INDEPENDENT TRACKING COORDINATION

PROGRAM QUARTERLY REPORT

July 1, 1966 to September 30, 1966

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INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

October 20, 1966

Dr. John T. Holoway, Acting Director
Office of Grants and Research Contracts
Office of Space Science and Applications
National Aeronautics and Space Administration
Reporters Building
Washington, D.C. 20546

Dear Dr. Holloway:

Our last regular report was forwarded to you under date of July 18, 1966, covering the period 1 April to 30 June, 1966.

Enclosed please find Summary and Report of Activities for the third quarter period - 1 July to 30 September, 1966. A complete set of Exhibits will be made available shortly and forwarded separately to the Office of Grants and Research Contracts.

A financial statement in the prescribed NASA Form 1030-1031 for the same period is going forward by separate mail.

Respectfully,

Norton Goodwin
Program Director

Enclosures:
(1) Summary and Report
(2) Exhibits A and B.
(3) Exhibits to follow:
C, D, E, F, G, H, I,
J, K, L, M, N, O, P, Q.

INDEPENDENT TRACKING COORDINATION PROGRAM

SUMMARY OF PROGRESS AND REPORT OF ACTIVITIES - 3rd Quarter 1966

I. TRACKING AND DATA ACQUISITION

A. During the period, a number of observations have been received from independent tracking sources overseas and forwarded to Goddard Space Flight Center. (See EXHIBIT A for complete listing of 2314 observations on 86 satellites. Some of these sightings covered the preceding period but did not reach ITCP until this period.

B. During the period, 2,528 complete sets of current gear ratio elements derived by NASA's Goddard Space Flight Center from NORAD data were included in ITCP biweekly airmail orbital element announcements. See EXHIBIT B for an itemized listing per satellite. Copies of each biweekly announcement mailed are submitted as EXHIBITS C, D, E, F, G and H.

C. During the period positional elements in the form of gear ratio element sets derived by independent observers were included in the airmail announcements on the satellites listed in Section B (Exhibit F, inside back page) These elements were received from Professor Erwin Baier, Vienna, Austria.

II. Form for Calculating Orbit Approach Times. A great deal of unnecessary computational effort in making local satellite predictions can be avoided by preparing in advance a schedule of the orbit approach times of selected satellites at the observer's latitude, as described in ITCP Bulletin of March 25, 1966. As an aid in preparing such a schedule, a new form, ITCP 5-66, has been developed during the period as an aid in preparing such schedules. Form ITCP 5-66 (EXHIBIT I) is used in calculating values for entry in the orbit approach schedule, using the observer's geocentric co-latitude and orbital elements as input. ITCP 5-66 is designed for the benefit of observers who do not have access to desk calculators and who may not be familiar with operations involving negative, as well as positive, numbers. It provides explicit conversion from mixed numbers to indexed numerators to facilitate slide-rule calculation. A filled-in example of how Form 5-66 is used in preparing a schedule of orbit approach times of six satellites for a specific observer latitude is given in Appendix A to ITCP Bulletin of September 29, 1966 (EXHIBIT J) (See item IV, below).

III. Schedule of Local Culmination. During the period, a form for scheduling the circumstances of local culmination was developed. ITCP Form 6-66 (EXHIBIT K) is also designed for the benefit of observers who do not have access to desk calculators and who may not be familiar with the operations involving negative as well as positive numbers. It also provides explicit conversion from mixed numbers to indexed numerators to facilitate slide-rule calculation. The schedule is designed for use with map coordinates for the station and satellite data in the form in which they appear in ITCP biweekly airmail orbital element announcements. (See item IB above.)

Form ITCP 6-66 is designed for use with methods described in ITCP Bulletin on Graphic Predictions of Local Culminations (ITCP Bulletin, September 29, 1966). See item IV below.

IV. Bulletin on Graphic Prediction of Local Culminations. The ITCP Bulletin of September 29, 1966 (EXHIBIT J) gives a step-by-step illustrated explanation of graphic methods for predicting the circumstances of local culmination, using ITCP Form 6-66 and the following graphic aids:

A Rationalized Meridional Stereographic Projection of the Hemisphere (ITCP 532);

A Rationalized Zenith Distance and Slant Range Finder;

A Chart for Determining True Anomaly from Mean Anomaly (ITCP 2-66);

A Chart for Determining Radius Vector from Mean Anomaly (ITCP 3-66); and

Brightness Charts (ITCP Bull. Sept. 30, 1965).

The method for graphic prediction assumes map coordinates for the station and gear ratio elements for the satellite as input. From these data, the following circumstances are determined:

(1) The time of local culmination (to the nearest minute);

(2) Azimuth (to the nearest degree of arc);

(3) Elevation (to the nearest degree of arc);

(4) Slant range (to the nearest 10 km.).

IV. (cont.)

Radio observers should consider the time of local culmination to be identical to the time of doppler inflection when the apparent satellite frequency is equal to the transmitted frequency. Radio observers require no further calculations on form ITCP 6-66.

For the benefit of optical observers, the following additional information is determined by graphic means:

(5) Sky brightness (before or after astronomical twilight);

(6) Satellite illumination (in or out of earth's shadow);

(7) Brightness gain due to slant range;

(8) Brightness gain due to phase angle;

(9) Brightness gain due to zenith distance;

(10) Apparent brightness; and

(11) Photovisual magnitude.

For the benefit of those who wish to plot the predicted position and motion of the satellite at the time of local culmination on a star chart, the method provides for determining the following additional data:

(12) Apparent right ascension (to the nearest hour and miniute);

(13) Apparent declination (to the nearest degree of arc); and

(14) Apparent direction of motion (to the nearest 100th of a turn);

The Bulletin on Graphic Prediction of Culmination includes step-by-step illulstrations on the use of all the graphic aids and follows through a complete satellite prediction plotted on a portion of a star atlas.

V. Bulletin on Practical Arithmetic. A Bulletin on Practical Arithmetic was issued September 30, 1966 (EXHIBIT M) as a companion to the Bulletin dated September 29th on Graphic Prediction of Local Culminations. It was prepared for the benefit of those who do not have access to desk calculators. The bulletin reviews briefly rules for arithmetic operations with signed numbers. It also provides rules for determining the index (position of the decimal point) in products

V. (cont.)

and quotients obtained with a slide-rule or with shortened forms of multiplication or division. The availability and use of the Atlas slide-rule for multiplication and division with an uncertainty of one unit in the 5th decimal position is explained in detail. Algorithms for multiplication and division by the method of progressive rounding are described.

VI. Updated Index of Satellites. An updated Index of Catalog Numbers (NCAT) and Popular Names Corresponding to IDENT Designations of Unclassified Earth Satellites in Orbit as of August 10, 1966 was published on August 23, 1966(EXHIBIT N). A Cross Index dated August 24, 1966 (EXHIBIT O) listed the same satellites in the order of their Catalog numbers (NCAT) for use in finding corresponding IDENT designations assigned by COSPAR.

VII. Current Space Junk List. In order to keep inconsequential data from displacing potentially useful information, the ITCP maintains a computer listing of space debris on which orbital elements are routinely suppressed. Recipients of ITCP airmail announcement services are periodically informed of the current space junk listing. A revised Junk List was published on August 25, 1966 (EXHIBIT P).

VIII. Additions to Radio Frequency Listing. A list of additional satellites presumed to be transmitting, together with the frequencies on each, was published as part of the Orbital Element Announcement of 39317.9 (July 11, 1966) (EXHIBIT L

IX. Tables of Standard Brightness Values. An updated listing of the Standard Brightness of Satellites ordered by Catalog Number was published under date of August 11, 1966. The list included a number of measured values forwarded by Professor Erwin Baier, Vienna, Austria. A companion table of the same information ordered by brightness value was given on the reverse side (EXHIBIT Q)

NOTE: Information on the calculated brightness of an artificial earth satellite under standard viewing conditions is an essential prerequisite to a determination of whether or not circumstances will permit optical observation. ITCP collects and disseminates such information as it becomes available and is the only known source from which such brightness data can be obtained.

X. Announcements and Bulletins

A. Summary of Current Gear Ratio Elements Issued.

Date	No. Dist.	No. Satellites	
39317.9	507	203	(See EXHIBIT C - July 11, 1966)
39331.9	505	251	(See EXHIBIT D - July 25, 1966)
39345.9	495	228	(See EXHIBIT E - Aug. 8, 1966)
39359.9	554	210	(See EXHIBIT F - Aug. 22, 1966)
39373.9	489	215	(See EXHIBIT G - Sept. 5, 1966)
39387.9	489	193	(See EXHIBIT H - Sept. 19, 1966)

EXHIBITS ATTACHED TO THIS REPORT

A - List of independent tracking observations received from sources overseas.

B - List of satellites and number of gear ratio element sets published on each satellite during the period.

C, D, E, F, G, H - Biweekly Airmail Orbital Element Announcements.

I - Form for Calculating Orbit Approach Times (ITCP 5-66)

J - Bulletin of September 29, 1966 - Graphic Prediction of Local Culminations.

K - Form ITCP 6-66 for use with Bulletin of Sept. 29 -(EX. J)

L - Additions to List of Radio-transmitting Satellites.

M - Bulletin of Sept. 30, 1966 on Practical Arithmetic.

N - Catalog Numbers and Popular Names Corresponding to IDENT Designations of Unclassified Satellites - August 23, 1966

O - Cross Index listing satellites in order of NCAT - Aug. 24, 1966

P - Current Space Junk Lixt dated August 25, 1966.

Q - Table of Standard Brightness Value issued August 11, 1966

INDEPENDENT TRACKING COORDINATION PROGRAM - NsG 35-60 10/20/66

EXHIBIT A

The following observations have been received from independent observers overseas and forwarded to Goddard Space Flight Center:

NCAT	No.	NCAT	No.	NCAT	No.
0049	418	0876	57	2119	2
0031	3	0877	3	2161	6
0045	3	0893	1	2168	1
0070	1	0897	1	2169	5
0116	1	0899	29	2172	1
0117	1	0922	1	2173	7
0163	15	0924	5	2176	1
0271	1	0931	81	2253	251
0285	2	0953	1	1089	86
0447	1	0965	1	2255	13
0513	1	1092	5	2256	1
0527	4	1097	6	2257	2
0564	22	1245	2	2296	1
0574	3	1314	1	2376	1
0594	1	1420	3	2403	10
0612	2	1428	1	2410	1
0613	3	1441	222	1777	52
0622	2	1570	61	1843	232
0624	8	1447	1		
0671	1	1448	1	Unknown	32
0683	3	1472	1		
0714	63	1510	1		
0717	1	1514	2		
0727	3	1522	1	TOTAL	2314
0730	2	1575	1		
0731	2	1584	7	on 86 satellites	
0740	314	1589	3		
0741	1	1726	1		
0751	2	1738	5		
0759	37	1779	1		
0824	4	1808	1		
0832	2	1814	6		
0851	1	1868	145		
0870	6	1869	7		

INDEPENDENT TRACKING COORDINATION PROGRAM - NsG 35-60 10/20/66

EXHIBIT B

Recapitulation of Current Gear Ratio Elements Published in Biweekly Airmail Announcements (See Exhibits O through U)

NCAT	No.	NCAT	No.	NCAT	No.	NCAT	No.	NCAT	No.
0004	13	0255	6	0694	8	0879	2	1272	1
0005	2	0257	6	0703	1	0897	2	1273	4
0011	2	0271	4	0704	2	0899	1	1291	4
0012	4	0285	8	0705	3	0900	4	1292	2
0016	2	0288	8	0714	12	0902	2	1293	7
0020	2	0309	1	0716	2	0922	6	1310	3
0022	3	0340	2	0717	2	0924	4	1314	1
0023	3	0311	2	0721	5	0925	9	1315	2
0028	3	0341	3	0727	3	0931	15	1317	3
0029	3	0388	2	0728	1	0932	3	1324	14
0031	16	0397	2	0729	1	0933	4	1328	1
0043	5	0398	2	0730	2	0959	2	1329	8
0045	3	0503	2	0731	1	0963	1	1359	1
0046	2	0504	3	0733	3	0965	4	1360	1
0047	3	0506	1	0734	3	0973	7	1361	2
0049	17	0509	1	0735	7	0978	3	1377	5
0050	3	0527	1	0737	2	0983	26	1378	2
0058	3	0534	2	0738	2	0987	3	1381	7
0059	1	0535	1	0740	10	1000	2	1385	2
0060	3	0564	4	0746	5	1001	2	1420	4
0062	8	0573	2	0748	7	1002	2	1422	10
0063	4	0574	2	0759	8	1085	5	1425	1
0064	-	0579	1	0771	5	1088	3	1430	1
0070	4	0589	3	0775	22	1089	22	1431	34
0079	3	0594	4	0801	2	1090	25	1441	7
0082	2	0604	2	0812	4	1091	20	1442	3
0099	6	0605	5	0813	2	1097	3	1443	4
0107	8	0612	10	0824	7	1098	11	1444	4
0116	4	0613	7	0829	8	1208	2	1445	4
0117	1	0614	13	0830	6	1228	16	1447	9
0162	2	0622	2	0851	17	1244	1	1448	5
0163	3	0624	10	0858	4	1245	1	1467	7
0165	2	0630	1	0869	2	1248	6	1468	3
0192	2	0635	2	0870	1	1250	16	1472	11
0202	7	0669	2	0871	2	1267	23	1504	1
0204	3	0670	1	0872	8	1268	20	1506	2
0205	2	0671	2	0876	4	1269	22	1508	2
0226	2	0682	-	0877	2	1270	27	1510	3
0227	4	0683	12	0878	5	1271	3	1511	2

EXHIBIT B - Page 2

NCAT	No.	NCAT	No.	NCAT	No.	NCAT	No.	NCAT	No.
1512	2	1864	2	2152	23	2249	-	2328	7
1514	2	1865	1	2158	6	2253	28	2330	1
1515	3	1868	4	2159	23	2254	5	2331	1
1570	2	1869	3	2167	2	2255	2	2332	2
1571	2	1902	1	2168	3	2256	3	2333	8
1573	2	1941	1	2169	6	2257	7	2334	2
1574	1	1949	21	2172	5	2259	24	2335	2
1575	2	1950	12	2173	2	2262	6	2336	4
1580	2	1952	3	2174	1	2263	3	2338	2
1584	1	;967	10	2176	3	2289	1	2339	10
1585	3	1982	2	2180	4	2290	32	2340	2
1586	2	1983	2	2182	31	2291	1	2358	15
1587	2	1997	9	2183	13	2292	3	2349	2
1588	2	2002	21	2184	19	2293	32	2350	1
1589	3	2003	25	2186	9	2294	6	2351	9
1613	13	2016	1	2195	1	2295	24	2352	2
1620	8	2017	1	2200	30	2296	35	2353	3
1624	7	2091	2	2201	8	2307	1	2354	1
1625	6	2100	1	2202	30	2308	1	2355	4
1726	4	2101	7	2203	12	2309	1	2356	2
1729	2	2102	2	2204	15	2310	1	2357	8
1738	19	2103	5	2205	24	2311	1	2358	3
1739	7	2104	19	2206	6	2312	1	2361	1
1777	28	2107	-	2207	2	2313	1	2362	1
1778	4	2119	2	2208	3	2314	1	2363	3
1779	32	2120	2	2215	1	2315	1	2364	1
1804	6	2121	3	2216	2	2316	1	2365	2
1805	6	2122	4	2217	2	2317	1	2367	2
1806	8	2123	2	2218	2	2318	1	2368	4
1807	4	2124	2	2219	2	2319	2	2369	10
1814	2	2125	2	2220	2	2320	1	2370	1
1815	3	2129	2	2221	4	2321	1	2371	1
1842	18	2142	2	2223	2	2322	9	2372	1
1843	2	2144	4	2224	4	2323	1	2373	2
1844	5	2145	2	2225	2	2324	18	2374	1
1846	10	2150	9	2226	1	2325	5	2375	2
		2151	8	2227	11	2326	3	2376	10
						2327	8	2377	1

EXHIBIT B - page 3

NCAT	No.
2378	1
2380	1
2381	1
2382	3
2383	12
2384	4
2385	5
2386	6
2387	14
2388	5
2389	6
2390	11
2391	5
2392	3
2393	19
2396	7
2397	5
2399	11
2400	1
2401	5
2403	6
2404	6
2405	6
2407	1
2408	2
2409	5
2410	11
2411	1
2412	2
2413	1
2414	1
2415	1
2418	3
2419	2
2420	1
2421	1
2422	11
2424	1

