120	049358
051240	049332
051426	049291
051593	049253
//////	//////
051959	049182
052065	049139
052287	049093
225145	225157

47

1958 BETA

HAVANA	580512
230636	230649
123346	123347
120120	777005
050070	038630
050150	038590
050230	038540
050300	038500
050380	038450
050460	038400
050530	038360
050610	038310
050690	038260
050770	038220
050840	038170
050920	038120
051010	038080
051100	038030
230636	230649

48

1958 BETA

LIMAPU	580513
014821	014840
140370	140370
115115	555005
050100	052950
050160	052910
050210	052870
050270	052830
050330	052790
050380	052750
050440	052710
050490	052660
050540	052620
050600	052580
050650	052540
050710	052500
050760	052460
050820	052420
050880	052380
050930	052340
050990	052300
051050	052260
051110	052220
051160	052180
014821	014840

49

1958 BETA

JOBURG	580513
023527	023601
902248	902248
112112	666005
046831	048000
047133	048110
047265	048225
047502	048318
047718	048435
047973	048557
048210	048664
048446	048770
048634	048862
048850	//////
049103	049070
049347	049149
049578	049278
049824	049406
050067	049515
050306	049618
050536	049711
050716	049725
050998	049942
051328	050007
051474	050150
051725	050269
051960	050374
052193	050494
052393	050559
//////	//////
052901	050798
053137	050842
053383	051022
053631	051134
053875	051261
054154	051364
054311	051363
//////	//////
054833	051683
023527	023601

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1958 BETA

FTSTEW	580513
162957	163018
018318	018318
115116	888005
045683	030282
046033	030402
046450	030528
046871	030678
047253	030809
047635	030933
048033	031069
048398	031195
048817	031348
049216	031484
049605	031625
050001	031745
050355	031903
050764	032048
051180	032195
051552	032339
051957	032463
052293	032659
052737	032795
053128	032918
053535	033114
053901	033223
162957	163018

51

1958 BETA

FTSTEW	580513
185303	185326
017317	017317
114116	777005
047364	062173
047619	062170
047845	062168
048098	062159
048337	062124
048556	062119
048843	062113
049089	062109
049333	062095
049556	062081
049830	062077
050068	062066
050317	062060
050617	062058
050798	062049
051055	062032
051292	062008
051516	062000
051786	061990
052033	061979
052275	061858
052516	061935
052706	061928
052996	061912
185303	185326

52

1958 BETA

BPOINT	580513
185418	185436
365325	365325
119119	777005
049240	031720
049450	031710
049680	031700
049900	031700
050120	031700
050350	031700
050570	031700
050790	031700
051010	031690
051230	031690
051450	031690
051680	031690
051900	031680
052110	031680
052340	031680
052560	031680
052780	031670
052990	031670
053200	031670
185418	185436

53

1958 BETA

NELCAL	580513
210650	210662
928989	930989
120118	999005
049551	059480
049842	059488
050124	059480
050426	059452
050670	059471
050901	059489
051118	059479
051403	059466
051711	059451
051890	059440
052157	059439
052433	059431
052696	059419
210650	210662

54

1958 BETA

HAVANA	580513
211744	211757
124346	124347
125125	555005
049500	070590
049650	070540
049800	070490
049950	070440
050040	070380
050170	070330
050300	070270
050420	070220
050540	070170
050660	070120
050780	070060
050900	070030
051070	069970
051200	069910
211744	211757

55

1958 BETA

FTSTEW	580513
211814	211828
018318	018318
125125	777005
049172	037642
049315	037622
049444	037559
049583	037548
049704	037455
049828	037425
049960	037371
050100	037323
050201	037281
050331	037233
050434	037183
050607	037133
050723	037073
050865	037053
050988	036996
211814	211828

56

1958 BETA

PANTIG	580513
212721	212731
163284	161282
121122	777005
049545	055366
049625	055305
049715	055255
049800	055195
049875	055155
049975	055095
050060	055035
050140	054975
050225	054925
050305	054865
050405	054805
212721	212731

57

1958 BETA

NELCAL	580513
233141	233153
928988	927987
122125	666005
050105	037343
050284	//////
050307	037288
050433	037241
050629	037185
050738	037162
050826	//////
050984	037059
051145	036990
051317	//////
051473	036904
051510	036882
051664	036838
233141	233153

58

1958 BETA

QUITOE	580513
235206	235218
060345	060345
130132	666005
050260	070105
050325	070060
050385	070015
050450	069965
050505	069915
050560	069880
050625	069835
050680	069780
050745	069740
050800	069690
050860	069640
050925	069590
050995	069540
235206	235218

59

1958 BETA

QUITOE	580514
122206	122218
060350	060350
110110	888005
047210	050465
047695	050815
048150	051145
048565	051455
049025	051795
049455	052125
049895	052450
050360	052800
050815	053130
051270	053455
051720	053800
052180	054130
052625	054450
122206	122218

60

1958 BETA	
FTSTEW	580514
170905	170927
018319	019319
116116	777005
045796	053670
046189	053749
046578	053813
046874	053877
047389	053990
047620	054018
048064	054157
048441	054241
048825	054315
049198	054395
049570	054478
049946	054545
050319	054645
050641	054682
051117	054711
051320	054852
051831	054862
052186	054966
052548	055081
052910	055167
053281	055225
053650	055317
053990	055356
170905	170927

61

1958 BETA	
FTSTEW	580514
193218	193241
018319	018314
117118	777005
047544	057252
047751	057205
048004	057164
048172	057130
048423	057109
048623	057057
048821	057014
049094	056972
049286	056952
049501	056919
049720	056880
049953	056835
050151	056792
050371	056751
050586	056719
050789	056678
051017	056674
051228	056618
051449	056564
051649	056535
051879	056497
052098	056469
052248	056420
052504	056377
193218	193241

62

1958 BETA	
BPOINT	580514
193336	193355
375335	375335
120120	777005
048920	027870
049100	027840
049290	027820
049490	027800
049680	027770
049870	027740
050040	027720
050230	027700
050420	027670
050600	027650
050790	027620
050990	027600
051150	027580
051340	027560
051520	027530
051710	027510
051900	027490
052070	027470
052250	027450
052440	027440
193336	193355

63

1958 BETA	
NELCAL	580514
214602	214614
930990	929989
120120	888005
049554	055445
049777	055423
049999	055385
050235	055343
050475	055305
050719	055219
050914	055240
051119	055197
051330	055175
051553	055119
051866	055095
052021	055061
052230	055022
214602	214614

64

1958 BETA	
QUITOE	580515
003606	003618
060350	060350
130132	777005
050220	044100
050280	044060
050340	044020
050400	043990
050450	043940
050510	043900
050580	043840
050620	043800
050680	043740
050740	043720
050800	043660
050850	043620
050920	043580
003606	003618

65

1958 BETA	
LIMAPU	580515
103655	103718
120370	120370
100105	888005
046950	034310
047490	034460
047770	034620
048050	034770
048310	034920
048590	035060
048870	035230
049150	035390
049420	035550
049700	035710
049980	035870
050260	036040
050540	036200
050800	036360
051090	036530
051370	036700
051670	036870
051940	037030
052240	037200
052520	037370
052790	037550
053100	037730
053380	037890
053660	038040
103655	103718

66

1958 BETA	
HAVANA	580515
152509	152522
123348	123347
115115	777005
047840	075880
048290	076050
048760	076220
049200	076370
049700	076550
050160	076700
050630	076860
051060	077020
051500	077170
051910	077300
052430	077460
052870	077590
053320	077730
053770	077880
152509	152522

67

1958 BETA	
FTSTEW	580515
201150	201211
016310	018313
118120	777005
047830	045925
048049	045865
048211	045808
048392	045760
048648	045716
048761	045681
048960	045610
049139	045562
049322	045491
049490	045446
049686	045343
049883	045331
050043	045303
050234	045228
050404	045188
050620	045150
050782	045105
050957	045005
051131	044965
051307	044908
051474	044859
051679	044763
201150	201211

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1958 BETA

HAVANA	580515
224005	224016
124346	128346
125125	777005
050000	029960
050080	029920
050180	029870
050260	029820
050360	029780
050450	029740
050540	029690
050630	029650
050730	029600
050820	029550
050910	029500
050990	029460
224005	224016

69

1958 BETA

LIMAPU	580516
012107	012129
120380	120380
122122	666005
049850	045270
049900	045230
049960	045190
050020	045150
050070	045110
050120	045070
050180	045030
050240	044980
050300	044940
050340	044900
050400	044860
050460	044820
050510	044780
050560	044740
050620	044700
050680	044660
050730	044620
050780	044590
050840	044540
050900	044500
050950	044470
051020	044430
051070	044400
012107	012129

70

1958 BETA

AGASTA	580516
085322	085342
200318	201319
112114	999005
047069	055069
047301	055154
047527	055274
047690	055425
057921	055513
048122	055627
048324	055745
048529	055858
048747	055976
048950	056179
049142	056212
049354	056330
049545	056432
049709	056558
049972	056669
050170	056783
050365	056892
050584	057007
050788	057126
050987	057212
051199	057365
085322	085342

71

1958 BETA

FTSTEW	580516
160434	160450
019315	020315
115120	777005
046085	040050
046570	040190
047035	040335
047512	040485
047995	040630
048466	040765
048934	040915
049409	041073
049903	041200
050340	041370
050816	041525
051274	041672
051772	041820
052230	041983
052728	042110
053187	042245
053645	042405
160434	160450

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1958 BETA

FTSTEW	580516
182711	182727
018314	018314
115115	777005
047751	062625
048035	062609
048340	062580
048634	062540
048915	062516
049203	062497
049488	062460
049786	062423
050087	062397
050355	062360
050652	062330
050931	062300
051218	062260
051494	062233
051823	062202
052073	062180
052364	062120
182711	182727

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1958 BETA

NELCAL	580516
204056	204108
929987	930987
115115	777005
049161	060078
049497	060054
049877	//////
050107	060046
050381	059994
050690	059961
051002	059939
051307	059918
051613	059894
051930	059863
052377	059849
052568	059837
052801	059798
204056	204108

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1958 BETA

HAVANA	580516
205130	205143
124347	124347
120125	777005
049550	065830
049700	065750
049830	065690
049990	065610
050140	065540
050300	065470
050470	065400
050630	065330
050800	065260
050940	065200
051060	065140
051210	065060
051350	065010
051500	064940
205130	205143