420 different satellites

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	G[illegible]
00813	9313	353190	386488	681799	106191	4175432	0001	277114	0721322	001022	0215200	-0543451
00824	9306	781482	849636	455737	110521	5200417	0025	228011	0688538	001314	-0191855	-0630488
00830	9307	700360	619490	982387	789	1096049	0000	163451	3973614	193172	-0172462	0056414
00851	9305	947680	766287	985662	77801	1474955	0134	265796	0830438	165610	0102914	-0493829
00851	9310	043433	771115	962437	78271	1475802	0117	265827	0830397	165539	0103117	-0493746
00851	9314	051750	775835	939699	78731	1476563	0103	265829	0830360	165507	0103142	-0493769
00869	9298	047875	076772	604339	1348	2060564	0296	187466	2608696	861458	-0154232	-0053774
00871	9309	162212	660148	685385	93821	3866491	0001	221946	0731992	007458	-0216190	-0521645
00872	9304	235327	381939	420736	98001	4666871	0017	274163	0705127	024453	0201370	-0589612
00876	9304	893058	371548	127613	96831	4471401	0002	180705	0711388	011914	-0550724	-0072182
00878	9310	687614	400723	365092	98931	4661867	0014	274213	0705288	024349	0201692	-0589014
00900	9307	859873	905365	768404	85551	3514252	0002	249712	0744665	001445	-0002156	-0595490
00922	9314	328956	615073	714112	92721	5180969	0024	227887	0689125	000662	-0192604	-0628665
00924	9316	010731	846304	366387	88631	4520388	0014	144289	0709693	025346	-0810366	0591528
00931	9304	960983	875392	665079	72731	2500241	0038	226079	0784388	088122	-0164861	-0488803
00931	9306	960884	871240	652637	72981	2500566	0055	226034	0784375	088059	-0165168	-0488573
00931	9315	920022	852786	597815	74101	2501775	0066	226061	0784324	087576	-0164963	-0488637
00932	9315	910739	855807	631296	73761	2391717	0001	225975	0788960	098199	-0164619	-0485443
00933	9304	992335	877956	699926	72391	2389259	0003	225953	0789065	098049	-0164705	-0485153
00933	9306	848869	874222	688866	72621	2389175	0001	225959	0789068	098059	-0164664	-0485183
00973	9311	645403	288720	849155	78541	4758169	0023	274202	0702217	018535	0203166	-0593659
00978	9311	831169	692177	097525	63991	2085212	0000	267820	0802244	093847	0117857	-0494497
00983	9307	822667	539587	335116	77711	5804070	3348	135238	0670694	013059	-0970017	0866336
00983	9310	415749	499881	371128	78121	5819433	4547	135212	0670259	012637	-0971408	0868011
00983	9311	363782	485224	383122	78271	5824770	3070	135203	0670108	012417	-0971888	0868597
00983	9312	438097	468771	400999	78441	5830430	2931	135242	0669949	012152	-0972053	0868096
00983	9314	711447	433733	432810	78801	5842422	2839	135217	0669611	012038	-0973195	0869527
00983	9315	405669	423149	440502	78911	5845293	2658	135191	0669530	011893	-0973597	0870321
00987	9316	069989	584385	484658	77841	4928328	0004	091258	0696550	003877	-1143582	1721071
01001	9305	060853	234223	363954	4978	9906793	0000	089247	0915620	001221	-0667129	1018512
01085	9312	589181	830742	399063	74981	4851965	0020	088188	0698928	011297	-1160276	1769077
01089	9310	941646	105877	451921	69051	4009814	0192	155726	0726865	062809	-0708443	0354362
01089	9314	938732	066176	472029	69611	4011061	0176	155718	0726822	062843	-0708594	0354561
01090	9310	178269	119157	453150	68891	4040064	0242	155736	0725821	061613	-0710037	0354997
01090	9314	095478	080041	472878	69441	4041649	0225	155748	0725766	061489	-0710026	0354809
01091	9305	176556	075594	469808	68811	4206956	0289	155767	0720126	056112	-0719463	0359243
01098	9304	447332	606649	739495	72441	4868168	0016	180614	0698678	009691	-0571541	-0073346
01098	9309	020965	567843	735000	73121	4868165	0016	180607	0698678	009815	-0571603	-0073228
01098	9313	728995	527878	728710	73821	4868163	0016	180645	0698678	009832	-0571312	-0073843
01228	9304	336941	209125	269089	70231	4962586	0360	249941	0695821	029990	-0000504	-0684574
01228	9307	344244	209134	237583	70671	4964237	0303	249941	0695770	029855	-0000504	-06[illegible]652
01228	9310	885694	209157	201322	71201	4966806	0346	249941	0695690	029906	-0000504	-06[illegible]17
01250	9304	784740	207639	294484	70131	4886886	0160	249954	0698177	031834	-0000397	-06[illegible]63
01250	9311	903972	207670	222288	71181	4890658	0227	249953	0698059	031962	-0000399	-0680518
01267	9305	255412	422472	333538	65271	4083323	0440	155680	0724334	060122	-0712878	0357278
01267	9307	456555	400330	344671	65571	4084671	0388	155635	0724287	060295	-0713330	0358196
01267	9309	373474	381059	354456	65851	4086025	0379	155696	0724241	060055	-0712936	0357067
01267	9312	284046	351765	369162	66251	4087632	0325	155673	0724186	060149	-0713228	0357557
01267	9315	123250	323263	383310	66661	4089324	0304	155717	0724128	059946	-0712984	0356769
01268	9308	427990	398225	338299	65681	4010753	0284	155718	0726833	062908	-0708596	0354564
01268	9310	926036	373356	350823	66031	4011740	0248	155687	0726799	062790	-0708826	0355146
01268	9314	280240	340017	367603	66501	4013091	0224	155686	0726752	062800	-0708926	0355205
01269	9305	393686	345532	367438	65791	4210924	0417	155700	0719991	056313	-0720247	0360663
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39317.9

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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39317.9

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02	26	39	31	44	96	15	38	93	62	82	00	109
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02	29	09	31	29	23	44	14	10	47	19	29	096
02	29	09	31	35	65	04	14	03	90	49	17	341
02	29	09	31	43	99	65	73	95	59	39	17	882
02	29	09	31	52	98	22	73	86	60	09	18	397
02	29	09	31	63	88	93	13	75	61	99	18	653
02	29	19	31	17	35	85	60	15	49	87	67	153
02	29	29	31	33	05	31	04	06	42	39	23	843
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20	15	73	51	47	97	75	17	61	23	06	72	767
29	15	80	02	25	10	30	17	62	39	06	70	919
10	15	57	41	50	28	87	17	62	23	06	77	395
15	15	58	37	40	35	99	17	62	81	06	77	117
32	15	59	43	17	84	87	17	62	63	06	76	811
42	15	60	15	11	41	54	17	62	85	06	76	603
15	15	60	41	23	52	66	17	62	68	06	76	527
36	15	64	79	67	78	87	17	62	53	06	75	263
21	56	06	18	13	76	81	35	54	70	67	63	530
12	15	60	55	11	12	91	13	55	04	06	76	372
41	56	20	05	21	32	61	35	65	30	67	59	530
12	15	62	02	92	11	56	13	56	01	06	75	946
32	15	62	52	90	19	22	13	55	87	06	75	802
1064384	-1132909	1836256
1064086	-1134874	1839541
1061391	-1142387	1851972
001465	-1295531	1983576
1021235	-0643852	-0003203
1021357	-0644153	-0001833
1021072	-0644400	-0001754
020835	-0644482	-0002024
020749	-0645007	-0001601
001465	-1295531	1983576
1018604	-0660276	0000164
1016934	-0654078	0001560
015555	-0656606	-0000566
020788	-0644759	-0000274
020673	-0644812	-0001311
1020946	-0645573	-0000990
018344	-0645498	-0001401
020715	-0646048	-0001076
019346	-0648433	-0000825
013367	-0951768	0844973
012942	-0951960	0845853
013379	-0952168	0843573
012526	-0952452	0844686
012493	-0952951	0845356

ADDITIONS TO INDEX

Catalog Numbers and Popular Names Corresponding to IDENT Designations of Recent Unclassified Earth Satellites

IDENT	NAME	NCAT	IDENT	NAME	NCAT
1966 38A	COSMOS 118	02168	1966 52A		02201
1966 38B		02169	1966 52B		02206
1966 39B		02172	1966 53A		02207
1966 40A	NIMBUS 2	02173	1966 53B		02215

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of [illegible]

NCAT	AJNE	ANRP	APRM1	ANGR	CP	CG	GR1	G
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02158	645311	551766	14870039	087947	005763	-1152780		1775858
02158	671037	631666	14874932	087947	005610	-1153278		1776624
02159	696401	903182	15820897	134351	005323	-0976328		0887353
02159	276150	922269	15826037	134346	005319	-0977389		0887865
02159	181638	961165	15836722	134330	005123	-0978367		0889013
02159	580293	993660	15846191	134352	004950	-0978987		0889207
02159	346919	019146	15853332	134348	004860	-0979606		0889849
02168	957415	412021	14827137	180587	003418	-0569458		-0072608
02169	306129	614853	14844561	180523	006507	-0570914		-0071691
02172	990122	758338	15101765	305443	001739	0471493		-0288255
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02180	319115	006504	13922896	250004	006607	0000033		-0619716
02182	312989	461976	14582033	134402	048930	-0884278		0802431
02182	138491	529961	14600081	134407	048167	-0885457		0803424
02183	910676	869090	12413772	179633	121748	-0477661		-0047254
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02226	931043	2335618278440 36	5261	341267	400012	474710	74841	9020154	-0018759	-0589647
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02253	930607	0973935034390937	49	793639	800002	417941	06176	7004399	-0030191	-0289034
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02254	931164	7345200977413277	1521	483394	900021	805110	69975	1003692	-0570399	-0071410
02255	930455	5034935396402218	37	794512	200002	416711	06099	0002985	-0030689	-0289339
02256	930302	3636935903296112	24	794016	300002	416666	06143	2002370	-0030684	-0289089
02256	930707	4176934772377507	57	794032	200062	414611	06141	7003117	-0031439	-0288899
02257	930348	5778269886355366	311	483428	601301	804990	69974	0006792	-0570577	-0071249
02257	930766	3644234532331488	931	483541	300064	805370	69970	5009693	-0570455	-0071888
02257	931615	1730142664325400	2191	483536	500012	805530	69970	7009502	-0570326	-007[illegible]
02259	930057	9071973544071778	271	418026	537229	079964	07208	1706512 8	-1132428	183[illegible]
02259	931063	6519[illegible]4099537	421	418932	405607	079979	07205	1006456 4	-1133030	183[illegible]
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39331.9

NO JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG	GR1	GR2
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Current Gear Ratio Elements Derived by [illegible]

NCAT JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG GR1 GR[illegible]
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39331.9

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NCAT JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG GR1	G...
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39331.9

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022939324312373295243912357					1831567804046551762630674399018598					-0649943	-0000992
022939326288461274974914440					2141569818450791762730673823018024					-0650912	-0001185
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023489329774788150219408183					781573405300000801800672520000206					-1278811	2069723

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of [illegible]

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	G[illegible]
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02349	93252	49994	238799	130272	515	12489	80000	08000	10690	468022	875-1216612	1971133
02350	93256	70584	229148	093753	1216	38229	73887	08017	60654	648002	292-1349637	2184398
02351	93266	61099	298363	463659	516	09993	60966	18041	80662	578001	583-0636965	-0077960
02351	93274	68342	290081	500413	1816	15753	54994	18052	30661	003002	831-0639113	-0080256
02351	93285	21079	279210	512643	3516	16660	34930	18052	70660	756002	858-0639559	-0080385
02351	93304	37468	259378	509747	6616	18641	25467	18057	00660	217002	629-0640228	-0081301
02352	93267	86299	297106	483505	716	14867	46316	18058	60661	245002	595-0638100	-0081343
02352	93271	60112	293292	520984	1316	15361	62175	18056	50661	110002	859-0638546	-0080993
02353	93285	43505	891151	719418	1151	36801	98001	04007	30073	833900	0661 0983369	1389768
02353	93303	70953	915765	754172	1401	36802	63001	24007	51073	833600	064C 0983472	1390167
02354	93293	97928	156167	122500	6815	77680	65611	08014	90671	303004	607-1283709	2078027
02355	93298	98908	147479	498246	7715	57486	10000	08023	70677	097000	250-1261327	2040733

ADDITIONS TO INDEX

Catalog Numbers and Popular Names Corresponding to IDENT Designations of Recent Unclassified Earth Satellites

IDENT	NAME	NCAT
1966 38A	COSMOS 118	02168
1966 38B		02169
1966 39B		02172
1966 40A	NIMBUS 2	02173
1966 40B		02174
1966 41A		02176
1966 41B		02180
1966 42A		02181
1966 43A	COSMOS 119	02182
1966 44A	EXPL. 32	02183
1966 44B		02184
1966 45A	SURVEY 1	02185
1966 45B		02187
1966 46A	ATDA	02186
1966 46B		02188
1966 46E		02228
1966 49A	OGO 3	02195
1966 50A	COSMOS 120	02196
1966 51A		02200
1966 51B		02205
1966 51C		02202
1966 52A		02201
1966 52B		02206
1966 53A		02207
1966 53B		02215
1966 53C		02216
1966 53D		02217
1966 53E		02218
1966 53F		02219
1966 53G		02220
1966 53H		02221
1966 53J		02222
1966 55A		02227
1966 56A	PAGEOS-1	02253
1966 56B		02255
1966 56C		02256
1966 57A	COSMOS 122	02254
1966 57B		02257
1966 58A	EXPL. 33	02258
1966 59A		02289
1966 60A	PROTON	02290
1966 60B		02293
1966 61A	COSMOS 123	02295
1966 61B		02296
1966 62A		02322
1966 63A		02324
1966 63B		02327
1966 64A		02325
1966 64B		02326
1966 65A		02348
1966 67	COSMOS 125	02351

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39345.9

NCAT JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG GR1 G[illegible]
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INDEPENDENT TRACKING COORDINATION PROGRAM, 824 CONNECTICUT AVENUE, WASHINGTON, D. C. 20006

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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39345.9

NO[illegible] JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG	GR1	GR2
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INDEPENDENT TRACKING COORDINATION PROGRAM, 824 CONNECTICUT AVENUE, WASHINGTON, D. C. 20006

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39345.9

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A D D I T I O N S   T O   I N D E X

Catalog Numbers and Popular Names Corresponding to IDENT Designations of Recent Unclassified Earth Satellites

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1966 38B	COS 118 R	02169
1966 39B		02172
1966 40A	NIMBUS 2	02173
1966 40B		02174
1966 41A		02176
1966 41B		02180
1966 42A		02181
1966 43A	COSMOS 119	02182
1966 44A	EXPL. 32	02183
1966 44B		02184
1966 45A	SURVEYOR 1	02185
1966 45B		02187
1966 46B		02188
1966 46E		02228
1966 49A	OGO 3	02195
1966 50A	COSMOS 120	02196
1966 51A		02200
1966 51B		02205
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1966 53J		02222
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1966 56B		02255
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1966 57A	COSMOS 122	02254
1966 57B		02257
1966 58A	EXPL. 33	02258
1966 59AL	DEBRIS	02352
1966 60A	PROTON 3	02290
1966 60B	PROTON 3 R	02293
1966 61A	COSMOS 123	02295
1966 61B		02296
1966 62A		02322
1966 63A	OV-8	02324
1966 63B		02327
1966 64A	COSMOS 124	02325
1966 64B		02326
1966 65A	AGENA TARGET	02348
1966 67A	COSMOS 125	02351
1966 68A	COSMOS 126	02368
1966 68B	COS 126 R	02369
1966 69A	US PAYLD	02376

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39359.9

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
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00775	9356	447545	274750	848598	12672	14885938	0893	143428	0698024	032564	-0844990	0630477
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00824	9349	211102	726053	049083	11696	15202750	0026	228005	0688467	001721	-0191948	-0630584
00824	9358	749963	698306	975883	11841	15203095	0021	228024	0688457	001734	-0191793	-0630714
00829	9355	091491	183645	415322	6580	85689930	0004	169046	1008786	330483	-0396617	0075673
00851	9349	496681	817713	738667	8281	11490008	0223	265756	0829712	164839	0102770	-0494509
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00922	9345	943823	522843	381049	9752	15182668	0031	227877	0689074	000447	-0192721	-0628697
00924	9348	309369	466248	644943	9332	14521198	0014	144294	0709667	025422	-0810411	0591493
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01088	9345	099624	289410	229990	7974	14838396	0008	088180	0699354	011694	-1148952	1767136
01089	9345	758000	759924	626525	7393	14025123	0301	155709	0726336	062398	-0709464	0355134
01089	9352	601806	691819	660809	7489	14029481	0315	155712	0726186	062282	-0709701	0355200
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01090	9358	566250	635309	697537	7568	14072057	0508	155647	0724720	060732	-0712527	0357599
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01098	9347	357489	242339	690155	7882	14868668	0016	180675	0698662	009987	-0571113	-0074337
01098	9352	132757	201824	685986	7953	14868690	0016	180644	0698661	010102	-0571362	-0073825
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01248	9350	235878	206451	807407	7709	15013541	0521	249989	0694246	028295	-0000098	-0687412
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01248	9356	562376	206391	742503	7805	15019165	0461	249989	0694073	027882	-0000098	-0687689
01250	9348	612985	207630	852011	7665	14911881	0312	249953	0697397	031490	-0000400	-0681730
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01250	9358	670153	207636	750536	7815	14917725	0290	249953	0697215	031028	-0000400	-0682007
01267	9345	979698	012541	541112	7100	14106578	0303	155657	0723537	059424	-0714394	0358388
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01269	9350	809725	879456	603550	7225	14239399	0370	155671	0719031	055326	-0722083	0362029
01269	9353	829183	848390	618804	7268	14241971	0395	155672	0718945	055140	-0722192	0362065
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01425	[illegible]	082295	[illegible]	262468	5605	13472526	0000	249924	0746201	005122	-0000566	-0593102
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39359.9 F

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00022	935	3421592	332067	539793	35563	14239407	0002	139733	0718987	025818	-0818124	0665935
00031	934	9001007	790119	176125	35283	15456668	0184	142257	0680729	009170	-0893133	0685856
00031	935	2559246	741031	213497	35338	15457587	0155	142248	0680702	009129	-0893261	0686097
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00051	934	7649932	914165	845169	26662	12178186	0000	131132	0797968	008274	-0704761	0678232
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00202	935	1230593	527665	033481	23581	13613208	0000	090037	0740736	007482	-1016341	1543041
00226	935	3676712	280781	596248	23675	14347559	0001	134104	0715353	006567	-0859067	0783919
00227	935	5012441	660293	412526	23464	14208533	0002	133681	0720011	012051	-0850846	0782528
00255	934	9328991	600362	987627	24268	14998385	0005	091195	0694378	001944	-1150986	1732995
00257	934	7033019	641356	947459	24232	15012752	0026	091180	0693934	002583	-1152544	1735537
00271	935	1499158	706608	387886	14947	9412834	0000	240703	0947637	030935	-0043029	-0362224
00285	935	1713260	549088	981175	22495	14365778	0048	149537	0714791	038476	-0767263	0481903
00288	934	5760152	577115	975288	22429	14395009	0070	149500	0713823	037516	-0769381	0483796
00288	935	7291357	449432	055185	22595	14396389	0062	149489	0713777	037416	-0769531	0484066
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00504	934	9025880	916907	834850	17165	13375145	0554	195275	0749769	088446	-0407303	-0260846
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00775	934	5288371	414788	744474	12507	14864666	1061	143502	0698690	033286	-0843041	0627859
00775	934	8247791	377672	772509	12550	14871082	1084	143465	0698488	032910	-0843693	0628931