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1958 BETA

PANTIG	580516
210049	210113
150271	148269
122122	555005
048905	046830
049015	046770
049100	046705
049200	046635
049290	046580
049380	046515
049485	046450
049575	046385
049665	046325
049775	046255
049875	046200
049955	046140
050040	046075
050140	046005
050230	045945
050330	045880
050420	045825
050510	045765
050605	045700
050695	045640
050780	045580
050885	045520
050975	045465
051065	045400
051165	045340
210049	210113

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1958 BETA

NELCAL	580516
230526	230538
928988	926988
124122	666005
049931	030150
050114	030116
050289	030080
050368	030011
050561	029969
050747	029946
050834	029891
050991	029823
051149	029772
051303	029729
051459	029659
051653	029638
051806	029551
230526	230538

77

1958 BETA

HAVANA	580517
142036	142047
123349	123350
110110	999005
047450	045930
048020	046230
048550	046530
049160	046840
049720	047130
050270	047440
050860	047770
051420	048070
051990	048390
052580	048700
053120	049000
053700	049300
142036	142047

78

1958 BETA

FTSTEW	580517
164334	164348
020315	019314
118118	777005
047090	060680
047530	060740
047980	060800
048410	060880
048860	060930
049280	060980
049720	061040
050140	061100
050560	061160
051000	061220
051420	061270
051850	061330
052280	061380
052680	061440
053130	061500
164334	164348

79

1958 BETA

NELCAL	580517
185719	185735
930989	930989
112114	999005
047363	054581
047798	054656
048247	054730
048714	054802
049169	054880
049623	054960
050074	055032
050520	055105
050990	055174
051432	055250
051868	055319
052307	055368
052760	055498
053260	055578
053667	055650
054104	055688
054567	055751
185719	185735

80

1958 BETA

QUITOE	580518
000912	000924
070360	075360
130133	777005
050170	035350
050230	035310
050280	035270
050340	035230
050380	035190
050450	035140
050510	035100
050570	035060
050620	035010
050680	034970
050730	034940
050800	034890
050860	034850
000912	000924

81

1958 BETA

LIMAPU	580518
001011	001034
110370	110370
122122	777005
049880	061060
049940	061020
050000	060960
050060	060920
050120	060870
050170	060820
050220	060780
050280	060740
050340	060690
050400	060640
050460	060600
050520	060550
050580	060510
050630	060460
050690	060420
050750	060380
050800	060340
050860	060290
050920	060240
050980	060200
051040	060160
051100	060110
051160	060060
051220	060020
001011	001034

82

1958 SOLAR BETA

LIMAPU	580518
101145	101204
120380	120380
100100	888005
048340	055340
048580	055510
048830	055690
049060	055860
049300	056050
049550	056220
049800	056400
050060	056580
050320	056760
050560	056930
050810	057120
051050	057290
051300	057460
051550	057640
051810	057820
052040	058000
052300	058190
052560	058370
052820	058550
053080	058720
101145	101204

83

1958 BETA

FTSTEW	580518
194551	194607
019313	019313
120120	888005
048309	038747
048524	038691
048740	038615
048937	038550
049120	038467
049350	038420
049540	038350
049757	038292
049963	038226
050176	038153
050374	038070
050574	038035
050787	037983
050990	037900
051190	037850
051387	037779
051583	037712
194551	194607

84

1958 BETA

PANTIG	580518
195313	195330
153271	154271
121122	666005
048918	063724
049049	063684
049178	063591
049297	063426
049433	063402
049579	063352
049695	063260
049826	063210
049945	063124
050081	063050
050205	062988
050328	062906
050469	062857
050579	062730
050764	062644
050855	062572
050973	062516
051103	062420
195313	195330

85

1958 BETA

AGASTA	580519
005833	005847
197313	198315
120123	666005
049510	056550
049565	056515
049625	056480
049680	056445
049740	056410
049800	056375
049860	056340
049920	056300
049990	056265
050035	056235
050085	056200
050150	056160
050210	056120
050270	056090
050325	056060
005833	005847

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1958 BETA

QUITOE	580519
105150	105202
060360	060360
125122	888005
049050	038650
049350	038870
049660	039080
049950	039270
050250	039470
050530	039670
050820	039880
051140	040090
051420	040290
051730	040510
052000	040710
052320	040910
052630	041120
105150	105202

87

1958 BETA

NELCAL	580519
175257	175309
931989	932989
110109	999005
047520	041924
048075	042067
048624	042210
049174	042339
049721	042506
050245	042642
050764	042789
051310	042940
051869	043074
052408	043226
052954	043372
053499	043517
054060	043676
175257	175309

88

1958 BETA

FTSTEW	580519
180123	180139
020317	020316
115117	555005
047360	061640
047710	061590
048050	061535
048390	061490
048730	061435
049070	061400
049400	061340
049750	061300
050070	061250
050420	061200
050760	061155
051090	061100
051420	061050
051770	060980
052080	060920
052430	060880
052770	060820
180123	180139