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39359.9

NO JNE AJNE AQNR ANRP	IPRM APRM1 M2 ANGR CP CG	GR1	GR2
014689345568120017008672825	56581512983500160801980690319000880	-1213643	1964038
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NCAT	RE	AJNE	AQNR	ANRP	IPRM APRM1 M2 ANGR CP CG	GR1	GR2
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02183	9351	542359	528696	841109	10041241990500841795880787698121845	-0478311	-0046681
02184	9348	540080	544321	842162	9691247134104541796030785531119884	-0480236	-0047076
02184	9351	506626	526584	840394	10061247371804271795780785432119845	-0480503	-0046756
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02200	9351	964605	728294	781915	7921249684387522500010784543129027	0000004	-0566738
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02215	[illegible]	260848	242143	853018	49 107897900000003664015333005493	-0040959	0081918
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02217	[illegible]	427976	236731	968611	49 107746700000004414019089013232	-0040888	0081776
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02219	[illegible]	525189	216937	930614	49 107388500000003444028022019868	-0040714	0081402
02220	[illegible]	601820	161436	957770	49 107146300000002814034090025739	-0040598	0081171
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02293	9346	952396	060117	909969	5411597651391681762460665975011206	-0665993	-000[illegible]4
02293	9348	078240	048182	909264	5591599902404211762200665350010400	-0667412	-0000213
02293	9349	951133	027946	910440	5891604059324441762470664201009709	-0669452	-0000734
02293	9351	383598	012690	911724	6121607507431631762550663251009108	-0671272	-0000883
02293	9352	688627	998571	909616	6331610671635191762590662382008415	-0672961	-0000964
02293	9354	424149	979728	910102	66191616225186041762250660864006473	-0676258	-0000319
02293	9355	412978	968833	905819	6771619601409661762690659946006489	-0677764	-0001166
02293	9356	830646	953252	910117	7001626410173311762440658103005314	-0681741	-0000684
02295	9347	568053	383928	475439	5221565465006661354960674956011826	-0955898	0849470
02295	9349	293086	358203	503115	5491565618105981354440674912011617	-0956363	0850753
02295	9354	465852	280742	572501	6301566203805831354360674744011351	-0956871	0851340
02295	9356	955661	243495	603050	6691566438105411354920674676011460	-0956685	0850246
02296	9346	396881	399093	463363	5051572629616501354250672904010048	-0962065	0856129
02296	9347	922390	375644	477008	5291573078616351355850672776010363	-0961356	0852855
02296	9349	002920	359317	489748	5461573368315751355750672694010359	-0961657	0853279
02296	9349	893022	345933	506136	5601573570914801355680672636010301	-0961869	0853589
02296	9354	466833	276695	568840	6321574880014851355950672263010011	-0962727	0853906
02296	9355	419086	262314	577892	6471575061313781355880672212009791	-0962900	0854166
02324	9345	987371	126487	910195	3541369452403024006260737824004276	0984345	1389916
02324	9347	958277	152992	936808	3811369462103034006160737820004351	0984311	1389752
02324	9350	002710	180593	972512	4091369446900904006030737826004470	0984245	1389512
02324	9352	996057	220915	022021	4501369481300704006180737813004569	0984344	1389824
02327	9345	424957	118370	986015	3461368065100134007050738322000703	0983304	1389389
02328	9352	955983	219880	179522	4491368101700004007080738309000753	0983353	1389494
02348	9345	466248	833771	919830	3251574815404540801940672118000325	-1280277	2071914
02348	9350	235097	737383	184552	4001575182904110802060672013000399	-1280625	2072343
02348	9358	227970	575832	371586	5261575780703840801860671843000309	-1281361	2073772
02369	9345	690189	161550	988949	1801626273035491438090658048002601	-0943804	0697469
02383	9347	432987	802520	121482	3501558143303930802090676907000516	-1262161	2042418
02383	9349	484836	761978	158411	3821558258303420802010676873000315	-1262321	2042779
02383	9355	069525	651994	369130	4691558585703010801890676779000458	-1262729	2043583
02386	9349	957130	828383	025229	19141369065500002494630738257010281	-0004088	-0606078
02387	[illegible]	843201	911132	586909	72931478999617021556550701074032933	-0754017	0378298
02387	[illegible]	830842	866774	612379	73521480345017191557160700649032533	-0754426	0377522
02387	[illegible]	721905	845598	624723	73801481069518121556080700420032432	-0755656	0379875
02387	[illegible]	512868	791933	654167	74511483130425691556180699771032125	-0756938	0380366
02389	[illegible]	332949	476913	135540	1671051770500402263570880072206104	-0141277	-0424987
02390	[illegible]	971160	244218	886560	37891491368612120893260697000004245	-1150986	1756254
02391	[illegible]	776774	368737	833669	201614422262801439530661265002942	-0933576	0687378
02391	[illegible]	141280	348176	877357	421614621116821439670661211003140	-0933628	0687170
02391	[illegible]	430792	313628	877521	791615331516101439180661017003099	-0934545	0688713
02391	[illegible]	968398	275317	907325	1201616166516511439530660789002955	-0934925	0688383
02392	[illegible]	340098	375169	808578	131617882661711439290660322003841	-0936452	0689[illegible]
02392	[illegible]	773325	368747	828432	201619432263321439490659900004909	-0937540	0690[illegible]
02392	[illegible]	202055	362175	785106	271622305752901439670659121003465	-0939569	0691[illegible]
02393	[illegible]	121759	897969	230065	41611143687912781040662337005232	0264494	-0636671
02393	[illegible]	238967	902735	225574	221612128233932780940662067005321	0264615	-0637277
02393	[illegible]	231299	906989	215132	381612615728562781160661934005109	0264926	-0637346
02393	[illegible]	967106	914385	196936	661613524727802781240661685004957	0265195	-0637758
02393	[illegible]	144314	919410	182297	851614111327352780980661525004702	0265082	-0638268

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39359.9

NC	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
02	39	39	35	39	27	09	91	61	898	11	41	61
02	39	39	56	29	30	31	93	72	60	14	79	30
02	39	39	58	27	17	70	94	56	64	12	56	90
02	39	69	35	41	48	23	88	34	55	41	70	87
02	39	69	35	47	08	01	98	35	38	31	66	01
02	39	69	35	56	40	09	58	36	60	71	58	22
02	39	69	35	66	95	64	08	38	05	31	46	26
02	39	69	35	79	98	48	08	39	87	21	33	05
02	39	79	35	41	26	10	68	34	50	25	71	93
02	39	79	35	70	04	91	98	37	80	82	09	13
02	39	99	35	52	55	89	39	67	66	32	00	21
02	39	99	35	62	86	24	95	05	48	22	53	68
02	39	99	35	77	53	85	89	25	66	62	63	52
02	39	99	35	84	28	91	59	14	21	72	81	11
02	40	09	35	45	20	57	48	35	12	21	70	25
02	40	19	35	53	21	23	81	76	92	40	69	75
02	40	19	35	60	62	02	91	76	81	50	53	31
02	40	39	35	71	50	04	88	87	58	92	12	76
02	40	49	35	62	87	22	74	78	52	41	40	24
02	40	49	35	85	69	20	34	75	10	91	29	99

11	41	61	50	59	32	79	52	78	08	80	66	12
15	21	61	62	79	42	82	22	78	13	40	66	09
18	41	61	77	74	33	62	52	78	08	80	66	05
6	16	10	20	22	21	45	25	91	10	06	62	60
15	16	08	80	26	25	62	25	90	11	06	62	99
30	16	10	21	43	73	79	25	89	49	06	62	60
47	16	11	18	97	57	03	25	90	07	06	62	33
68	16	12	82	77	63	69	25	89	85	06	61	89
5	15	16	88	82	12	31	25	88	41	06	89	49
49	15	16	84	73	00	13	25	88	01	06	89	51
9	14	81	01	17	10	73	09	15	86	07	00	25
24	14	81	18	92	10	77	09	16	60	07	00	19
47	14	81	46	59	10	82	09	16	02	07	00	11
57	14	81	57	18	10	85	09	15	77	07	00	07
12	16	15	09	07	61	23	25	90	76	06	61	27
3	13	48	83	01	00	00	24	67	05	07	45	61
13	13	48	57	81	02	42	24	68	39	07	45	71
3	8	59	51	09	00	00	25	01	92	10	06	81
156	10	51	73	55	00	90	22	63	59	08	80	09
180	10	51	72	33	00	09	22	63	36	08	80	09

4	35	39	40	35	39	27	09	91	61	898	11	41
3	56	29	30	31	93	72	60	14	79	30	15	21
7	09	45	66	41	25	69	0	27	81	34	06	60
8	34	55	41	70	87	1	45	20	22	14	52	59
3	83	16	66	01	58	36	60	71	58	22	15	16
7	15	82	25	3	46	26	5	38	05	31	46	26
2	57	19	31	33	05	0	6	81	89	0	00	98
5	71	93	41	26	10	68	34	50	25	71	93	41
1	70	09	13	70	04	91	98	37	80	82	09	13
3	22	17	21	99	35	52	55	89	39	67	66	32
5	48	22	53	68	62	86	24	95	05	48	22	53
1	11	11	70	63	52	77	53	85	89	25	66	62
1	11	11	70	72	11	11	84	28	91	59	14	21
2	50	25	70	25	20	57	48	35	12	21	70	25
2	69	75	40	69	75	53	21	23	81	76	92	40
2	53	11	31	53	05	0	62	60	71	91	76	81
2	12	76	92	12	71	50	04	88	87	58	92	12
2	24	78	40	24	14	0	24	87	22	74	78	52
2	34	75	10	91	29	99	35	69	20	34	75	10

CURRENT GEAR RATIO DATA

ERWIN BAIER, WIEN

00	62	29	34	38	96	87	59	81	84	97	36	022
00	62	49	34	39	13	88	19	52	38	56	78	047
00	93	19	34	38	26	10	77	95	46	54	25	027
01	72	69	34	78	64	67	75	46	64	46	72	148
02	17	69	34	79	25	84	99	27	12	96	93	605
02	18	39	35	08	98	25	65	32	63	08	41	869
02	25	39	35	18	07	71	39	23	64	33	19	049

9566	85	79	21	90	00	02	45	63	31	00	80	57
9571	86	08	02	40	00	02	43	92	31	00	57	78
77	59	12	50	99	97	01	19	22	61	42	07	84
33	17	11	96	76	25	00	00	16	49	32	08	07
11	67	13	92	58	68	00	00	25	00	04	07	29
99	61	24	19	03	50	05	31	79	60	40	78	78
412	79	38	23	80	00	02	41	67	91	06	17	66

342	-0017833	-0323744
651	-0025488	-0331468
558	-0164553	-0489485
604	-0521395	-0152237
435	0000039	-0619883
990	-0478039	-0046891
348	-0030642	-0289222

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39373.9

NCAT	INC	AJNE	AQRR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
00669	9362	519679	008653	067757	14276	13447042	0000	249739	0747143	002024	-0001939	-0591553
00683	9361	498036	060605	122163	14459	14104198	0057	163583	0723639	052389	-0658529	0213362
00683	9368	729604	993437	143540	14561	14105270	0070	163570	0723603	052329	-0658670	0213610
00694	9369	152126	578309	923797	13468	13360198	0006	084284	0750046	064268	-1028197	1622697
00714	9363	940691	572539	820440	12250	12541580	0080	214564	0782657	078562	-0215906	-0444193
00714	9367	927048	561776	798787	12300	12543292	0148	218545	0782586	078722	-0216091	-0444186
00714	9372	630267	549088	772884	12359	12545563	0202	218623	0782491	078875	-0215634	-0444851
00717	9361	432756	680131	486988	14171	14505924	0004	162545	0710215	001542	-0683816	0238147
00721	9370	656668	563758	789101	12279	12430555	0002	218311	0787309	090257	-0216391	-0440015
00727	9370	623770	635192	582456	13430	13920161	0000	194147	0730070	000977	-0425966	-0253453
00731	9362	703494	682894	580411	13319	13919514	0000	194206	0730093	001213	-0425509	-0254179
00733	9370	299758	676304	988796	13603	14218882	0001	275404	0719854	003047	0202582	-0556777
00734	9365	588018	664122	098102	13540	14221730	0001	275422	0719758	001306	0202770	-0556796
00735	9367	347609	669545	108404	13559	14215415	0001	275459	0719971	001324	0202938	-0556238
00737	9370	687033	691052	197759	7061	7395347	0000	128644	1112788	267088	-0414814	0416042
00740	[illegible]	885779	965564	298071	12566	13374737	0159	226217	0749823	012806	-0174985	-0522544
00746	9363	035008	696026	510795	7985	8510542	0005	169161	1013400	334730	-0394070	0074038
00748	9359	953855	631453	999056	988	1061729	0002	161976	4058783	188118	-0143555	0051880
00748	9370	082200	628757	999889	1003	1061661	00-1	162000	4058956	184956	-0142570	0051439
00759	9364	532089	091476	066645	13877	15248323	0038	227979	0687095	001112	-0192941	-0632943
00759	9370	106495	075139	015994	13962	15249136	0060	227957	0687071	001111	-0193151	-0632853
00771	9360	127304	371682	777042	12647	14664070	0570	143399	0705047	038994	-0829896	0619670
00771	9364	149793	322780	813062	12706	14670162	0708	143422	0704852	038824	-0830162	0619503
00771	9369	397191	258821	861014	12783	14677608	0702	143433	0704613	038515	-0830577	0619651
00771	9371	372590	234696	878881	12812	14681495	0804	143464	0704489	038421	-0830643	0619214
00775	9363	363260	187682	913335	12775	14900620	1038	143420	0697565	032075	-0846051	0631401
00812	9368	091610	553388	261549	11397	14178235	0001	277099	0721227	000395	0215141	-0543689
00813	9364	074620	542014	291058	11338	14175491	0001	277165	0721320	001020	0215602	-0543114
00824	9367	695769	672245	897171	11977	15203741	0033	227995	0688437	001722	-0192056	-0630575
00830	9357	880782	608919	984995	844	1096053	0000	163344	3973605	189082	-0171068	0056389
00830	9370	654069	606211	985533	858	1096023	0000	163281	3973677	188050	-0170743	0056542
00851	9359	156001	829158	683873	8392	11493189	0170	265799	0829559	164735	0103080	-0494517
00851	9364	636992	835648	652733	8455	11495257	0181	265804	0829460	164661	0103134	-0494592
00871	9364	835031	493312	273149	10154	13866627	0001	221936	0731987	007451	-0216264	-0521588
00872	9362	525266	554366	917494	10654	14669386	0025	274223	0705047	024676	0201920	-0589398
00872	9367	160655	568115	877780	10722	14669964	0045	274256	0705028	024644	0202210	-0589214
00872	9371	659496	581443	838938	10788	14670710	0066	274265	0705004	024698	0202294	-0589208
00897	9371	655661	903401	256128	9415	13510186	0000	249709	0744815	001178	-0002175	-0595250
00902	9364	555613	903588	246632	9318	13508484	0000	249732	0744877	001293	-0002006	-0595150
00922	9361	945383	476173	182106	9995	15183538	0026	227890	0689047	000880	-0192624	-0628624
00924	9365	112188	268555	790367	9575	14521741	0029	144301	0709649	025727	-0810451	05[illegible]08
00925	9361	927510	467302	117478	10011	15237961	0830	227887	-687405	00-673	-0193568	-06[illegible]13
00925	9365	866678	455753	107372	10071	15239110	0122	227896	0687372	000751	-0193509	-0631932
00925	9369	474887	445087	061381	10126	15240346	0146	227885	0687335	000740	-0193627	-0631933
00925	9370	853265	441037	056363	10147	15241140	0181	227908	0687311	000752	-0193436	-0632117
00931	9359	647600	762681	327154	7957	12517107	0153	226178	0783684	089722	-0164641	-0490672
00931	9368	035240	745332	276135	8062	12519898	0165	226142	0783568	089759	-0164944	-0490647
00931	9369	952089	741344	264676	8086	12520911	0197	226084	0783525	089917	-0165378	-0490448
00932	9365	540272	754667	332222	7991	12391900	0002	225983	0788953	097934	-0164540	-0485411
00959	9372	609019	396257	542305	8542	13545117	0000	249910	0743534	003044	-0000674	-0597326
00965	9362	790883	396112	627078	8409	13545428	0005	249921	0743523	002830	-0000596	-0597343
00973	9367	270326	455347	358839	8676	14760445	0013	274151	0702145	018309	0202779	-0594080
00987	9364	300237	759815	732142	8504	14928785	0005	091252	0696535	003696	-1143650	1721240
01001	9363	505522	847357	953673	5556	9906789	0000	089279	0915620	001221	-0667045	1018156
01085	9358	574504	043902	610789	8181	14853253	0012	088183	0698888	010996	-1150395	1769301
01088	9363	497728	975411	712165	8248	14838532	0004	088183	0699350	011645	-1148947	1767088
01089	9359	585547	622195	695413	7586	14035257	0388	155704	0725986	062295	-0710152	0355543
01089	9360	582885	612277	700202	7600	14036739	0461	155690	0725935	061965	-0710237	0355802
01089	9363	503414	583101	714916	7641	14040102	0523	155682	0725819	062194	-0710601	0356112
01089	9365	497498	563213	724970	7669	14042584	0560	155688	0725734	062154	-0710711	0356063
01089	9367	633629	541880	735935	7699	14045363	0594	155671	0725638	062119	-0711003	0356467
01089	9369	911632	519139	747342	7731	14048700	0652	155668	0725523	061786	-0711141	0356588
01089	9371	406216	504196	754613	7751	14051264	0715	155661	0725435	061697	-0711331	0356786
01090	9359	560971	625345	701991	7582	14073657	0574	155655	0724665	060447	-0712493	0357472
01090	9362	686911	593994	718235	7626	14077786	0618	155624	0724523	060336	-0712945	0358168
01090	9363	681251	583955	723286	7640	14079705	0687	155634	0724458	060736	-0713140	0358111
01090	9365	450024	[illegible]	732500	7665	14082826	0756	155664	0724351	060720	-0713149	0357661
01090	9368	438399	536184	747551	7707	14087908	0808	155653	0724176	060439	-0713612	0358368
01090	9370	212531	518345	756283	7731	14092345	0977	155631	0724024	059925	-0713758	0358464
01091	9360	628051	506392	756126	7669	14263897	0887	155623	0718208	054742	-0723904	0363690
01091	9362	941172	482519	768137	7702	14268473	0928	155644	0718054	054621	-0724036	0363427
01091	9363	922245	472410	773400	7716	14270746	0978	155630	0717978	054500	-0724251	0363756
01091	9366	304162	447742	785584	7750	14276384	1062	155612	0717789	054533	-0724771	0364298
01091	9369	525378	414402	802484	7796	14283869	1113	155610	0717538	054272	-0725212	0364542
01091	9372	254712	386097	816484	7835	14291826	1255	155700	0717272	053852	-0725521	0364458
01098	9364	171826	099556	676737	8132	14868792	0016	180648	0698658	010111	-0571332	-0073903
01098	9368	005253	067015	669992	8189	14868759	0016	180641	0698659	010206	-0571395	-0073776
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INDEPENDENT TRACKING COORDINATION PROGRAM, 824 CONNECTICUT AVENUE, WASHINGTON, D. C. 20006

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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39373.9

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022959364294447133415700176	7841567566207721354990674353011015-0957517	0850873
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Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39373.9

NC[illegible]	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
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02295937124473502906779607	1	8921569113511581354480673909011007									-0958878	0852324
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02324936511529638440822765	9	6161369547400234006[illegible]73779000527[illegible]									0984412	1389[illegible]
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02407936205530527763261695	0	1216332164313614406806561820008									91-0947193	0695366
02408936208012627716099314	1	1116284773469914400706574540003									68-0943985	0694087
02408936230987827369475320	1	1516305512217614408106568970014									36-0945040	0693552
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A D D I T I O N S to I N D E X

Catalog Numbers and Popular Names Corresponding to IDENT Designations of Recent Unclassified Earth Satellites

IDENT	NAME	NCAT
1966 73A	LUNAR ORB 1	02394
1966 73B	LUNAR ORB 1 R	02395
1966 74A		02396
1966 74B		02397
1966 76A		02401
1966 77A		02403
1966 78A	LUNA 11	02406
1966 78B	LUNA 11 R	02407
1966 79A	COSMOS 128	02409
1966 79B	COS 128 R	02410