89

1958 BETA

NELCAL	580519
201510	201522
932991	932992
115115	888005
049144	059123
049406	059061
049888	059046
050178	058994
050520	058961
050884	058915
051234	058865
051600	058820
051950	058769
052299	058725
052647	058682
052979	058632
053361	058583
201510	201522

90

1958 BETA

HAVANA	580519
202526	202542
123350	123349
115115	999005
049180	058900
049380	058800
049540	058720
049700	058620
049900	058540
050040	058460
050240	058340
050380	058260
050620	058180
050700	058080
050900	058000
051120	057920
051280	057840
051460	057740
051580	057640
051740	057560
051900	057460
202526	202542

91

1958 BETA

PANTIG	580519
203435	203451
151267	151268
123123	777005
048673	036480
048759	036420
048823	036340
048945	036200
049069	036210
049153	036150
049273	036100
049363	036020
049473	035950
049569	035890
049667	035830
049771	035770
049886	035700
050001	035640
050067	035590
050162	035520
050294	035460
203435	203451

92

1958 BETA

LIMAPU	580519
225951	230006
060350	060350
120120	666005
049840	077870
049900	077830
049970	077780
050030	077730
050100	077690
050160	077640
050230	077590
050300	077550
050360	077500
050420	077460
050500	077410
050560	077360
050620	077320
050680	077280
050760	077230
050820	077180
225951	230006

93

1958 BETA

LIMAPU	580520
090547	090605
070370	070370
115115	666005
049870	032280
050050	032370
050210	032460
050380	032550
050560	032640
050740	032730
050910	032820
051090	032920
051270	033020
051440	033120
051620	033210
051790	033310
051970	033410
052150	033500
052320	033590
052510	033690
052680	033780
052860	033880
053050	033980
090547	090605

94

1958 BETA

HAVANA	580520
135525	135539
123349	122348
110115	777005
046860	069610
047500	069840
047900	070100
048510	070350
049060	070580
049580	070810
050160	071040
050710	071270
051260	071490
051800	071730
052360	071960
052860	072170
053420	072390
053930	072600
054500	072810
135525	135539

95

1958 BETA

WELCAL	580520
183148	183200
928990	927989
111110	999005
047564	060699
048042	060758
048558	060789
049067	060855
049574	060899
050081	060959
050537	061007
051109	061061
051614	061115
052130	061159
052637	061213
053155	061252
053664	061282
183148	183200

96

1958 BETA

FTSTEW	580520
184030	184048
018316	018315
115117	666005
047587	048361
047871	048302
048151	048246
048450	048163
048748	048063
049025	047986
049340	047906
049602	047822
049918	047762
050209	047688
050500	047609
050792	047525
051092	047468
051340	047384
051628	047305
051949	047298
052241	047134
052513	047065
052803	046993
184030	184048

97

1958 BETA

HAVANA	580520
210605	210618
123348	123348
110115	777005
049300	032710
049440	032620
049580	032550
049730	032500
049880	032430
050040	032360
050100	032310
050250	032230
050340	032140
050460	032100
050570	032030
050700	031970
050890	031900
051040	031840
210605	210618

98

1958 BETA

LIMAPU	580520
234321	234337
080370	080370
120120	777005
049990	052440
050060	052390
050120	052340
050180	052300
050240	052250
050300	052200
050360	052160
050430	052110
050490	052060
050550	052010
050610	051960
050680	051910
050740	051860
050810	051820
050870	051770
050930	051720
051000	051670
234321	234337

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The following are additional data for the 1958 BETA messages:

Message Number	Meridian Crossing Time			Elevation Angle		Residuals* (Radians)	
	Hr	Min	Sec	Deg	Min	East-West	North-South
1	00	00	28.64	87	41N	2.5974281,-04	1.9628167,-04
2	02	41	18.70	83	29S	-6.5678748,-04	-1.0145575,-03
3	17	20	38.38	76	27N	3.7129782,-04	3.6531500,-04
4	19	02	02.47	79	31S	-5.9544661,-04	1.1434426,-03
5	21	59	02.58	84	23N	-2.7097213,-04	-2.7434411,-04
6	00	24	58.30	86	50S	5.1020602,-04	-1.7921737,-04
7	00	43	09.97	72	17S	3.2169916,-04	9.0257136,-04
8	08	25	46.33	87	38S	7.2479107,-04	4.2820896,-04
9	10	49	47.11	89	38N	-6.4986650,-03	-3.1399948,-03
10	18	00	32.28	79	44S	-2.9472110,-05	-9.8026299,-04
11	19	41	23.92	84	39N	9.0867806,-04	2.1570060,-03
12	20	14	13.57	73	31S	1.1477057,-03	-6.2657863,-04
13	20	24	56.28	80	55N	4.5787868,-04	-1.6754749,-04
14	22	38	32.95	82	56N	-5.4484271,-04	1.9822857,-04
15	22	51	51.13	76	15N	6.1070766,-04	9.6000207,-05
16	22	52	21.06	74	54S	1.0126723,-03	-4.9219309,-04
17	01	05	39.96	74	49S	-8.5928078,-04	4.3777399,-05
18	01	29	58.52	78	50N	3.0445119,-04	-5.4297652,-04
19	09	05	08.48	79	50N	4.9685055,-04	1.7225198,-03
20	16	15	38.85	76	49S	-1.2075170,-03	-5.9840844,-04
21	18	39	55.45	84	29N	-1.2798279,-03	-3.7835200,-04
22	18	41	12.11	67	33S	-3.5289500,-05	-7.3946051,-04
23	20	53	37.28	88	50N	-7.4303039,-04	-3.0662777,-04
24	21	04	39.50	86	26N	7.9228921,-05	-6.1569362,-04
25	23	34	04.45	59	10S	5.2191506,-05	-1.1000336,-03
26	02	14	25.07	74	31S	4.1414805,-04	-1.7277669,-03
27	02	15	28.34	79	31N	-2.1793141,-03	-9.1491266,-04
28	09	44	47.13	70	15S	7.6244818,-05	1.6683758,-03
29	12	07	24.18	83	31S	-4.0523707,-03	4.5572275,-03
30	19	19	14.19	79	08N	-1.0350412,-03	-1.8474936,-05
31	19	20	32.96	72	08S	1.3985719,-03	-8.1950658,-04
32	21	32	55.09	82	02N	-1.1842063,-03	5.6646938,-05
33	21	44	47.30	82	48S	6.3749724,-04	-1.4336822,-03
34	21	46	38.04	58	37S	5.3825363,-04	-1.2891195,-03
35	23	58	15.76	82	13S	4.7570720,-05	-7.8187644,-04
36	19	48	36.26	80	38S	6.6328010,-03	4.5701395,-05
37	19	58	36.63	81	24N	3.1352747,-03	4.2629393,-04
38	20	00	00.08	69	59S	2.6634049,-03	3.4288759,-04
39	22	12	15.62	83	18N	2.9447273,-03	8.5411814,-04
40	01	03	04.17	87	58N	2.1848434,-03	2.2451895,-04
41	01	04	29.23	62	51N	1.4009519,-03	6.0778114,-04
42	01	56	00.38	68	26S	6.4829118,-03	6.2697153,-04
43	08	39	18.84	74	08N	5.3096240,-03	1.6409094,-04
44	18	14	03.28	80	01N	1.8412043,-03	2.7924904,-04
45	18	15	14.65	67	33S	8.4591752,-04	-7.8112073,-04
46	22	51	48.99	88	59S	1.1167100,-03	1.2079655,-03
47	23	06	43.76	77	16S	1.6099472,-03	9.3023359,-04
48	01	48	28.92	88	16N	2.6680662,-03	1.0738793,-04
49	02	35	45.95	89	08S	9.2347827,-03	2.1347815,-03
50	16	30	06.95	70	03S	-2.7808692,-04	-1.5207376,-03

(Cont'd)

Message Number	Meridian Crossing Time			Elevation Angle		Residuals* (Radians)	
	Hr	Min	Sec	Deg	Min	East-West	North-South
51	18	53	12.03	77	40N	-8.7704028,-04	8.9921419,-04
52	18	54	25.98	69	40S	-5.8622603,-04	3.8832658,-06
53	21	06	55.09	80	28N	-2.7078272,-04	1.2291409,-03
54	21	17	52.91	68	58N	4.3988824,-05	1.8565605,-03
55	21	18	17.12	76	29S	3.5976905,-04	6.9808971,-04
56	21	27	26.79	84	47N	1.2177716,-03	8.9244295,-04
57	23	31	47.60	75	59S	8.5127669,-04	1.9084858,-03
58	23	52	11.57	69	45N	2.2008089,-03	7.7360842,-04
59	12	22	13.50	87	47N	9.6254465,-03	3.7769187,-03
60	17	09	15.05	85	43N	-2.5719308,-03	3.7420308,-04
61	19	32	27.38	83	10N	-9.0573406,-04	1.1655219,-03
62	19	33	47.24	65	01S	-1.1136190,-03	6.2226201,-05
63	21	46	08.06	84	56N	-1.3961067,-03	1.3964993,-03
64	00	36	12.49	82	39S	3.1778875,-03	-2.0811011,-03
65	10	37	06.87	74	23S	2.2196047,-03	7.3654891,-04
66	15	25	15.12	61	10N	-3.5920179,-03	-1,0784546,-03
67	20	11	59.42	84	52S	-7.1669241,-04	5.8356818,-04
68	22	40	12.42	67	50S	1.0414056,-03	5.3740234,-04
69	01	21	19.14	83	31S	3.1608418,-03	-8.0426749,-04
70	08	53	35.36	83	56N	-4.1809293,-03	1.8517681,-03
71	16	04	41.36	80	20S	-3.4499339,-03	-9.6304155,-04
72	18	27	17.31	77	17N	-1.1050277,-03	1.0277320,-03
73	20	41	01.71	79	58N	-1.6903306,-03	9.9355063,-04
74	20	51	37.28	74	15N	6.0357648,-04	1.1550767,-03
75	21	01	00.81	85	52S	1.6270667,-03	-1.1390046,-03
76	23	05	32.68	68	03S	1.2005022,-03	-5.5661785,-04
77	14	20	41.65	87	09S	8.3683204,-04	1.9068433,-03
78	16	43	39.70	78	48N	5.1605908,-04	5.8745918,-04
79	18	57	26.99	84	59N	8.8588014,-05	4.8422079,-04
80	00	09	19.80	73	25S	3.1608369,-06	-2.5862503,-03
81	00	10	21.87	79	56N	1.8063394,-04	5.7980986,-04
82	10	11	53.86	83	48N	5.3367656,-04	4.2069585,-05
83	19	45	57.15	77	22S	-4.4125121,-05	1.3717373,-04
84	19	53	21.69	76	17N	2.9304963,-04	4.7770926,-04
85	00	58	42.21	84	20N	9.8127959,-04	1.3922529,-03
86	10	51	55.19	78	18S	-6.6526838,-04	1.4897640,-03
87	17	53	03.28	82	06S	-6.7745138,-04	4.0238686,-04
88	18	01	29.54	78	29N	7.6399658,-04	1.4094116,-04
89	20	15	15.12	81	04N	1.0701890,-04	2.4451599,-04
90	20	25	34.48	81	55N	-6.4306412,-04	-5.2833039,-04
91	20	34	48.70	74	45S	5.7111490,-04	-9.6490801,-04
92	22	59	03.60	89	05N	-4.5428752,-05	-8.9073013,-04
93	09	05	50.43	70	27S	3.9633114,-04	2.4052726,-03
94	13	55	31.90	67	41N	-2.4455265,-03	2.6872738,-03
95	18	31	54.66	78	48N	2.1660971,-05	1.2407321,-03
96	18	40	36.87	87	30S	3.1155181,-04	-3.0174895,-03
97	21	06	15.41	70	26S	2.6408156,-05	-1.1793646,-03
98	23	43	28.83	88	51N	5.5458222,-04	-2.2272669,-03