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39387.9

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR[illegible]
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00878	9378	2062	2260	0359	7829	55	1088	2146	6666	6000	7427	4707
00878	9386	6569	7262	5368	7100	80	1100	7146	6751	1005	7427	4262
00922	9381	2425	6241	9900	0140	89	1028	8151	8523	3004	2227	8920
00922	9385	3904	2340	7840	9600	88	1035	1518	5247	0022	2279	1006
00924	9384	8063	0403	6601	9576	56	9861	1452	2237	0011	1442	4307
00925	9381	7462	3340	8931	9137	4	1031	3152	4436	0013	9227	9020
00925	9383	9761	8040	2353	9628	47	1034	7152	4438	8009	6227	8747
00931	9380	0134	3772	0461	2031	34	8211	2524	7210	1512	2603	0783
00931	9380	3327	7171	9823	2009	92	8215	2524	9590	1652	2606	1078
00931	9381	6901	5071	7001	1929	31	8232	2524	9530	1252	2602	0078
00931	9385	4426	0570	9252	1697	23	8279	2525	5110	0099	2260	4507
00965	9385	5303	1439	5873	4581	76	8717	1354	5510	0004	2498	6507
00973	9380	4133	4849	4752	2439	07	8869	1476	0935	0018	2741	8407
00978	9373	6422	9979	9827	2843	2	7147	1208	5198	0000	2677	8708
01085	9377	2907	1572	4099	1026	45	8458	1485	3661	0012	0881	8406
01088	9383	2434	2563	8392	2297	68	8540	1483	8774	0006	0881	8106
01089	9375	2484	4946	5771	7737	61	7805	1405	7130	0744	1556	4607
01089	9379	3026	8542	5230	7939	40	7862	1406	1962	0640	1556	1907
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01089	9385	2038	1236	6164	8232	96	7945	1406	8444	0570	1556	5907
01090	9374	3268	2747	6890	7771	42	7789	1410	1665	1084	1556	0807
01090	9378	5096	5243	4737	7985	09	7848	1410	9505	0972	1556	2407
01090	9380	4939	3041	4687	0813	9	7876	1412	6470	9060	1556	1107
01090	9383	2570	1338	6753	8219	92	7915	1411	7133	0865	1556	2007
01090	9384	2487	3437	6770	8273	36	7929	1411	8410	0816	1555	9607
01091	9379	1780	7431	4283	8524	73	7934	1406	2320	0990	1556	4307
01091	9381	6242	1728	8882	8646	62	7969	1431	0377	0924	1556	2107
01091	9384	3492	6826	0611	8788	41	8008	1431	3952	0772	1556	2907
01097	9372	2669	5201	9811	7808	83	8259	1488	1912	0003	1806	2406
01098	9380	7165	7295	9030	6575	02	8378	1486	8953	0016	1806	4306
01208	9373	0196	9524	6160	5007	65	7574	1391	5394	0000	1946	6207
01228	9378	6410	2020	9306	5072	89	8137	1502	2472	0264	2499	4106
01228	9383	6331	5920	9331	4554	96	8212	1502	4782	0242	2499	4106
01248	9379	6507	1820	6287	5019	09	8152	1503	7766	0305	2499	8806
01248	9383	5739	9520	6254	6168	1	8211	1503	9654	0268	2499	8806
01250	9373	9490	7120	7591	5949	03	8044	1492	7186	0306	2499	5306
01250	9376	6286	3820	7581	5672	28	8084	1492	8499	0283	2499	5306
01250	9378	1024	2320	7599	5521	23	8106	1492	8474	0229	2499	5306
01250	9381	5854	3320	7508	5172	59	8158	1492	9539	0175	2499	5306
01267	9373	6059	5473	3519	6817	12	7490	1413	2845	0741	1556	2807
01267	9376	5772	5370	3380	6971	28	7532	1413	7464	0755	1556	5407
01267	9385	4853	6761	3212	7420	38	7658	1415	1991	0916	1556	4607
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008309378865470604583985769	867 109604100011633143973633186384	-0170056	0056161
008519371595551843887613104	85351149792101882657880829332164401	0103035	-0494704
008519384726396859440538408	86861150098901002657760829184164181	0102971	-0494805
008729381201919609727756993	109281467139000662742750704963024688	0202405	-0589208

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39387.9

NO[illegible]	JNE	AJNE	AQNR	ANRP	IPRM APRM1 M2 ANCR CP CG	GR1	GR2
01613	9375	414204	506847	427414	3862114622280000400760830779151670	0831322	[illegible]
01613	9379	427291	545093	481416	3908114624150000400756083077015174 0	0831359	[illegible]
01620	9380	351381	525486	416898	459413808644001724272608734048054151	-0056615	-[illegible]
01624	9371	723326	123999	296215	46531440946400280897530713176002619	-1097455	[illegible]
01624	9382	548948	952467	552080	48091441006700260897530713156002832	-1097523	[illegible]
01625	9382	601118	523788	393436	46281381721000212427340733745053724	-0056592	-[illegible]
01625	9386	509368	520708	360669	46821381714900102427380733747053761	-0056558	-[illegible]
01738	9376	811265	029792	882118	41951429101000001658590717325011242	-0647703	[illegible]
01738	9384	996929	953982	893556	43121429276600001658380717267011560	-0647977	[illegible]
01739	9377	070857	026040	922675	42001429286000061658341150988014484	-0647882	[illegible]
01777	9373	767864	419902	871831	38481404504231241344010725590067184	-0847576	0769136
01777	9374	835521	407068	883744	38631405229431761343720725340066896	-0848220	0770147
01777	9380	096529	344359	940345	39371408021827691344290724381065832	-0849704	0770667
01777	9382	652353	313824	967672	39731409147423701344560723995065370	-0850265	0770793
01777	9385	418509	280547	996837	40121410538824631343930723318064893	-0851577	0772888
01778	9371	664829	994743	255421	37241325108300070951290754188063422	-0973517	1422980
01778	9380	494258	880772	421858	38411325117300050951440754184063631	-0973555	1422867
01779	9376	744147	327576	954357	39231429691534441344620717042058086	-0864022	0783164
01779	9379	470514	293901	984902	39621431379832641344150716478057986	-0865650	0785333
01779	9384	914132	226267	046088	40401434422728741344420715464056983	-0867580	0786692
01804	9386	237765	931445	130196	34751186170100092217470812281123944	-0185285	-0442828
01805	9372	572848	989266	264213	37331324082000090951150754577063756	-0972703	1421947
01805	9384	354593	837304	487975	38891324109900100951350754567063120	-0972370	1421244
01806	9381	295912	940765	153759	34201187913400432217980811486123057	-0185210	-0443726
01806	9385	673353	931093	130739	34721187930400342217600811478123103	-0185467	-0443532
01807	9379	657392	945391	162840	33991186797500052217920811995123556	-0185075	-0443279
01815	9383	223737	998854	260683	40651439782100022107560713864000743	-0316332	-0454962
01842	9372	375402	725854	886939	377811449936703610838010710207045294	-1141277	1806695
01842	9378	236749	628620	039049	38631450352603490837840710071045512	-1141881	1807847
01842	9380	925798	584048	111569	39021450482503010837820710029045206	-1141899	1807894
01842	9384	097048	531455	194558	39481450622802680837650709983044864	-1141980	1808223
01843	9385	322095	143471	497423	40471475838400041805450702137000897	-0566237	-0071477
01864	9386	443559	540332	079790	37051371035200012475410737550008831	-0018765	-0606488
01868	9383	933874	919687	571384	38821484812900051556530699243001515	-0754648	0378644
01869	9381	014596	959546	613378	38351483460000071557050699668002449	-0753377	0377170
01902	9376	438894	969208	453582	47601464017011930884820705657017807	-1127998	1731305
01949	9375	553323	375251	110625	35141577346815411343610671558007513	-0973080	0883706
01949	9377	518297	345083	134288	35451577716612561343900671453007272	-0973167	0883294
01949	9383	410245	254446	218548	36381579181312701343980671038007162	-0974432	0884605
01949	9383	980304	245753	228124	36471579270012001343980671013006801	-0974361	0884244
0[illegible]2	9373	221478	217063	537806	29851359513800002491760741710017337	-0006221	-0600825
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01[illegible]7	9372	231178	791844	912447	31361520326700482279790688451000185	-0192184	-0630445
01997	9382	440046	762114	027392	32921520414300432279740688425000135	-0192239	-0630467
02002	9383	133549	920459	760327	33041563293418181357440675582016574	-0952995	0842814
02003	9376	656503	770875	090438	32191538935111462279140682893000047	-0195894	-0640358
02003	9377	761252	767565	079547	32361539026210702279390682866000521	-0195690	-0640561
02003	9379	653976	761739	192978	32651539336209072279320682774000339	-0195809	-0640687
02003	9381	709506	755616	816193	32961539617608092278990682691000100	-0196148	-0640640
02003	9384	306420	747804	777082	33361539982207632278970682583000091	-0196223	-0640835
02017	9373	128321	432479	101530	2422121307000100945800799952111752	-0889499	1305741
02096	9383	373350	824224	166371	25221268766100002803910776639003280	0207822	-0448883
02104	9376	393976	232486	011164	27361558009701700801850676945000439	-1262123	2042648
02104	9381	269029	136416	152792	28121558133401450801720676910000410	-1262311	2043107
02104	9385	695488	049161	265767	28811558235301280801780676880000430	-1262394	2043169
02120	9374	334398	811867	842948	22451367403000012492560738855011736	-0005655	-0605137
02121	9374	039465	011348	067304	22211383544900004014560732801005659	1001674	1424298
02122	9377	748749	975294	950556	22261363201600014018100740075003279	0983556	1402670
02150	9373	906975	022178	690965	1297 949839500322290480941949268920	-0115820	-0403149
02150	9382	329246	012910	658740	1377 949884500272290550941919268845	-0115774	-0403165
02151	9374	406606	934126	536596	273 20280810-111804182636471944783	-0193573	-0023695
02152	9375	997833	847450	898388	21141578926610101343590671110006208	-0974316	0884860
02152	9377	708146	821136	926805	21411579119308561343130671055006062	-0974783	0886044
02152	9382	076787	753940	988332	22101579805208191343590670861006127	-0975034	0885504
02169	9373	994830	331238	555562	17431484593000091805070699375006550	-0571108	-0071441
02169	9378	305924	294717	553519	18071484603000091804650699371006559	-0571435	-0070763
02172	9373	052050	945211	507435	17111510417700263054630691411002052	0471760	-0288038
02172	9381	261482	403678	470944	18341510466300263054610691397002027	0471761	-0288082
02180	9380	695111	924717	411321	16241392301200022500040730024006137	000002[illegible]	-061[illegible]
02182	9377	426536	366914	312754	15871496718033381344000695468037905	-0912253	0827848
02182	9382	032003	304051	368119	16561499654132011344450694560036280	-0913907	0828654
02182	9382	965570	291203	380422	16701500116930251344140694417035965	-0914399	0829581
02183	9376	335837	381436	826428	13121242580501341795890787449121867	-0478629	-0046730
02183	9379	313486	363749	824676	13491242632101141795760787427121843	-0478735	-0046549
02183	9384	222276	334554	821705	14101242715400961795690787392121822	-0478644	-0046826
02184	9376	169023	378407	825359	13141250577606961795780784089118824	-0481844	-0046876
02184	9377	128649	372646	825074	13261250653606401795630784057118563	-0481876	-0046675
02184	9379	607174	357721	823805	13571250916805971796000783947118476	-0481753	-0047183
02184	9381	125998	348595	822656	13761251059705581795680783887118445	-0482018	-0046758
02184	9384	482749	328321	820692	14181251390605241795820783749118416	-0482094	-0046967
02200	9373	671946	728292	622401	10691291805886222500090767400112640	0000066	-0585700
02200	9374	678068	728392	614740	10821293163980342500090766863112066	0000064	-0586294
02200	9375	606063	728380	607569	10941293677456952500090766660111610	0000064	-0586409
[illegible]00	9378	539790	728345	585063	11321297093561652500080765314109822	0000059	-0587752
[illegible]00	9381	619320	728321	561778	11721300454547142500080763995108926	0000057	-0589464
02200	9383	540597	728294	546686	11971301992541312500080763393108072	0000055	-0590048
02200	9385	536145	728314	531627	12231303799343682500070762688107636	0000053	-0590990
02201	9384	815159	694479	960209	992 1005783500011133640906473204417	-0675266	0831631
02202	9374	679044	728301	641524	10571232159349812500000791963136649	-0000002	-0559298
02202	9375	409554	728386	637495	10661232448438722499990791839134148	-0000004	-0558240
02202	9378	733105	728272	614090	11071234834636302499990790819134009	-0000006	-0559697

Current Earth Mean Elements Derived by NASA GSFC from NORAD Data as of [illegible]

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR[illegible]
02202	9381	2421	8272	8209	596120	1138	1236	2409	2896	2499	9079	0219134373
02202	9383	5059	5972	8385	79914	1166	1237	4780	2784	2499	9078	9692133727
02205	9372	6894	4972	8699	666127	1022	1203	2141	3202	2500	7908	0461014955
02205	9376	5089	1472	8676	641162	1068	1205	4720	2926	2500	5080	3605148331
02205	9378	2510	3572	8836	629505	1089	1206	0093	2408	2501	0408	0336614704
02205	9378	7486	5172	8672	626390	1095	1206	1196	2106	2501	0908	0331814813
02205	9380	7379	3872	8676	613305	1119	1206	8035	1690	2501	0908	0301414798
02206	9378	2497	9473	9184	905186	9261	0058	1880	0001	1339	1090	6451204374
02253	9374	2320	2917	8713	53113	590	7943	5480	0392	4138	3106	1130059137
02253	9380	9044	2991	6308	343992	643	7944	4010	0492	4138	1061	0550615661
02253	9382	1637	1915	9673	47106	653	7944	7470	0562	4138	9106	1024062862
02259	9372	4789	0922	3157	74406	9341	4709	4305	1490	8003	3070	3416047922
02259	9373	3622	1890	6943	799889	9471	4721	8415	8730	7999	8070	3020047684
02259	9375	4662	4587	0563	857723	9781	4744	3925	4810	7994	7070	2303048031
02259	9377	4319	3085	3651	914524	10071	4763	8255	2450	8001	6070	1686046440
02259	9383	2446	7373	2732	082861	10931	4825	0875	1530	8003	0069	9751044080
02259	9384	1886	1671	6593	107377	11071	4833	9245	0280	7999	6069	9473044038
02259	9386	2094	1368	0597	165348	11371	4855	4675	1530	7996	6069	8796043675
02290	9373	1797	4978	8728	916458	9551	6055	5780	6991	7623	4066	3787010098
02290	9374	6106	1677	3256	908931	9781	6082	0189	8351	7629	1066	3060009114
02290	9376	7224	2675	0398	910600	10121	6122	1900	9071	7624	5066	1958008212
02290	9377	5893	4740	9809	06641	10261	6144	8463	4931	7624	6066	1339007775
02290	9379	3221	3172	2062	909684	10541	6190	2555	3334	7622	6066	0102006547
02290	9381	4800	3469	8278	907114	10891	6253	2327	3541	7612	1065	8396005164
02290	9382	4021	0068	8804	909623	11041	6290	1727	1551	7625	9065	7401004933
02295	9380	1608	9489	4766	912185	10321	5710	6871	0361	3550	7067	3350010705
02295	9383	9793	6883	7114	964595	10921	5716	8080	9001	3549	9067	3175010377
02296	9373	1549	1599	1690	815162	9261	3841	5324	9211	3562	8066	9637008308
02296	9374	1643	5197	6268	822753	9421	3848	2254	1161	3566	8066	9448008100
02296	9375	1106	2961	9141	834603	9571	3855	3954	1311	3566	9066	9247007407
02296	9376	1203	5594	6318	859532	9731	3860	2703	3541	3565	7066	9109007978
02296	9381	0328	0287	0453	927239	10511	3895	3593	4771	3558	4066	8124007085
02296	9382	9823	7284	0158	954120	10821	3907	5333	3671	3557	6066	7783006615
02296	9383	9881	4782	4634	972432	10981	3915	6063	6611	3561	8066	7575006350
02296	9385	9336	4779	4579	986382	11291	3937	2205	1841	3557	8066	6953006454
02324	9377	3042	6054	8915	389867	7841	3694	7680	0004	0070	0073	7815004570
02348	9372	4378	1028	7813	866895	7501	3775	1250	6910	8015	8067	1351000966
02348	9372	7528	2828	1400	847068	7551	3775	9400	8340	8015	8067	1328000541
02348	9376	4921	4720	5538	969714	8141	3780	2630	5520	8014	6067	1205000472
02348	9380	6743	3812	0643	113812	8801	3785	2630	5900	8016	5067	1063000431
02348	9385	4853	0702	2906	226147	9561	3790	4760	5710	8018	1067	0916000194
02383	9375	7745	1824	3048	936335	7921	5608	5230	6930	8018	5067	6123000683
02383	9376	7405	1522	3864	044737	8071	5609	4490	6550	8015	7067	6076000492
02383	9378	8432	4182	2509	334806	8401	5611	8605	6408	0150	0676	0460000591
02383	9381	5377	3412	8881	088544	8821	5613	6090	5050	8016	0067	5976000408
02384	9379	1102	3766	3968	495735	3674	1481	2436	0028	0913	6070	0177012658
02385	9376	4900	9604	6276	353574	3381	4441	2295	0006	0893	6071	3083003212
02385	9378	5022	7801	4597	401906	3410	4441	2279	0004	0893	6071	3084003211
02386	9365	6608	1282	8573	890083	2129	1369	0717	0000	2494	6307	3825510689
02386	9379	6118	1383	0141	774317	2320	1369	1039	0035	2494	6307	3824410689
02387	9372	3576	7162	3604	735847	7672	1496	3999	6212	1556	3906	9562902911
02387	9377	3589	4356	8367	66331	7746	1503	0266	7089	1556	0506	9358202606
02387	9381	2824	3352	0494	787333	7805	1506	4395	5944	1556	3706	9253402606
02387	9384	2003	0548	6747	807679	7849	1509	6825	5917	1555	2106	9154201916
02388	9373	7470	6828	3805	991893	7601	5594	1480	4770	8020	0067	6539000399
02388	9378	7381	0518	5300	991339	8381	5598	0660	4220	8014	9067	6425000512
02388	9379	7111	3516	5867	199744	8531	5598	3680	3550	8018	4067	6416000650
02388	9383	6101	5808	8894	146862	9141	5600	7250	3110	8018	3067	6348000501
02389	9373	5916	7445	2768	062909	3381	0518	1100	3022	6325	0880	0552059 66
02390	9374	3646	4978	6613	458260	4185	1503	5998	3663	0389	4306	9321300265 5
02390	9378	2282	4771	9671	679138	4243	1505	3269	2675	0892	5906	9268300508 1
02390	9379	2921	2669	9958	726365	4258	1505	8517	2682	0893	1206	9252200144 8
02390	9382	1738	2565	0028	219103	4301	1507	2090	2466	0893	0206	9210600517 3
02393	9373	2037	6300	8742	881976	4241	6146	7723	1432	7814	8066	1371003511
02393	9375	3081	3001	7811	888610	4581	6197	2764	4262	7812	0065	9960021033
02393	9377	8905	4028	9383	815596	5001	6322	2706	6612	7808	1065	6624001233
02397	9374	9398	2185	8735	079418	3211	5169	7830	0402	5880	4068	9471000939
02397	9384	3688	3486	9737	019750	4641	5170	2270	0025	5880	4068	9458000929
02399	9377	1754	4259	7302	757296	3341	4845	2230	8770	9158	4069	9148035963
02399	9381	8894	8951	7420	876090	4041	4852	7540	7970	9157	3069	8912036180
02401	9385	6156	8167	3128	50625	4121	3485	6470	0002	4678	5074	5717002844
02403	9374	7263	2588	7520	211664	154	8594	1480	0002	5035	9100	6889001374
02403	9379	1473	4888	7533	194818	192	8594	2290	0002	5036	4100	6882001204
02403	9383	6867	5088	7456	196134	231	8594	3680	0002	5035	6100	6871001738
02404	9371	3084	1545	6157	073189	3141	0519	3280	0071	2263	2608	7998220583
02404	9373	5916	7445	2768	062909	3381	0518	0110	0302	2632	5088	0055205966
02404	9381	5746	0144	0917	027199	4221	0520	5150	0053	2263	0908	7991520571
02405	9374	1999	4647	3436	81791	2911	4868	5019	9920	9162	1069	8415035581
02405	9378	2332	3578	7487	83621	3501	4883	6051	9500	9158	8069	7945035345
02405	9381	0541	3530	6168	95573	3921	4894	0191	9100	9159	6069	7620034959
02405	9383	0679	3249	6171	906562	4221	4900	8901	8530	9158	4069	7405034879
02410	9372	4012	1361	2618	78283	1251	0194	2045	9881	8047	5066	0005002813
02410	9373	3448	4634	9417	806988	1431	0262	2302	4651	8050	9065	8162002115
02410	9374	0228	1834	2280	841352	1541	0298	3158	9291	8034	0657	1920025190
02411	9378	7110	0887	6081	54243	188	4590	2620	0000	2503	2610	0672400001
02412	9383	8872	7887	6611	77534	230	4590	1550	0000	2502	9410	0720100120 7
02413	9376	0170	4409	1062	6	625361	3485	4030	0000	5500	0745	7260[illegible]
02414	9380	7178	8076	0816	[illegible]	31[illegible]	2017	[illegible]	1066	7266	[illegible]	1299434
02415	9380	7178	8076	0816	[illegible]	31[illegible]	2017	[illegible]	1066	7266	[illegible]	1299434
02418	9384	5350	3294	4856	[illegible]	51[illegible]	1600	[illegible]	1707	1720	[illegible]	0188856
02418	9385	1[illegible]	4343	3311	5895[illegible]	141[illegible]	[illegible]	[illegible]	0717	1640	[illegible]	0188768

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39387.9

NC	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
02	41	89	38	62	54	21	03	34	23	6538	113	30
02	41	99	38	50	01	15	28	97	185	157	636	41
02	41	99	38	59	31	24	88	98	862	141	748	19
02	42	09	38	51	16	47	38	97	364	787	585	51
02	42	19	38	52	49	75	49	83	599	895	191	74
02	42	29	38	47	84	14	53	30	182	553	354	91
02	42	49	38	56	44	57	18	98	146	843	037	13

NC	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
02	41	89	38	62	54	21	03	34	23	6538	113	30
02	41	99	38	50	01	15	28	97	185	157	636	41
02	41	99	38	59	31	24	88	98	862	141	748	19
02	42	09	38	51	16	47	38	97	364	787	585	51
02	42	19	38	52	49	75	49	83	599	895	191	74
02	42	29	38	47	84	14	53	30	182	553	354	91
02	42	49	38	56	44	57	18	98	146	843	037	13

A D D I T I O N S T O

TABLE OF STANDARD BRIGHTNESS ORDERED BY NCAT

from David Brierley, Cheshire, England

(observed apparent brightness adjusted to standard viewing conditions)

IDENT	POPULAR NAME	NCAT	dbz
1961 01B	Samos 2R	00079	-30M
1964 15B	Ariel 2R	00775	-27M
1965 95A	Cosmos 97	01777	-27M*
1965 106B	Cos 100 R	01844	-19M
1966 11A	Cos 108	02002	-23M
1966 40A	Nimbus 2	02173	-21M
1966 43A	Cos 119	02182	-09M
1966 44A	Expl. 32	02183	-28M
1966 44B	Expl. 32 R	02184	-28M
1966 51A	None	02200	-14M
1966 56A	Pageos 1	02253	03M
1966 60A	Proton 3	02290	-13M
1966 61A	Cos 123	02295	-29M
1966 61B	Cos 123 R	02296	-11M

*Brierley reports that the brightness on Cosmos 97 (NCAT 01777) has been twice observed to increase by about 14 db. The cause for the observed "broad maxima" has not been determined.

ADDITIONS to INDEX

Catalog Numbers and Popular Names Corresponding to IDENT Designations of Recent Unclassified Earth Satellites

IDENT	NAME	NCAT	
1966 74A	NONE	02396	
1966 74B	NONE	02397	
1966 75B	PIONEER 7R	02399	
1966 75C	DEBRIS	02402	
1966 75D	DEBRIS	02405	
1966 76A		02401	
1966 77A	SECOR 7R	02403	
1966 77B	EGRS 7	02411	
1966 77C	ERS 15	02412	
1966 78B	LUNA II R	02407	
1966 79A	COSMOS 128	02409	
1966 79B	COS 128 R	02410	
1966 80A	AGENA	02414	GEMINI 11 TARGET VEHICLE
1966 81A	GEMINI 11	02415	DOWN
1966 82A		02418	
1966 83A		02419	

FORM FOR CALCULATING TNOn, TNOs, and 10*TNR1 @ NGO = .

a NCAT					
b NGR					
c M1					
d * GR1					
e = QNR1					
f JNL	0.000	0.000	0.000	0.000	0.000
g - JNE					
h = ENL					
i = ENL					
j i*e					
k = dQNR					
m + QNRo					
n = QNR					
p - QNT sched					
q = TNR					
r + RNOn net					
s = TNOn					
t TNOs = q-r					
u 10*TNQ1	-.0274	-.0274	-.0274	-.0274	-.0274
v + 10*e					
w = 10*TNR1					

FORM FOR CALCULATING TNOn, TNOs, and 10*TNR1 @ NGO = .

ITCP5-66

a NCAT					
b NGR	.	.	.	.	.
c M1					
d * GR1					
e = QNR1					
f JNL	0.000	0.000	0.000	0.000	0.000
g - JNE	.	.	.	.	.
h = ENL	.	.	.	.	.
i = ENL					
j i*e					
k = dQNR	.	.	.	.	.
m + QNRo					
n = QNR	.	.	.	.	.
p - QNT sched					
q = TNR	.	.	.	.	.
r + RNOn net					
s = TNOn	.	.	.	.	.
t TNOs = q-r	.	.	.	.	.
u 10*TNQ1	-.0274	-.0274	-.0274	-.0274	-.0274
v + 10*e					
w = 10*TNR1	.	.	.	.	.

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

J

September 29, 1966

BULLETIN

GRAPHIC PREDICTION OF LOCAL CULMINATIONS

In making satellite predictions, a great deal of unnecessary calculation can be avoided by first making a preliminary schedule of the local mean times when the observer's station will be closest to the orbits of selected satellites. An example of such a schedule on ITCP form 4-66 is given in Appendix A (Exhibit 3). In it, orbit approach times for a number of the brighter satellites are scheduled for a given latitude. Scheduling the time of a local culmination requires calculations that also take into account the observer's longitude. A step-by-step example of such a prediction is given below on ITCP Form 6-66.

At the time of local culmination, a satellite appears at its highest point above the observer's horizon, and appears to be moving parallel to the horizon. The relative motion of the satellite at the instant of local culmination is practically perpendicular to the observer's line of sight. At this time the satellite has no significant motion toward or away from the observer. Radio observers should consider the time of local culmination to be the time of Doppler inflection, when the apparent signal frequency is equal to that of the transmitted signal.

ITCP Form 6-66 was designed for beginners who do not have access to desk calculators, and who may have had little practical experience in working out problems involving both small and large numbers. The form provides for explicit conversion between the kind of notation that simplifies addition and the kind of notation that helps keep track of the decimal point in multiplication, as described in a companion Bulletin on Practical Arithmetic (ITCP Bull. Sept. 30, 1966). Substantial computational effort is conserved through the use of a meridional stereographic net and other graphic aids obtainable from ITCP.

The precision obtainable with ITCP Form 6-66 is limited by the precision that can be obtained from measurements on the stereographic net. This corresponds to an uncertainty of about ± .001 turn. Calculations are carried out to one more significant digit. In the example given below, the predictions are within a minute of time and a degree of arc of values determined by a precise numerical solution.

GRAPHIC PREDICTION OF CIRCUMSTANCES OF LOCAL CULMINATION

1a	scale from map:	
1b	Sta. Lat.	40 °86
1c	E. Long	286 °09
1d	IF 1c > 180°,	-360°00
1e =	E. Long.	73 °91
1f	UT @ Sta. noon	16 H
1g	GO (table 1)	6369 k m
1h	Sta. elev.	0 k m
1i	NGO (table 1)	.1370
1j	LNO=1e/360°	-.2053
1k	GO=1g+1h	6369 k m
1m	Zone=12H-1f	-04 H

2a	NCAT	1098
2b	JNT	313 .0000
2c	TNE	.7290
2d	QNRo	.5279
2e	NRPo	.7287
2f	PRMo	.0000
2g	M1	1486816+2
2h	M2	1600-4
2i	NGR	.1806
2j	CP	6987 k m
2k -	CG	98 k m
2m =	GP	6889 k m
2n	CG/CP = e	.014
2p	GR1	-57131-3
2q	GR2	-73843-4
2r	Std. Brtns.	-20 d b z

3a	date 1 966 Y07 M26 D	
3b =	JNT	332 .0000
3c +	TNO est.	000 .9430
3d =	JNO	332 .9430
3e -	LNO (1j)	-.2053
3f =	JNL	333 .1483

4a -	JNEq	330 .0000
4b =	ENLq	3 .1483
4c =	ENLq	31483+1
4d *	QNT1	27379-2
4e =	dQNT	862-2
4f =	dQNT	.0086
4g +	QNTo sched.	.0869
4h =	QNT	.0955

5a	JNL (3f)	333 .1483	333 .1267
5b -	JNE (2b+c)	313 .7290	313 .7290
5c =	ENL	19 .4193	19 .3977
5d =	ENL	1941930+2	1939770+2
5e	M1*ENL	2887293+3	2884081+3
5f	ENL²	37711+3	
5g	M2*ENL²	60338-2	
5h =	M2*ENL²	.0060	.0060
5i +	M1*ENL	288 .7293	288 .4081
5j =	dPRM	288 .7353	288 .4141
5k =	dPRM	28874+3	
5m	dPRM*GR1	-16496+0	
5n =	dQNR	-.1650	
5p +	QNRo (2d)	.5279	
5q =	QNR	.3629	
5r	dPRM*GR2	-21321-1	
5s =	dNRP	-.0213	
5t +	NRPo (2e)	.7287	
5u =	NRP	.7074	

6a	PRM (5j)	.7353	.4141
6b	IF abs. >.5	-1 .0000	-1 .0000
6c =	PRM	-.2647	.4141
6d +	MRV chart	-.0040	.0030
6e =	PRV	-.2687	.4171
6f +	NRP (5u)	.7074	.7074
6g =	NRV	.4387	.1245

7a	RNQ = -(5q)	-.3629	
7b +	QNT (4h)	.0955	
7c =	RNT	-.2674	-.2674
7d +	TNL (5a)	.1483	.1267
7e =	RNL	-.1191	-.1407
7f +	LNO (1j)	-.2053	-.2053
7g =	RNO	-.3244	-.3460
7h	IF abs. >.5	±1 .0000	±1 .0000
7i =	RNO	-.3244	-.3460

8a	N @ pole, plot O @ NGO, RNO		
8b	R @ pole, measure ORN		
8c	ORN (8b)	-.1180	-.1075
8d +	NRV (6g)	.4387	.1245
8e =	ORV	.3207	.0170
8f		go to 9a	go to 9g

9a	-ORV = -(8e)	-3207+0
9b	9a/2g	-2157-1
9c =	dJNL	-0 .0216
9d +	JNL 5a	333 .1483
9e =	JNL	333 .1267
9f		carry to 5a'
9g	-ORV = -(8e')	-1700-1
9h	9g/2g	-1140-2
9i =	dJNL	-0 .0011
9j +	JNL 9e	333 .1267
9k =	JNL	333 .1256

10a	RNO (7i')	-.3460
10b +	(9i)	-.0011
10c =	RNO	-.3471
10d	N @ pole, plot O @ RNO = 10c, NGO = 1j	
10e	draw N - tan at O	
10f	R @ pole, plot V @ NRV = NRO, NGV = .25	
10g	draw V - tan at O	
10h	measure OGV, NOV	
10i	OGV on merid.	.019
10j	NOV prot. @ O	.867
10k	1.0 - NOV =	.133
10m	az. = 10k*360° =	48°

11a	PRM (6c')	.4141
11b -	(8e')	.0170
11c =	PRM	.3971
11d	GV/GP chart	1026+1
11e *	GP (2m)	6889+4
11f =	GV	7061+4
11g =	GV	7061 k m
11h	plot on finder O@GO = 1k,	
11i	V@GV = 11g, OGV = 10i	
11j	X@VX // GO, VX = GO	
11k	OV=GX finder	1070 k m
11m	OGX finder	.147
11n	.250 - 11m	.103
11p	elev. = 11n*360°	37°

12a	JNL (9k)	333 .1256
12b =		07M27D03H01 M
12c +	Zone	-04 H
12d =		07M26D23H01 M

13a	RNT (7c)	-.2676
13b +	TNS sched	.0044
=	RNS	-.2632
	IF abs. >.5	±1 .0000
13c =	RNS	-.2632
13d	NGS sched	.3046
13e	N @ Pole, plot S	
13f	@ NGS = 13d, RNS = 13c	
13g	measure SGO on net	
13h	SGO on merid.	.185
13i	MAX SGO	.200
13j	SKY: Dark, Bright	
13k	measure SGV on net	
13m	SGV	.190
13n	MIN SGV @ GV	.180
13p	SAT. Dark, Bright	

14a	R @ pole, plot X on O merid. @ OGX = 11m	
14b	measure SGX on net	
14c	SGX on merid	.234
14d	enter and scale from brightness charts:	
14e	phase @ 14c	-2 .7 db
14f +	range @ 11k	-0 .5 db
14g +	Z. dist @11m	-0 .9 db
14h =	net gain	-4 .1 db
14i +	Std. Brtn.	-20 .0 dbz
14j =	App. Brtn.	-24 .1 dbz
14k ÷	db/m	-4 .0
14m =	App. Mag.	6 .0 m

15a	N @ pole draw N-tan @ X	
15b	RNX from net	-.126
15c +	QNR (5q)	.363
15d =	QNX	.237
15e -	1/4 turn	.250
15f =	R. A. in days	.987
15g *	24H/day	23 H688
15h +	fract*60M/H	41 M
15i =	R. A.	23 H41 M
15j	NGX on merid.	.103
15k	.250 - NGX =	.147
15m	Decl. = 15k*360°	53°
15n	R@pole draw R-tan @ X	
15p	NXR protractor	.692

PART 1: ENTER STATION COORDINATES.

1a	scale from map:	
1b	Sta. Lat.	40°86
1c	E. Long	286°09
1d	IF 1c > 180°,	-360°00
1e	= E. Long.	-73°91
1f	UT @ Sta. noon	16H
1g	GO (table 1)	6369 km
1h	Sta. elev.	0 km
1i	NGO (table 1)	.1370
1j	LNO=1e/360°	-.2053
1k	GO=1g+1h	6369 km
1m	Zone=12H-1f	-04H

Station sea level, (1g), depends upon the geodetic latitude of the station. GO is taken from Table 1 at the station latitude (1b) scaled from a map.

Station elevation, (1h), is evaluated in kilometers above mean sea level. For graphic methods, an elevation of less than .5 km is not significant.

Observer's radial distance, GO (1k), is measured from the center of the earth, G, to the observer, O. GO is the sum of (1g) and (1h).

Observer's polar distance, NGO (1i), is measured at the center of the earth, G, from the North pole, N, to the observer, O. NGO depends on the station's geodetic latitude (1b), and is taken from Table 1.

Observer's east longitude, LNO (1j), is the right-handed polar angle measured from the Greenwich meridian, L, around the north pole, N, to the observer's meridian, O. LNO is reduced to the range 0 ± .5.

Observer's time zone, (1m), is the difference between the observer's civil noon and the corresponding Universal Time (1f).

NOTE: once items (1i) through (1m) have been found for a given station, they may be entered directly in Part 1 of Form 6-66.

TABLE I

Geocentric Coordinates for Northern Latitudes

LAT (deg)	NGU (turns)	NGO (turns)	GO (km)	LAT (deg)	NGU (turns)	NGO (turns)	GO (km)
0	.2500000	.2500000	6378.388	45	.1250000	.1255368	6367.695
1	.2472222	.2472409	6378.381	46	.1222222	.1227587	6367.320
2	.2444444	.2444818	6378.362	47	.1194444	.1199800	6366.946
3	.2416667	.2417226	6378.330	48	.1166667	.1172007	6366.572
4	.2388889	.2389633	6378.284	49	.1138889	.1144207	6366.200
5	.2361111	.2362040	6378.226	50	.1111111	.1116400	6365.829
6	.2333333	.2334446	6378.155	51	.1083333	.1088587	6365.461
7	.2305556	.2306850	6378.072	52	.1055556	.1060768	6365.095
8	.2277778	.2279252	6377.975	53	.1027778	.1032942	6364.732
9	.2250000	.2251653	6377.867	54	.1000000	.1005110	6364.373
10	.2222222	.2224052	6377.746	55	.0972222	.0977272	6364.017
11	.2194444	.2196449	6377.612	56	.0944444	.0949428	6363.666
12	.2166667	.2168843	6377.467	57	.0916667	.0921577	6363.320
13	.2138889	.2141235	6377.310	58	.0888889	.0893721	6362.979
14	.2111111	.2113624	6377.141	59	.0861111	.0865858	6362.644
15	.2083333	.2086009	6376.961	60	.0833333	.0837990	6362.315
16	.2055556	.2058392	6376.769	61	.0805556	.0810116	6361.992
17	.2027778	.2030771	6376.566	62	.0777778	.0782236	6361.676
18	.2000000	.2003146	6376.353	63	.0750000	.0754351	6361.368
19	.1972222	.1975518	6376.129	64	.0722222	.0726461	6361.067
20	.1944444	.1947886	6375.894	65	.0694444	.0698565	6360.774
21	.1916667	.1920249	6375.650	66	.0666667	.0670665	6360.490
22	.1888889	.1892609	6375.396	67	.0638889	.0642759	6360.214
23	.1861111	.1864963	6375.133	68	.0611111	.0614849	6359.948
24	.1833333	.1837313	6374.860	69	.0583333	.0586934	6359.690
25	.1805556	.1809659	6374.579	70	.0555556	.0559015	6359.443
26	.1777778	.1781999	6374.289	71	.0527778	.0531091	6359.206
27	.1750000	.1754334	6373.991	72	.0500000	.0503164	6358.978
28	.1722222	.1726664	6373.686	73	.0472222	.0475232	6358.762
29	.1694444	.1698988	6373.373	74	.0444444	.0447297	6358.556
30	.1666667	.1671307	6373.053	75	.0416667	.0419358	6358.362
31	.1638889	.1643621	6372.726	76	.0388889	.0391416	6358.179
32	.1611111	.1615928	6372.394	77	.0361111	.0363471	6358.007
33	.1583333	.1588230	6372.055	78	.0333333	.0335523	6357.848
34	.1555556	.1560526	6371.711	79	.0305556	.0307573	6357.700
35	.1527778	.1532816	6371.362	80	.0277778	.0279619	6357.565
36	.1500000	.1505100	6371.009	81	.0250000	.0251664	6357.442
37	.1472222	.1477377	6370.651	82	.0222222	.0223707	6357.331
38	.1444444	.1449649	6370.290	83	.0194444	.0195747	6357.234
39	.1416667	.1421913	6369.926	84	.0166667	.0167786	6357.149
40	.1388889	.1394172	6369.558	85	.0138889	.0139824	6357.077
41	.1361111	.1366424	6369.189	86	.0111111	.0111861	6357.017
42	.1333333	.1338670	6368.817	87	.0083333	.0083896	6356.971
43	.1305556	.1310909	6368.444	88	.0055556	.0055931	6356.938
44	.1277778	.1283142	6368.070	89	.0027778	.0027966	6356.919
45	.1250000	.1255368	6367.695	90	.0000000	.0000000	6356.912

For southern latitudes, subtract tabular values of NGO and NGU from ½.