*The last two numbers following the comma in each residual indicate the power of ten by which the residual should be multiplied.

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Appendix C

MINITRACK STATION INFORMATION

The information given here is necessary or useful in the adjustment of Minitrack data for orbit computation. The WWV transmission delay times, ΔT, given here, are corrected for Minitrack receiver time delay, while the true WWV time delay is 0.0003 second less than the values given.

BLOSSOM POINT (BPOINT), STATION 1

Latitude = $38^\circ\ 25'\ 49.718''$ N

Longitude = $77^\circ\ 05'\ 11.830''$ W

= $05^h\ 08^m\ 20.788^s$

Correction constants for calculating a_o, b_o

a_o (EW)		b_o (NS)	
$K_f\ (a)$	= 0.037 sec	$K_f\ (b)$	= 0.037 sec
$K_c - K_{s_1}\ (a)$	= 50.642	$K_c - K_{s_1}\ (b)$	= 50.438

ΔT = 0.0005 sec

Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= -.00556107	C_o	= .00247012
C_1	= .99987595	C_1	= .00449655
C_2	= .00006308	C_2	= 1.00006096
C_3	= .00000350	C_3	= -.00001303
C_4	= .00019398	C_4	= -.00044802
C_5	= -.00001534	C_5	= -.00004839
C_6	= -.00000057	C_6	= -.00000094
C_7	= -.00245287	C_7	= -.00055400
C_8	= .00265016	C_8	= .00255954

FORT STEWART (FTSTEW), STATION 2

Latitude = $31^\circ\ 59'\ 07.805''$ N

Longitude = $81^\circ\ 29'\ 41.960''$ W

= $05^h\ 25^m\ 58.797^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a) = 0.038$ sec	$K_f\ (b) = 0.035$ sec
$K_c - K_{s_1}\ (a) = 49.574$	$K_c - K_{s_1}\ (b) = 50.036$

$\Delta T = 0.0042$ sec

Correction constants for calculating a_c, b_c

a_c (EW)	b_c (NS)
$C_o = .00255106$	$C_o = -.00151427$
$C_1 = .99579100$	$C_1 = -.00099363$
$C_2 = -.00007050$	$C_2 = .99982107$
$C_3 = -.00000792$	$C_3 = .00000651$
$C_4 = -.00030097$	$C_4 = .00000706$
$C_5 = .00000291$	$C_5 = .00000317$
$C_6 = .00000020$	$C_6 = .00000017$
$C_7 = -.00022668$	$C_7 = .00198475$
$C_8 = .00248910$	$C_8 = -.00007290$

HAVANA (HAVANA), STATION 3

Latitude = 22° 52′ 18.132″ N

Longitude = 82° 31′ 26.120″ W

= $05^h\ 30^m\ 05.741^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a) = 0.036$ sec	$K_f\ (b) = 0.036$ sec
$K_c - K_{s_1}\ (a) = 50.542$	$K_c - K_{s_1}\ (b) = 50.045$

$\Delta T = 0.0071$ sec

Correction constants for calculating a_c, b_c

a_c (EW)	b_c (NS)
$C_o = .00264235$	$C_o = .00056146$
$C_1 = 1.00039475$	$C_1 = .00064399$
$C_2 = .00043344$	$C_2 = .99909800$
$C_3 = .00000469$	$C_3 = -.00003755$
$C_4 = .00024361$	$C_4 = .00025918$
$C_5 = .00000327$	$C_5 = -.00000855$

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C_6 = -.00000065	C_6 = .00000124
C_7 = -.00183571	C_7 = .00056337
C_8 = .00120195	C_8 = .00216724