PART 2: ENTER SATELLITE DATA

The following orbital elements appeared in an ITCP airmail announcement:

CAT	[illegible]	AJNE	[illegible]	ANRP	[illegible]	APRM1	[illegible]	ANGR	[illegible]	CG	[illegible]	GR2
1098	[illegible]	728995	[illegible]	728710	[illegible]	14868163	[illegible]	180645	[illegible]	009832	[illegible]	-0073843

The above data are entered in Part 2 as follows:

2a	NCAT	1098
2b	JNT	313 .0000
2c	TNE	.7290
2d	QNRo	.5279
2e	NRPo	.7287
2f	PRMo	.0000
2g	M1	1486816+2
2h	M2	1600-4
2i	NGR	.1806
2j	CP	6987 km
2k -	CG	98 km
2m=	GP	6889 km
2n	CG/CP = e	.014
2p	GR1	-57131-3
2q	GR2	-73843-4
2r	Std. Brtns.	-20 dbz

Satellite Catalog Number, NCAT (2a), is an integer. The corresponding COSPAR identification and popular name, if any, are found in cross-indexes periodically published by ITCP.

Day number at epoch of elements, JNT (2b), is the integral number of revolutions the Greenwich Meridian has made with respect to the mean time meridian, T, since Nov. 17.0 1858. The corresponding Gregorian Calendar date can be found by referring to tables contained in the Bulletin on EPOCH SPECIFICATION (ITCP Bull. Dec. 30, 1965).

Universal Time at epoch, TNE (2c), is the right-handed polar angle measured from the mean time meridian, T, around the north pole, N, to the Greenwich Meridian at epoch, E. TNE is identical to Greenwich mean time expressed in decimal fractions of a day.

Longitude of the orbit pole at epoch, QNRo (2d), is the right-handed polar angle measured from the pole of the ecliptic, Q, around the north pole, N, to the satellite's orbit pole, R.

Argument of perigee at epoch, NRPo (2e), is the right-handed polar angle measured from the north pole, N, around the orbit pole, R, to the perigee point, P. At perigee, the satellite is closest to the center of the earth, G.

Mean anomaly at epoch, PRMo (2f), is the right-handed polar angle measured from the perigee point, P, around the orbit pole, R, to the position of a fictitious mean satellite, M, in an equivalent circular orbit. The fractional part of PRM is identical to the fraction of a period elapsed since last perigee passage. Gear ratio elements are always referred to an epoch of perigee and the value of PRMo (2f) will always be zero.

Change in mean anomaly per day, M1, is entered in (2g) as an indexed numerator. M1 is given in microturns in current gear ratio elements under the column headed APRM1.

Change in mean anomaly per day, squared, M2, is entered in (2h) in turns as an indexed numerator. In gear ratio element announcements, M2 is given in microturns.

Orbit inclination, NGR (2i), is the polar distance from the north pole, N, to the satellite's orbit pole, R. In earth satellite predictions, all polar distances are measured at the center of the earth, G.

Semi-major axis, CP, is measured from the orbit center, C, to the perigee point, P. It is entered in (2j) to the nearest kilometer.

Orbit displacement, CG, is measured from the center of the orbit, C, to the center of mass of the earth, G. It is entered in (2k) to the nearest kilometer.

Radius of perigee, GP, is measured from the center of mass of the earth, G, to perigee, P. The value entered in (2m) is obtained by subtracting CG from CP (2j - 2k).

Orbit eccentricity, e, is the ratio of which orbit displacement, CG, is the numerator and semi-major axis, CP, is the denominator. The ratio is entered at (2n).

Change in longitude of the orbit pole per day, QNR1, is given in gear ratio elements as the ratio, QNR1/M1, and identified as GR1. In orbit element messages, the actual ratio is multiplied by 100 to conserve space. GR1 as given in current element sets is multiplied by 1/100 and entered in (2p) as an indexed numerator.

Change in argument of perigee per day, NRP1, is expressed in gear ratio elements as the ratio, NRP1/M1, and identified as GR2. In orbit element messages, the actual ratio is multiplied by 100 to conserve space. GR2 as given in current element sets is multiplied by 1/100 and entered in (2q) as an indexed numerator.

Standard Brightnesses (2r) of artificial earth satellites tabulated by the ITCP are normalized to 1 megameter slant range, zero phase angle, and zero zenith distance. Standard Brightness values are given in dbz; i.e. decibels above or below the brightness of a zero magnitude star. Tables for predicting apparent brightness are given in a bulletin on Standard Brightness (ITCP Bull. Sept. 30, 1965).

PART 3: MAKE PRECISE INITIAL ESTIMATE OF LOCAL CULMINATION TIME

3a	date 1 966 Y07M26 D	
3b	= JNT	332 .0000
3c	+ TNO est.	000 .9430
3d	= JNO	332 .9430
3e	- LNO (1j)	- .2053
3f	= JNL	333 .1483

Choice of observation date (3a) is up to the observer. ITCP Form 4-66 is used in selecting days when there will be opportunities for visual or radio observations of a particular satellite.

Local mean time of orbit, TNO (3c), for the selected day is found by interpolating between tabular entries in ITCP Form 4-66 (Appendix A, Exhibit 3).

Initial estimate of epoch of culmination, JNL (3f), is obtained by adjusting the epoch from local mean time, JNO (3d), to Universal Time by subtracting LNO (3e).

NOTE: In this case, subtracting a negative number (3e) is the same as adding a positive number of the same absolute value. This is always so. Rules for operations with signed numbers are given in the Companion Bulletin on Practical Arithmetic dated Sept. 30, 1966.

NOTE: In general, arithmetic operator symbols appear in the form in a separate column and are not to be confused with the signs of numbers. Unsigned numbers are assumed to be positive. Multiplication is represented by an asterisk (*).

Part 4: FIND LONGITUDE OF MEAN MIDNIGHT

3f	= JNL	333 .1483
4a	- JNEq	330 .0000
4b	= ENLq	3 .1483
4c	= ENLq	3 1483 ÷ 1
4d	* QNT1	27379 - 2
4e	= dQNT	862 - 2
4f	= dQNT	.0086
4g	+ QNTo sched.	.0869
4h	= QNT	.0955

Longitude of mean midnight, QNTo (4g), at a specified epoch, JNEq (4a), is found in ITCP Form 4-66 (Appendix A).

Change in longitude of mean midnight per day, QNT1 (4d), is invariant. The rate may be expressed as the mixed decimal number 0.0027379 or as the indexed numerator 27379-2.

Longitude of mean midnight at culmination time, QNT (4h), is found by adding the longitude difference, dQNT (4f), and given longitude, QNTo (4g).

PART 5: FIND MEAN ANOMALY, LONGITUDE OF THE ORBIT POLE, and ARGUMENT OF PERIGEE AT EPOCH.

5a	JNL (3f)	333.1483	333.1267
5b -	JNE (2b+c)	313.7290	313.7290
5c =	ENL	19.4193	19.3977
5d =	ENL	1941930+2	1939770+2
5e	M1*ENL	2887293+3	2884081+3
5f	ENL^2	37711+3	
5g	$M2*ENL^2$	60338-2	
5h =	$M2*ENL^2$	.0060	.0060
5i +	M1*ENL	288.7293	288.4081
5j =	dPRM	288.7353	288.4141
5k =	dPRM	28874+3	
5m	dPRM*GR1	-16496+0	
5n =	dQNR	-.1650	
5p +	QNRo (2d)	.5279	
5q =	QNR	.3629	
5r	dPRM*GR2	-21321-1	
5s =	dNRP	-.0213	
5t +	NRPo (2e)	.7287	
5u =	NRP	.7074	

Note: Figures in right-hand column are from a second round of calculations.

Time elapsed since epoch of elements, ENL (5c), is found by subtracting the epoch of the orbital elements, JNE (5b), from the epoch of culmination, JNL (5a).

Change in mean anomaly since epoch of elements, dPRM (5j), is found by adding daily change times elapsed time, M1*ENL (5i), and change per day, squared, times elapsed time, squared, $M2*ENL^2$ (5h).

Change in longitude of orbit pole, dQNR (5n), is the product of change in mean anomaly times the first gear ratio, dPRM*GR1 (5m).

Longitude of the orbit pole at epoch, QNR (5q), is found by adding longitude at epoch, QNRo (5p), and the change since epoch, dQNR (5n).

Change in argument of perigee since epoch, dNRP (5s), is the product of change in mean anomaly times the second gear ratio, dPRM*GR2 (5r).

Argument of perigee at epoch, NRP (5u), is found by adding argument of perigee at epoch, NRPo (5t), and the change since epoch, dNRP (5s).

PART 6: FIND LONGITUDE OF SATELLITE AT EPOCH.

6a PRM (5j)	.7353	.4141
6b IF abs. >.5	-1.0000	-1.0000
6c = PRM	-.2647	.4141
6d + MRV chart	-.0040	.0030
6e = PRV	-.2687	.4171
6f + NRP (5u)	.7074	.7074
6g = NRV	.4387	.1245

Mean anomaly, PRM (6a), is the fractional portion of change in mean anomaly, dPRM (5j), plus mean anomaly at epoch, PRMo (2f), which, in case of gear ratio elements, is always zero. If the absolute value of PRM is greater than 0.5, it is reduced by one complete turn to obtain a value in the range 0.0 ± 0.5 turns so as to permit entry into ITCP Form 2-66 (Fig. 1).

True anomaly, PRV (6e), is found by adding the value of MRV determined graphically from ITCP Form 2-66 and mean anomly, PRM, (6c + 6d).

Longitude of the satellite, NRV (6g), is the right-handed polar angle measured from the North pole, N, around the orbit pole, R, to the true satellite, V. It is found by adding true anomaly, PRV, and argument of perigee, NRP, (6e + 6f).

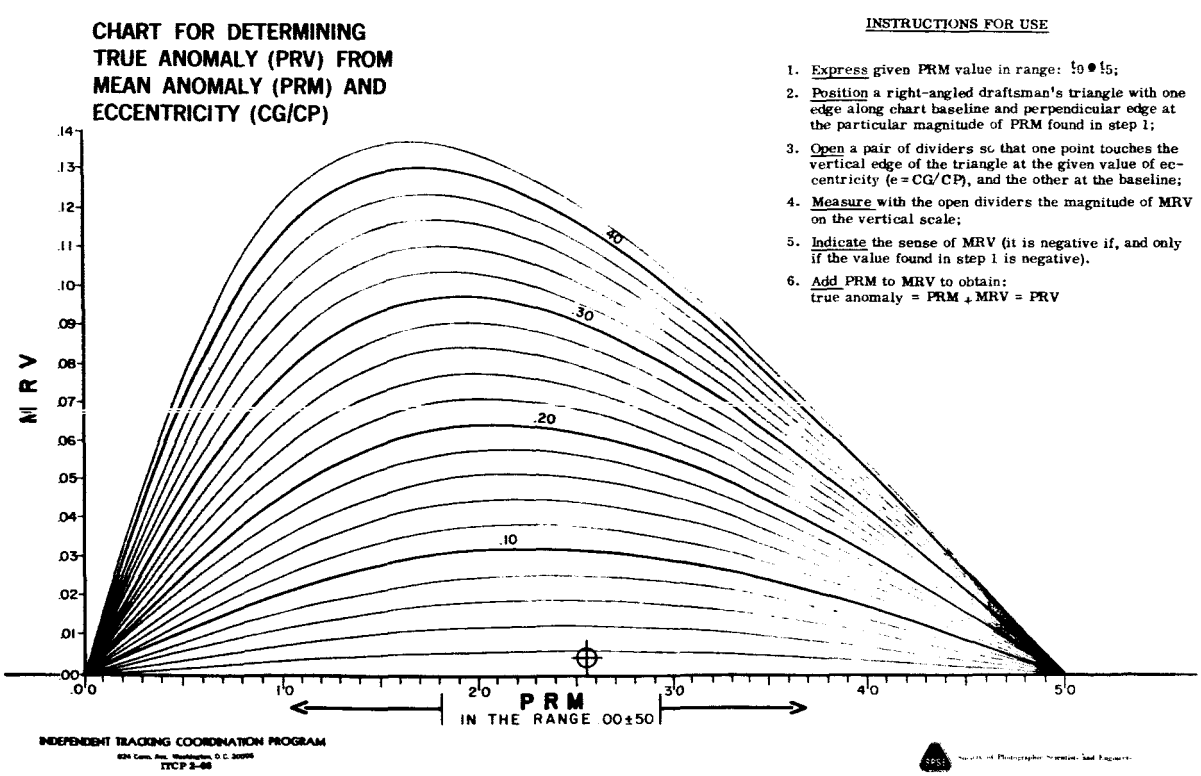


Fig. 1. Determination of MRV = -.004, given: PRM = -.265 (6c), e = .014 (2n).

PART 7: FIND LONGITUDE OF OBSERVER AT EPOCH.

7a RNQ = - (5q)	- .3629	
7b + QNT (4h)	.0955	
7c = RNT	- .2674	- .2674
7d + TNL (5a)	.1483	.1267
7e = RNL	- .1191	- .1407
7f + LNO (1j)	- .2053	- .2053
7g = RNO	- .3244	- .3460
7h IF abs.>.5	± 1 .0000	± 1 .0000
7i = RNO	- .3244	- .3460

Longitude of observer from orbit pole, RNO (7g), is found by adding together: RNQ (-5q), QNT (4h), TNL (fraction part of 5a) and LNO (1j). Any of these variables might be expressed in negative numbers. For the convenience of those who do not have mechanical calculators, the form lists each addition separately.

IF the absolute value of RNO is greater than 0.5, provision is made for adding or subtracting one complete turn, as may be required, in order to reduce the value of RNO to the range 0.0 ± 0.5 (7i).

PART 8: FIND LONGITUDE ERROR

8a N @ pole, plot O @ NGO, RNO		
8b R @ pole, measure ORN		
8c ORN (8b)	- .1180	- .1075
8d + NRV (6g)	.4387	.1245
8e = ORV	.3207	.0170
8f	go to 9a	go to 9g

The time of local culmination, JNL (5a), is defined as the time when the satellite, V, lies on the same meridian from the orbit pole, R, as the observer, O. Only at a time of local culmination will the satellite longitude from the observer's meridian ORV (8e), be zero.

Longitude of north measured at the orbit pole from the observer's meridian, ORN (8c), is found by first plotting the observer's north polar coordinates, NGO (1i), RNO (7i), on a transparent overlay pivoted at the center of a rationalized Wulff net (ITCP Form 532), as shown in Fig. 2, then rotating the overlay by an amount equal to the orbit inclination, NGR (2i), to permit measurement of ORN (8c) as shown in Fig. 3.

Longitude error at epoch, ORV (8e), is obtained by adding ORN (8c) and NRV (8d).

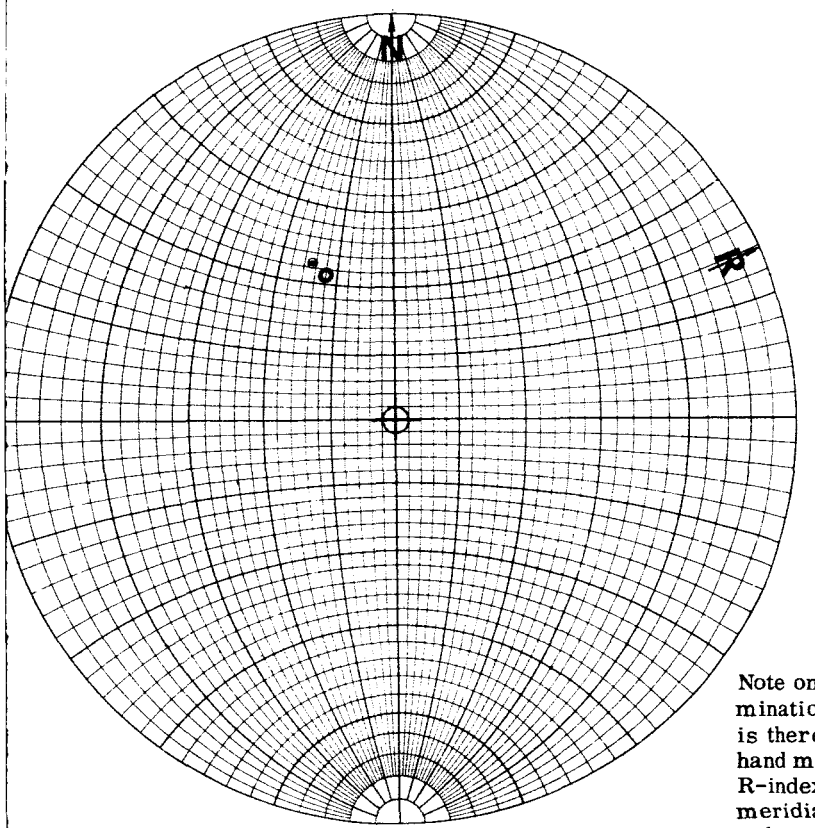


Fig. 2. Overlay pivoted at center of meridional stereographic net. An N-index is located at the pole of the net, and an R-index at the polar distance NGR = .1806 (2i). The observer's station, O, is plotted at the polar distance NGO = .137 (1i) and the polar angle RNO = -.324 (7i).

Note on Fig. 2: in this case RNO at culmination (7i) is negative, and the R-index is therefore located on the extreme right-hand meridian. When RNO is positive, the R-index is located on the extreme left-hand meridian because positive right-handed polar angles are measured by counting meridians from left to right.

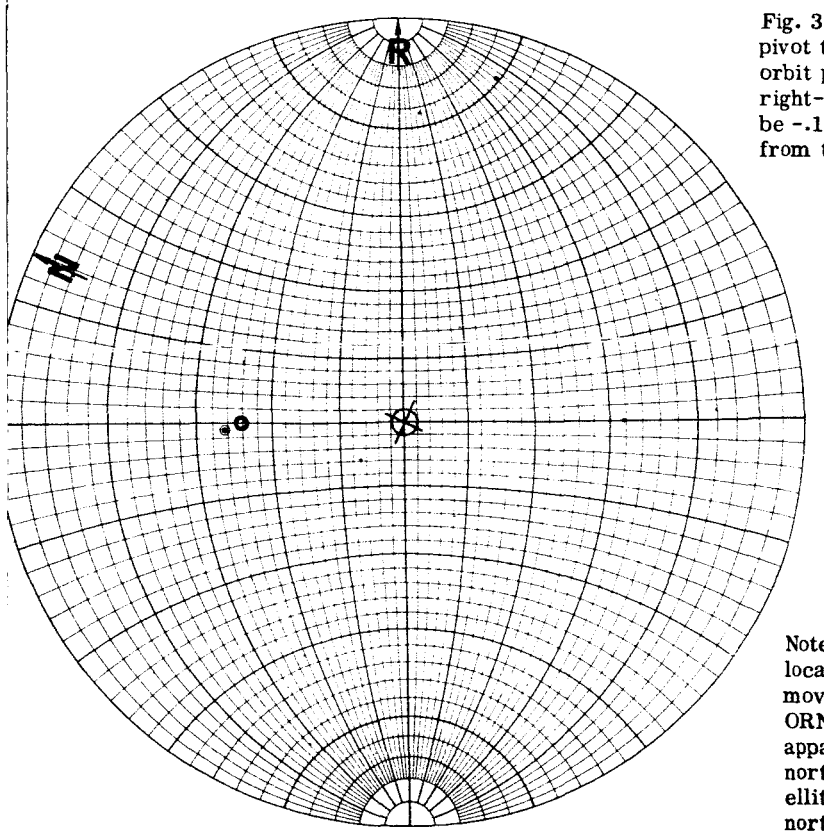


Fig. 3. Overlay rotated around central pivot to bring R-index to the pole and the orbit plane to the equator of the net. The right-handed polar angle ORN is found to be -.118 (8c) by counting meridians from the O-meridian to the N-meridian.

Note on Fig. 3: in this case a satellite located on the O meridian would be moving southward. In general, when ORN at culmination (8c) is positive, the apparent direction of the satellite is northward, when it is negative, the satellite appears to move away from the north pole.

PART 9: ADJUST EPOCH

9a	-ORV = -(8e)	-3207+0
9b	9a/2g	-2157-1
9c	= dJNL	-0.0216
9d	+ JNL 5a	333.1483
9e	= JNL	333.1267
9f		carry to 5a'

Approximate epoch adjustment, dJNL (9c), is found by dividing the negative of longitude error, ORV, by mean motion, M1 (9a/2g).

Improved epoch, JNL (9e), is found by adding the adjustment, dJNL (9c), to the original JNL (9d). The improved epoch (9e) is then carried back to (5a') for a second round of calculations ending in a reduced longitude error, ORV (8e').

9g	-ORV = -(8e')	-1700-1
9h	9g/2g	-1140-2
9i	= dJNL	-0.0011
9j	+ JNL 9e	333.1267
9k	= JNL	333.1256

Second adjustment to epoch, dJNL (9i), is found by dividing the negative of the reduced longitude error by mean motion, M1 (9g/2g).

Further improved epoch, JNL (9k), is found by adding the second adjustment to epoch, dJNL (9i), and the improved epoch, JNL (9j).

PART 10: FIND AZIMUTH AT CULMINATION TIME.

10a	RNO (7i')	-.3460
10b	+ (9i)	-.0011
10c	= RNO	-.3471
10d	N @ pole, plot O	
	@ RNO = 10c, NGO = 1j	
10e	draw N - tan at O	
10f	R @ pole, plot V	
	@ NRV = NRO, NGV = .25	
10g	draw V - tan at O	
10h	measure OGV, NOV	
10i	OGV on merid.	.019
10j	NOV prot. @ O	.867
10k	1.0 - NOV =	.133
10m	az. = 10k*360° =	48°

Observer longitude at epoch, RNO (10c), is obtained by adjusting the value obtained on the previous round of calculations, (7i'), by the time difference (9i).

Polar distance of satellite from observer, OGV (10i), is measured on the stereographic net as shown in Fig. 5b.

Topocentric satellite direction, NOV (10j), is the right-handed polar angle measured with a protractor from the direction of north, N, around the observer's position, O, to the direction of the satellite, V, as shown in Fig. 6.

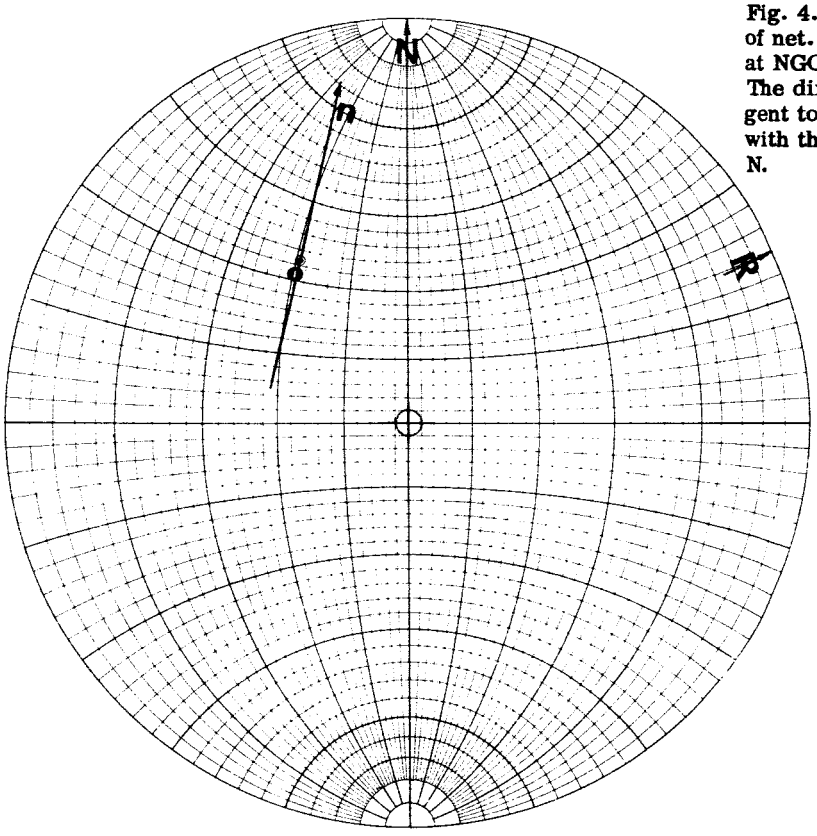


Fig. 4. Overlay positioned with N at pole of net. Observer's station, O, is plotted at NGO = .137 (1i), RNO = -.347 (10c). The direction toward North is drawn tangent to the observer's meridian at O, with the northward terminus identified by N.

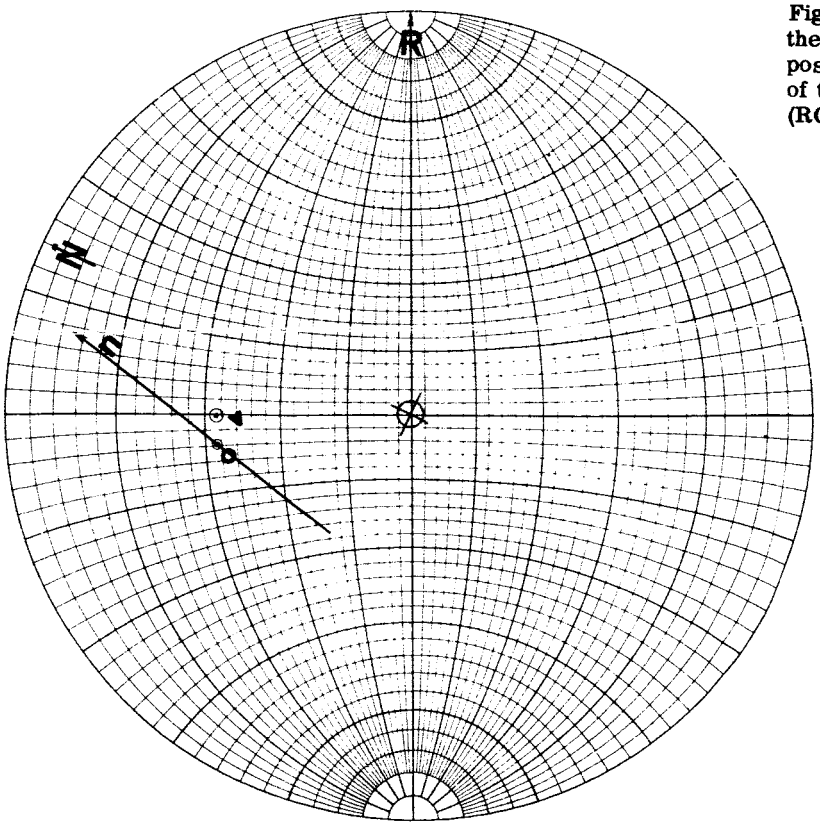


Fig. 5a. Overlay positioned with R at the pole of the net. The satellite's position, V, is plotted at the equator of the net on the same meridian as O. (RGV is always .25)

Fig. 5b. Overlay positioned with R at pole of net. A tangent to the O-meridian is drawn at O. The terminal lying in the same direction as V is marked V. The polar distance, OGV, is found to be .019 (10i) by counting small circle graduations along the meridian.

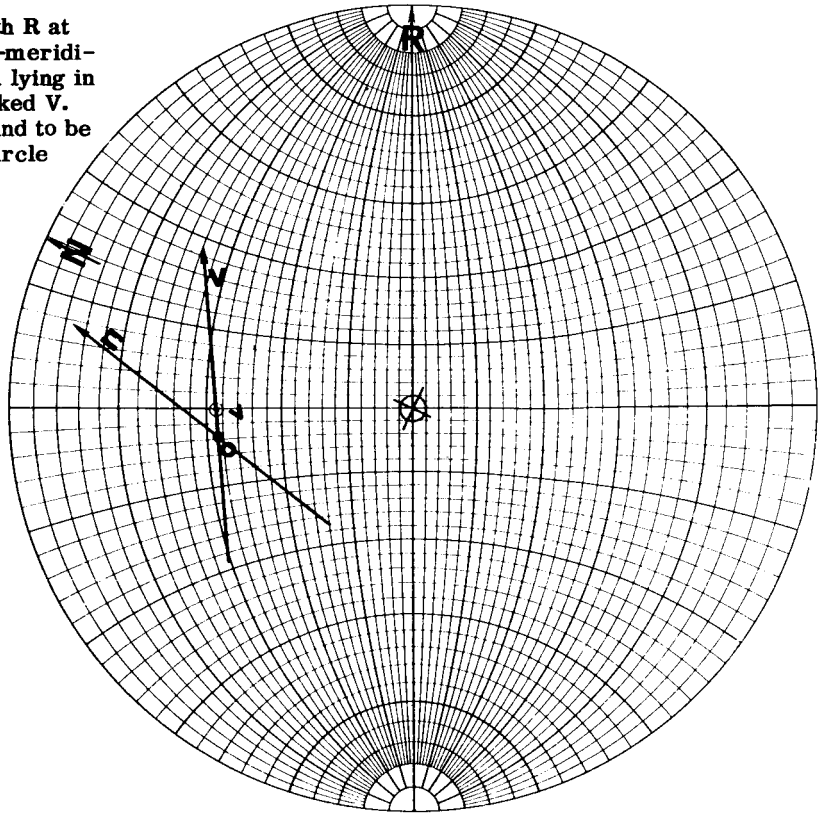
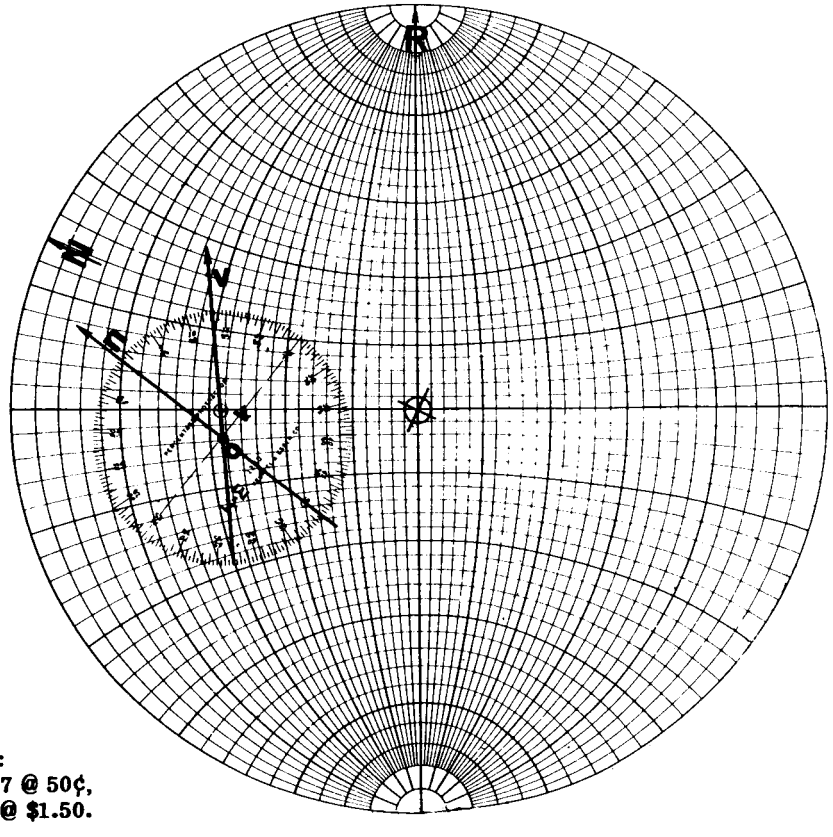


Fig. 6. NOV, the right-handed polar angle from N measured around O to V is found to be .867 (10j) by measuring with a percentage protractor* the angle formed by the two tangent lines. Azimuth is measured in degrees from north through east. Azimuth may be determined from NOV or measured directly with a protractor graduated in degrees. Either way, azimuth is found to be 48° (10m).



*Available at stationary stores: C-thru Ruler Company # P-257 @ 50¢, or Keuffel & Esser Co. #1280 @ $1.50.

PART 11: FIND SLANT RANGE AND ELEVATION

11a	PRM (6c')	.4141
11b -	(8e')	.0170
11c =	PRM	.3971
11d	GV/GP chart	1025 +1
11e *	GP (2m)	6889 +4
11f =	GV	7061 +4
11g =	GV	7061 k m

Satellite radius ratio, GV/GP (11d), is measured from ITCP Form 3-66 as shown in Fig. 7.

Satellite radius, GV (11f), (11g), is found by multiplying radius ratio times perigee radius, (11d*11e).

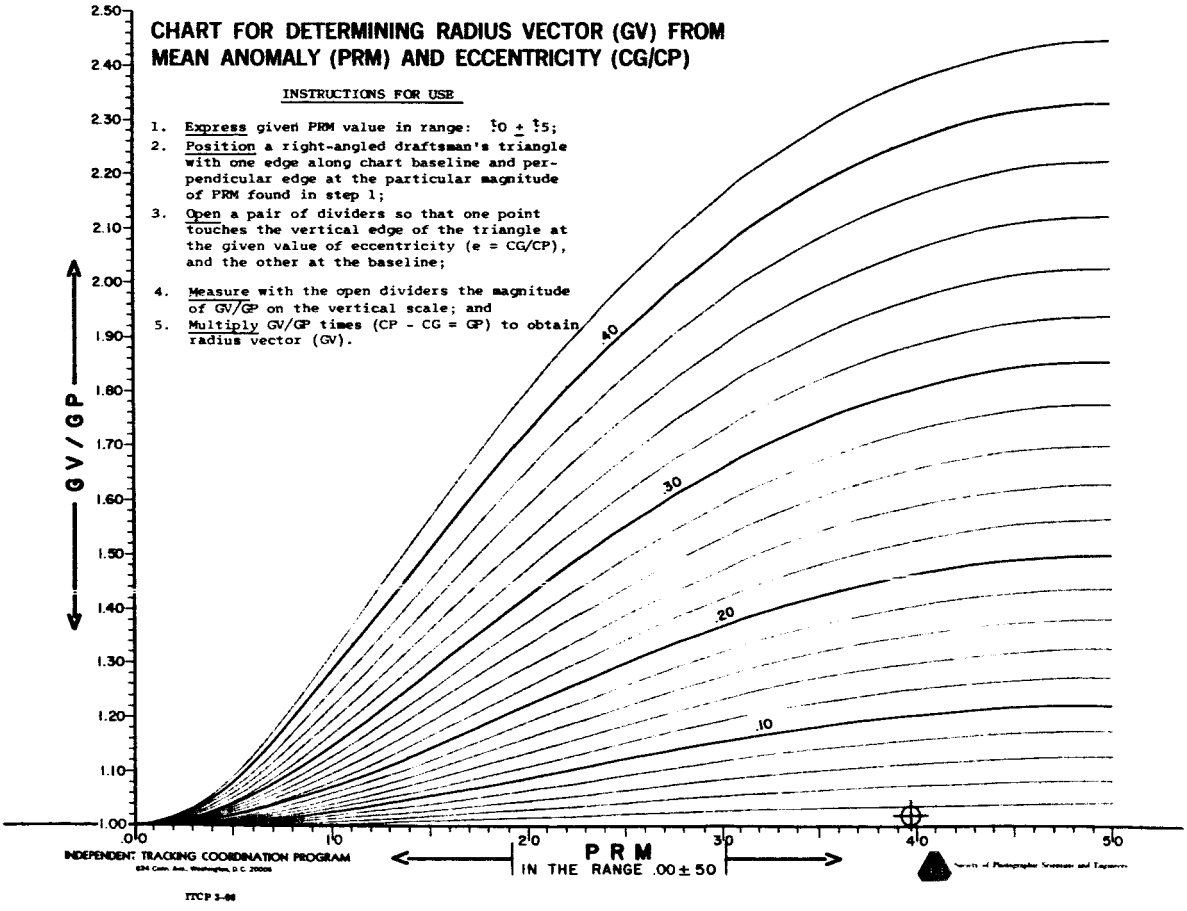


Fig. 7. Determination of GV/GP = 1.025, given PRM = .3971 (11c), e = .014 (2n).