WOOMERA (OOMERA), STATION 4

Latitude = 31° 06′ 09.490″ S

Longitude = 136° 46′ 59.520″ E

= $09^h\ 07^m\ 08.000^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a)$ = 0.036 sec	$K_f\ (b)$ = 0.038 sec
$K_c - K_{s_1}\ (a)$ = 49.912	$K_c - K_{s_1}(b)$ = 50.447

ΔT = 0.0592 sec

Correction constants for calculating a_c, b_c

a_c (EW)	b_c (NS)
C_o = .00033957	C_o = .00097259
C_1 = .99942252	C_1 = .00000752
C_2 = -.00033148	C_2 = 1.00006449
C_3 = -.00000222	C_3 = -.00000656
C_4 = -.00001972	C_4 = -.00025210
C_5 = -.00006641	C_5 = .00003811
C_6 = -.00000070	C_6 = -.00000085
C_7 = -.00108156	C_7 = -.00181704
C_8 = .00119592	C_8 = .00135404

QUITO (QUITOE), STATION 5

Latitude = 00° 37′ 21.751″ S

Longitude = 78° 34′ 45.230″ W

= $05^h\ 14^m\ 19.051^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a)$ = 0.037 sec	$K_f\ (b)$ = 0.037 sec
$K_c - K_{s_1}(a)$ = 50.538	$K_c - K_{s_1}(b)$ = 50.500

ΔT = 0.0161 sec

a_c (EW)	b_c (NS)
Not Available	Not Available

LIMA (LIMAPU), STATION 6

Latitude = 11° 46′ 36.492″ S

Longitude = 77° 09′ 01.816″ W

= $05^h\ 14^m\ 19.051^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a)$ = 0.037 sec	$K_f\ (b)$ = 0.035 sec
$K_c - K_{s_1}\ (a)$ = 50.392	$K_c - K_{s_1}\ (b)$ = 50.596

ΔT = 0.0202 sec

Correction constants for calculating a_c, b_c

a_c (EW)	b_c (NS)
C_o = -.00874135	C_o = -.00216710
C_1 = .99933606	C_1 = .00144955
C_2 = .00001416	C_2 = 1.00003780
C_3 = .00000469	C_3 = -.00000974
C_4 = .00003195	C_4 = .00023152
C_5 = .00001439	C_5 = -.00000303
C_6 = -.00000007	C_6 = -.00000006
C_7 = -.00095979	C_7 = -.00237657
C_8 = .00226136	C_8 = -.00281737

ANTOFAGASTA (AGASTA), STATION 7

Latitude = 23° 37′ 15.993″ S

Longitude = 70° 16′ 23.162″ W

= $05^h\ 41^m\ 05.544^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a)$ = 0.035 sec	$K_f\ (b)$ = 0.035 sec
$K_c - K_{s_1}\ (a)$ = 49.833	$K_c - K_{s_1}\ (b)$ = 50.483

ΔT = 0.0253 sec

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Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= -.01431411	C_o	= -.00122082
C_1	= .99898387	C_1	= .00056909
C_2	= -.00044002	C_2	= .99978069
C_3	= .00000682	C_3	= .00002113
C_4	= -.00007993	C_4	= .00004305
C_5	= -.00002519	C_5	= -.00003930
C_6	= .00000071	C_6	= .00000086
C_7	= -.00223855	C_7	= -.00130019
C_8	= -.00054936	C_8	= .00443858

SANTIAGO (SNTAGO), STATION 8

Latitude = 33° 08′ 58.106″S

Longitude = 70° 40′ 08.717″ W

= $04^h\ 42^m\ 40.581^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a) = 0.035$ sec	$K_f\ (b) = 0.035$ sec
$K_c - K_{s_1}\ (a) = 50.723$	$K_c - K_{s_1}(b) = 49.937$

$\Delta T = 0.0302$ sec

Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= .00009182	C_o	= -.00012094
C_1	= -.99933028	C_1	= .00022778
C_2	= -.00022083	C_2	= .99983078
C_3	= .00000746	C_3	= .00000845
C_4	= .00001513	C_4	= .00012467
C_5	= -.00001304	C_5	= -.00002229
C_6	= .00000084	C_6	= .00000085
C_7	= .00217408	C_7	= .00357407
C_8	= -.00048738	C_8	= -.00293296

ANTIGUA (PANTIG), STATION 9

Latitude = 17° 08′ 32.586″ N
Longitude = 61° 46′ 43.464″ W
= $04^h\ 07^m\ 06.898^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a) = 0.032$ sec	$K_f\ (b) = 0.034$ sec
$K_c - K_{s_1}\ (a) = 49.874$	$K_c - K_{s_1}\ (b) = 49.771$

$\Delta T = 0.0103$ sec

Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= -.00303914	C_o	= -.00014096
C_1	= .99993472	C_1	= .00079328
C_2	= .00088206	C_2	= 1.00030655
C_3	= .00005416	C_3	= -.00000070
C_4	= .00025811	C_4	= -.00002543
C_5	= -.00010294	C_5	= -.00001359
C_6	= -.00000352	C_6	= -.00000093
C_7	= -.00209201	C_7	= -.00475523
C_8	= -.00133575	C_8	= -.00457846

SAN DIEGO (NELCAL), STATION 10

Latitude = 32° 34′ 47.420″ N
Longitude = 116° 58′ 16.922″ W
= $07^h\ 47^m\ 53.128^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a) = 0.035$ sec	$K_f\ (b) = 0.035$ sec
$K_c - K_{s_1}(a) = 50.006$	$K_c - K_{s_1}\ (b) = 49.391$

$\Delta T = 0.0137$ sec

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Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= -.00014782	C_o	= .00143814
C_1	= 1.00035944	C_1	= .00169431
C_2	= .00086871	C_2	= 1.00018498
C_3	= .00002403	C_3	= .00001449
C_4	= .00004249	C_4	= -.00031896
C_5	= -.00005240	C_5	= -.00001893
C_6	= -.00000148	C_6	= -.00000101
C_7	= .00068459	C_7	= .00096549
C_8	= .00025666	C_8	= .00009781

ESSELEN PARK (JOBURG), STATION 11

Latitude = 26° 01′ 56.846″ S

Longitude = 28° 14′ 28.376″ E

= $01^h\ 52^m\ 57.867^s$

Correction constants for calculating a_o, b_o

a_o (EW)	b_o (NS)
$K_f\ (a)$ = 0.038 sec	$K_f\ (b)$ = 0.036 sec
$K_c - K_{s_1}\ (a)$ = 50.064	$K_c - K_{s_1}\ (b)$ = 50.673

ΔT = 0.0466 sec

Correction constants for calculating a_c, b_c

a_c (EW)		b_c (NS)	
C_o	= .00044249	C_o	= .00068233
C_1	= .99742768	C_1	= .00208813
C_2	= .00027577	C_2	= 1.00026758
C_3	= -.00000136	C_3	= -.00001295
C_4	= .00013060	C_4	= -.00026938
C_5	= .00002286	C_5	= .00001257
C_6	= -.00000055	C_6	= -.00000032
C_7	= .00026498	C_7	= .00474859
C_8	= .00154181	C_8	= .00303026

Appendix D

CONVERSION TABLE, DEGREES FROM ZENITH TO LOBE NUMBERS FROM 050.000

Degrees From Zenith	Lobe Number	Degrees From Zenith	Lobe Number	Degrees From Zenith	Lobe Number	Degrees From Zenith	Lobe Number
1	0.96	26	24.07	51	42.67	76	53.27
2	1.92	27	24.92	52	43.26	77	53.49
3	2.87	28	25.77	53	43.85	78	53.70
4	3.83	29	26.62	54	44.42	79	53.89
5	4.79	30	27.45	55	44.97	80	54.07
6	5.74	31	28.28	56	45.52	81	54.23
7	6.69	32	29.09	57	46.04	82	54.37
8	7.64	33	29.90	58	46.56	83	54.49
9	8.59	34	30.70	59	47.06	84	54.60
10	9.53	35	31.49	60	47.55	85	54.69
11	10.48	36	32.27	61	48.02	86	54.77
12	11.41	37	33.04	62	48.48	87	54.83
13	12.35	38	33.80	63	48.92	88	54.87
14	13.28	39	34.55	64	49.35	89	54.89
15	14.21	40	35.29	65	49.76	90	54.90
16	15.13	41	36.02	66	50.16	-	-
17	16.05	42	36.74	67	50.54	-	-
18	16.97	43	37.44	68	50.90	-	-
19	17.87	44	38.14	69	51.26	-	-
20	18.78	45	38.82	70	51.59	-	-
21	19.68	46	39.49	71	51.91	-	-
22	20.57	47	40.15	72	52.22	-	-
23	21.45	48	40.80	73	52.50	-	-
24	22.33	49	41.44	74	52.78	-	-
25	23.20	50	42.06	75	53.03	-	-

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Appendix E

ORBITAL ELEMENTS OF 1958 ALPHA AND 1958 BETA

The following are the orbital elements of 1958 Alpha (Explorer I) issued on 28 May 1958 by the Vanguard Computing Center of the U. S. Naval Research Laboratory.

Epoch	21 May 1958 00 Hr 00 Min U.T.
Anomalistic Period	114.106 Min
Eccentricity	0.13630
Inclination	33.235 degrees
Longitude of Ascending Node	120.834 degrees (Motion minus 4.338 degrees per day)
Argument of Perigee	93.466 degrees (Motion plus 6.474 degrees per day)
Mean Anomaly at Epoch	111.305 degrees
Semimajor Axis	1.2218 earth radii
Perigee	219.0 statute miles
Apogee	1539.1 statute miles

The following are the orbital elements of 1958 Beta (Vanguard TV-4) issued on 11 June 1958 by the Vanguard Computing Center of the U. S. Naval Research Laboratory.

Epoch	7 June 1958 12 Hr 27 Min U.T.
Anomalistic Period	134.266 Min
Eccentricity	0.19042
Inclination	34.25 degrees
Longitude of Ascending Node	266.92 degrees (Motion minus 3.04 degrees per day)
Argument of Perigee	129.18 degrees (Motion plus 4.45 degrees per day)
Mean Anomaly at Epoch	138.22 degrees
Semimajor Axis	1.3618 earth radii
Perigee	406.06 statute miles
Apogee	2461.54 statute miles