PART 11: (continued)

11h	plot on finder O@GO = 1k,	
11i	V@GV = 11g, OGV = 10i	
11j	X@VX // GO, VX = GO	
11k	OV=GX finder	1070 k m
11m	OGX finder	.147
11n	.250 - 11m	.103
11p	elev. = 11n*360°	37°

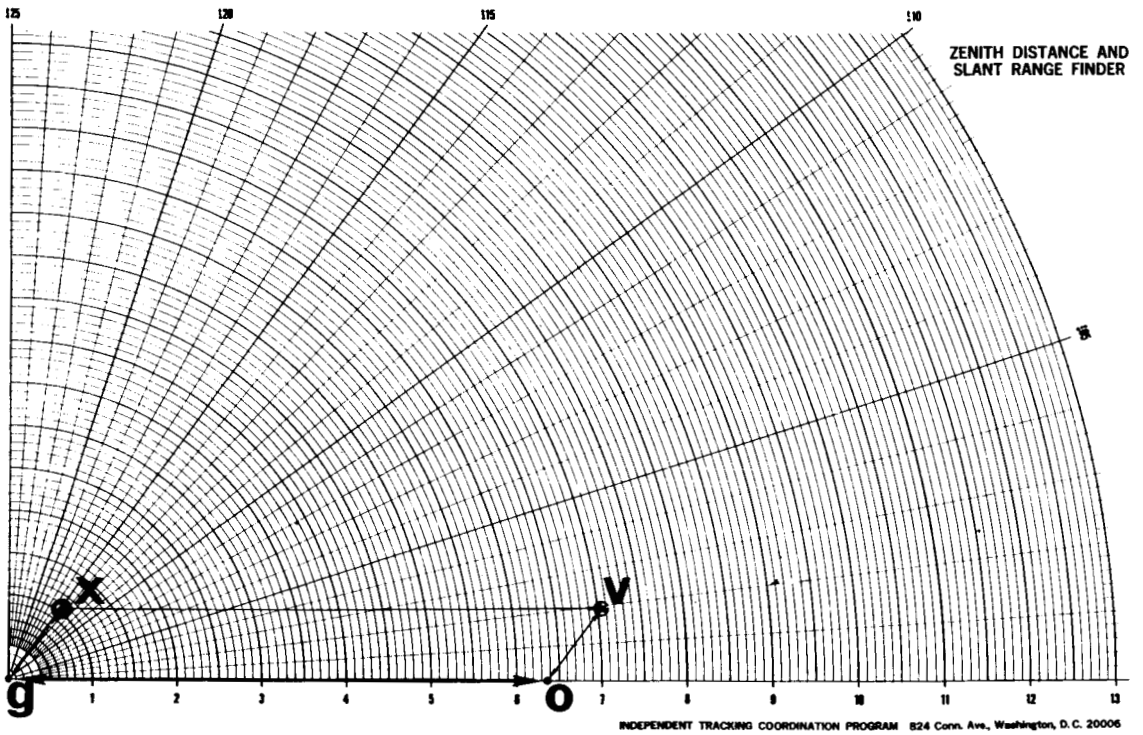


Fig. 8. Observer's position, O, plotted along the base of finder at GO = 6369 km (1k). Satellite position, V, is plotted at GV = 7061 km (11g) along the radial OGV = .019 (10i). X is plotted on a line parallel to GO, at a point where VX = GO. OV = GX and is found to be 1070 km (11k). The polar distance OGX is found to be .147 (11m), from which elevation in degrees can be determined. Elevation can also be measured from the perpendicular at G, using a protractor calibrated in degrees. Either way, the apparent elevation of the satellite above the horizon is found to be 37° (11p).

Slant range from observer to satellite, OV (11k), is found graphically as shown in fig. 8 by counting divisions from G to X. OV = GX.

Zenith distance, OGX (11m), is also found as shown in Fig. 8.

Elevation above the observor's horizon (11p) may be found by multiplying 1/4 turn less zenith distance times 360 (11n, 11p), or measured directly with a degree protractor from the perpendicular of the finder.

PART 12: FIND CIVIL DATE, HOUR, and MINUTE OF EPOCH.

12a	JNL (9k)	333.1256
12b =		07M27D03H01M
12c + Zone		-04H
12d =		07M26D23H01M

U.T. Month and day (12b) are determined from the integral part of JNL (12a) by reference to tables given in Bulletin on EPOCH SPECIFICATION (ITCP Bull. Dec. 30, 1965).

U.T. Hours (12b) are found by multiplying the fractional part of JNL (12a) by 24.

Minutes (12b) are found by multiplying the fractional part of hours by 60.

Civil month, day, hour and minute of local culmination (12d) are found by adding the observer's time zone (12c) to the U.T. month, day, hour and minute (12b) of local culmination.

Note on Arithmetic Operations. The only time those who do not have access to a desk calculator will have to perform arithmetic operations off form ITCP 6-66 is when finding M1*ENL (5e, 5e') to seven or more significant digits. All other products and quotients are found with sufficient accuracy with a spiral slide rule. The particular values of (5e) and (5e') in the sample prediction were hand calculated by the method of progressive rounding as follows:

1486816÷2	1486816÷2
1941930÷2	1939770÷2
1486816 1*1486816.0	1486816 1*1486816.0
1338134 9*148681.6	1338134 9*148681.6
59473 4*14868.2	44605 3*14868.2
1487 1*1486.8	13381 9*1486.8
1338 9*148.7	1041 7*148.7
45 3*14.9	104 7*14.9
2887353÷3	2884081÷3

In the above examples the screened numbers show operations carried out in the head. The method is described in greater detail in a Bulletin on Practical Arithmetic (ITCP Bull. Sept. 30, 1966).

RADIO OBSERVERS STOP HERE

PART 13: TEST SKY DARKNESS, SATELLITE BRIGHTNESS.

13a	RNT (7c)	− .2676
13b +	TNS sched	.0044
=	RNS	− .2632
IF abs.>.5		± 1 .0000
13c =	RNS	− .2632
13d	NGS sched	.3046
13e	N @ Pole, plot S	
13f	@ NGS = 13d, RNS = 13c	
13g	measure SGO on net	
13h	SGO on merid.	.185
13i	MAX SGO	.200
13j	SKY: Dark Bright	
13k	measure SGV on net	
13m	SGV	.190
13n	MIN SGV @ GV	.180
13p	SAT. Dark, Bright	

Longitude in mean midnight, RNT (13a), is the right-handed polar angle measured from the orbit pole, R, around the north pole, N, to the mean midnight meridian, T. RNT is taken from (7c).

Equation of time, TNS (13b), is the right-handed polar angle measured from the mean midnight meridian, T, around the north pole, N, to the earth's shadow center, S. TNS at JNL (9k) is found by interpolating between values given in ITCP Form 4-66, Appendix A, Exhibit 3.

Polar distance of earth's shadow center, NGS (13b), is measured from the north pole, N, to the earth's shadow center, S. NGS at JNL (9k), is found by interpolating between values given in ITCP Form 4-66, Appendix A, Exhibit 3.

Polar distance of observer from shadow center, SGO (13h), is measured from the earth's shadow center, S, to the observer, O, as shown in Figs. 9 and 10.

Maximum polar distance, MAX SGO (13i), determines the beginning and ending of astronomincal twilight. MAX SGO does not change. If SGO is greater than .200 (13i), the sky will be too bright for visual observation of any but the very brightest earth satellites.

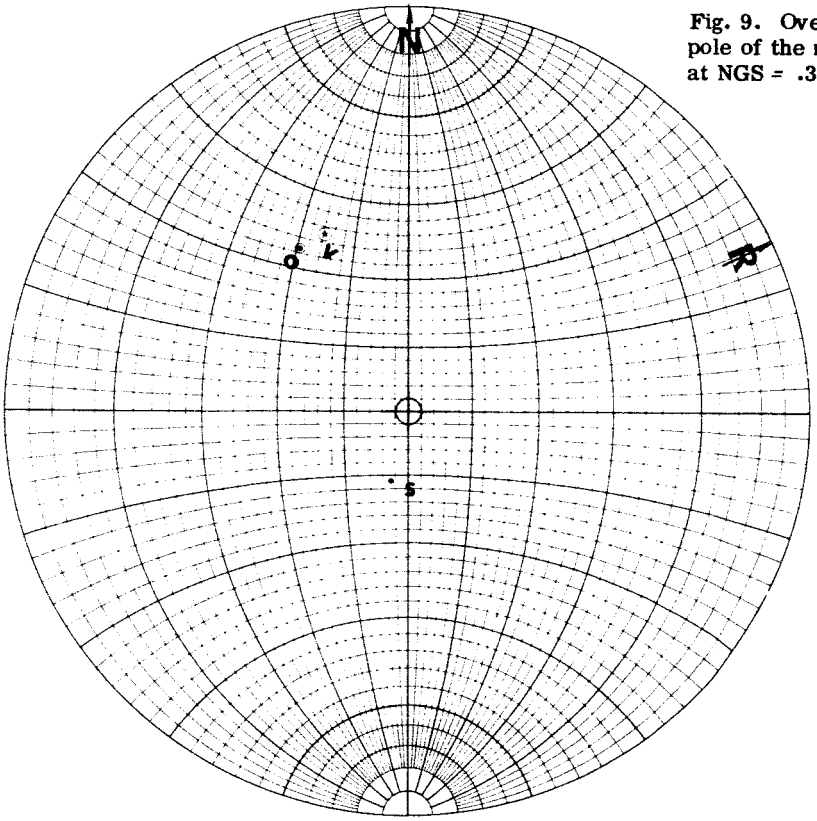


Fig. 9. Overlay positioned with N at the pole of the net. The point, S, is plotted at NGS = .305 (13d), RNS = -.263 (13c).

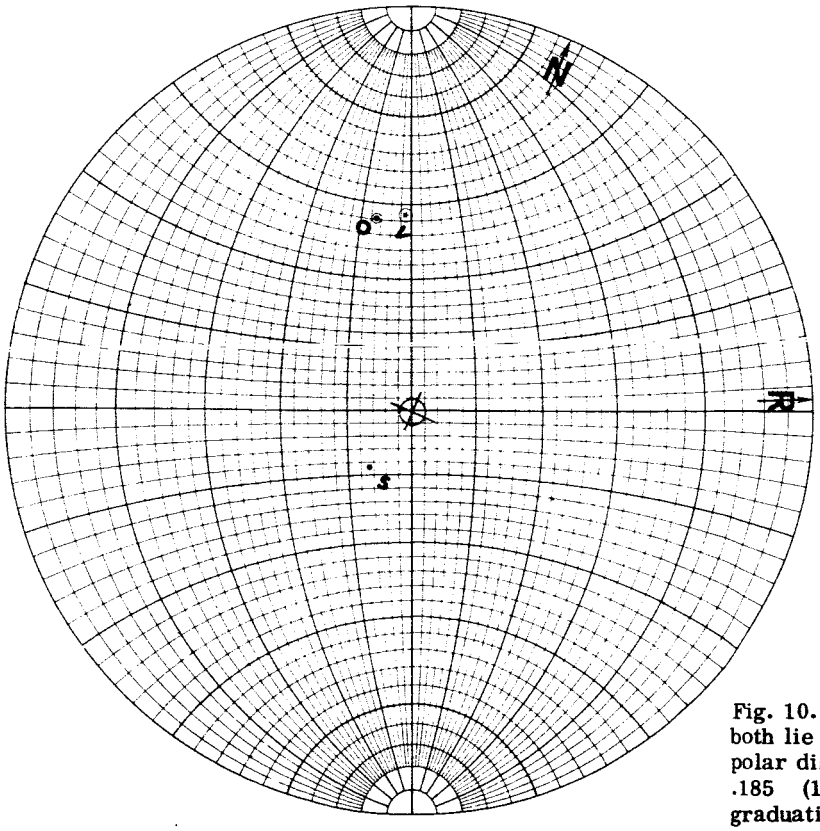


Fig. 10. Overlay rotated until S and O both lie on the same meridian. The polar distance, SGO, is found to be .185 (13h) by counting small circle graduations along the meridian.

TABLE 2

Minimum Polar Distances (SGV) from Center of Earth's Shadow, S, for Optical Observations on Satellites at Selected Radial Distances

GV (km.)	SGV Min (turns)
6400	.237
6500	.219
6600	.208
6700	.200
6800	.194
6900	.188
7000	.182
7100	.178
7200	.173
7300	.169
7400	.165
7500	.162
7600	.158
7700	.155
7800	.152
7900	.150
8000	.147
8500	.135
9000	.125
9500	.117
10000	.110
10500	.104
11000	.098
11500	.094
12000	.089
—	
13000	.082
—	
14000	.075
—	
15000	.070
—	
20000	.052

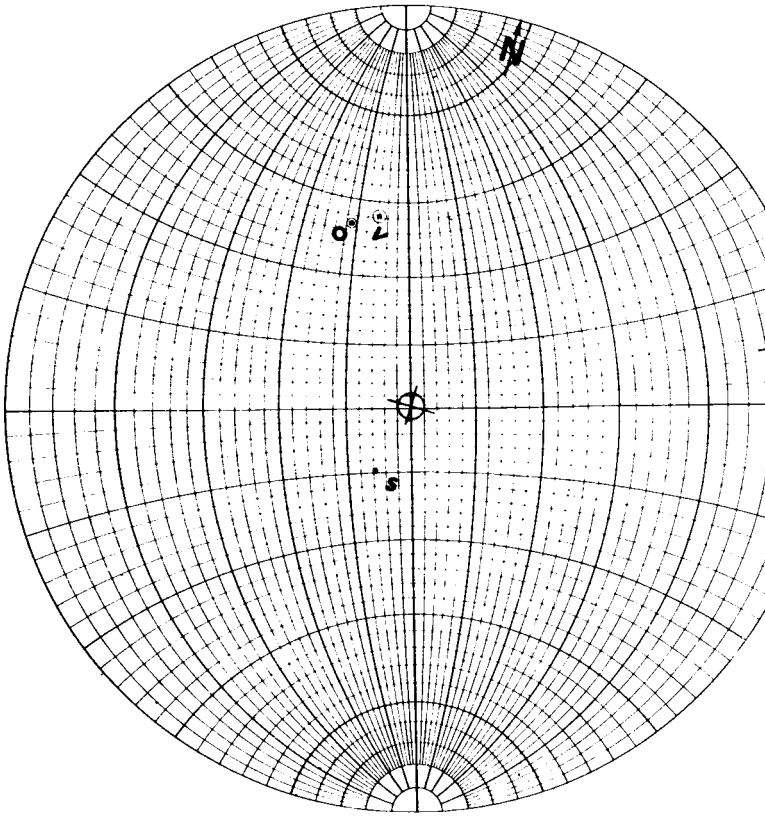


Fig. 11. Overlay rotated until both S and V lie on the same meridian. The polar distance, SGV, is found to be .190 (13m) by counting small circle graduations along the meridian.

PART 13: (continued)

Polar distance of satellite, SGV (13m), is measured from the earth's shadow, center, S, to the satellite, V, as shown in Fig. 11

Minimum polar distance for satellite to be seen in sunlight, MIN SGV @ GV (13n), is taken from Table 2 for the value of GV found at (11g).

If SGV is greater than MIN SGV, the satellite will be in sunlight.

PART 14: FIND APPARENT BRIGHTNESS OF SATELLITE.

14a R @ pole, plot X on
O merid. @ OGX = 11m

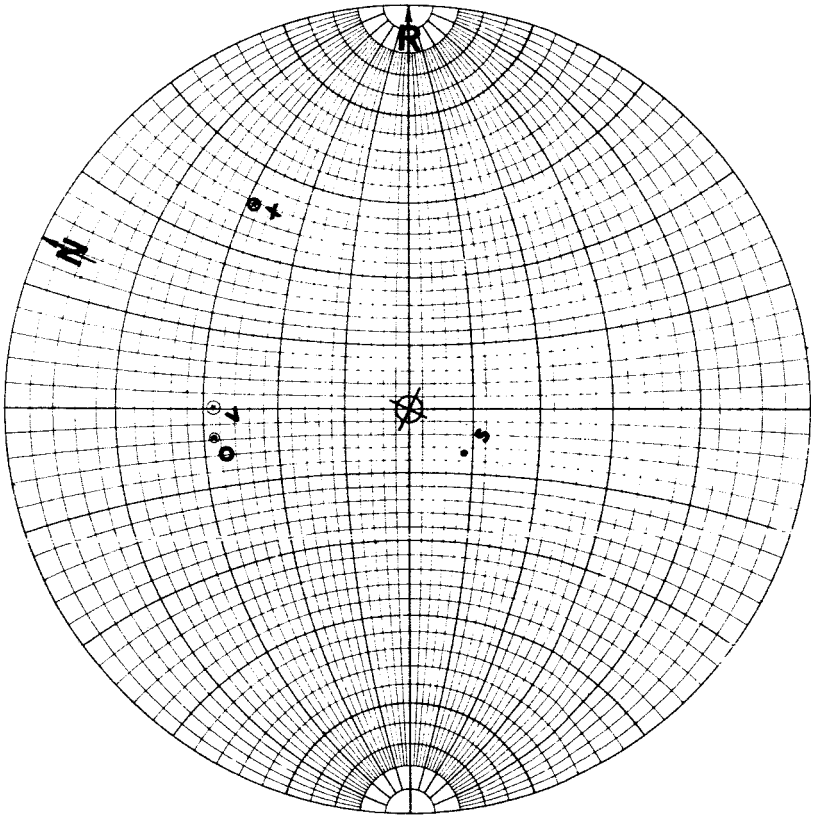


Fig. 12. Overlay positioned with R at the pole of the net. X, the apparent position of the satellite, is plotted on the O-meridian in the direction of V at a polar distance, OGX = .147 (11m).

PART 14: (continued)

14a	R @ pole, plot X on O merid. @ OGX = 11m	
14b	measure SGX on net	
14c	SGX on merid	.234
14d	enter and scale from brightness charts:	
14e	phase @ 14c	− 2.7 db
14f	+ range @ 11k	− 0.5 db
14g	+ Z. dist @11m	− 0.9 db
14h	= net gain	− 4.1 db
14i	+ Std. Brtn.	−20.0 dbz
14j	= App. Brtn.	−24.1 dbz
14k	÷ db/m	- 4.0
14m	= App. Mag.	6.0 m

Phase angle, SGX (14c), can be measured from the earth's shadow center, S, to the position of the apparent satellite, X, as seen by the observer. SGX is found as shown in Figs. 12 and 13.

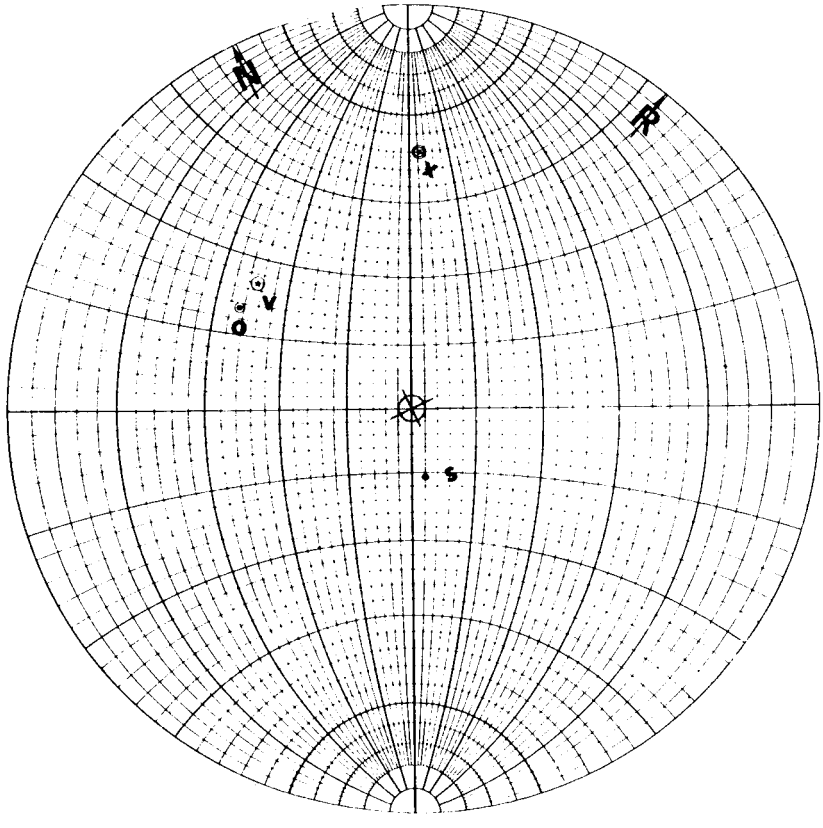


Fig. 13. Overlay is rotated until S and X lie on the same meridian. The polar distance, SGX, is found to be .234 (14c) by counting small circle graduations along the meridian.

PART 14: (continued)

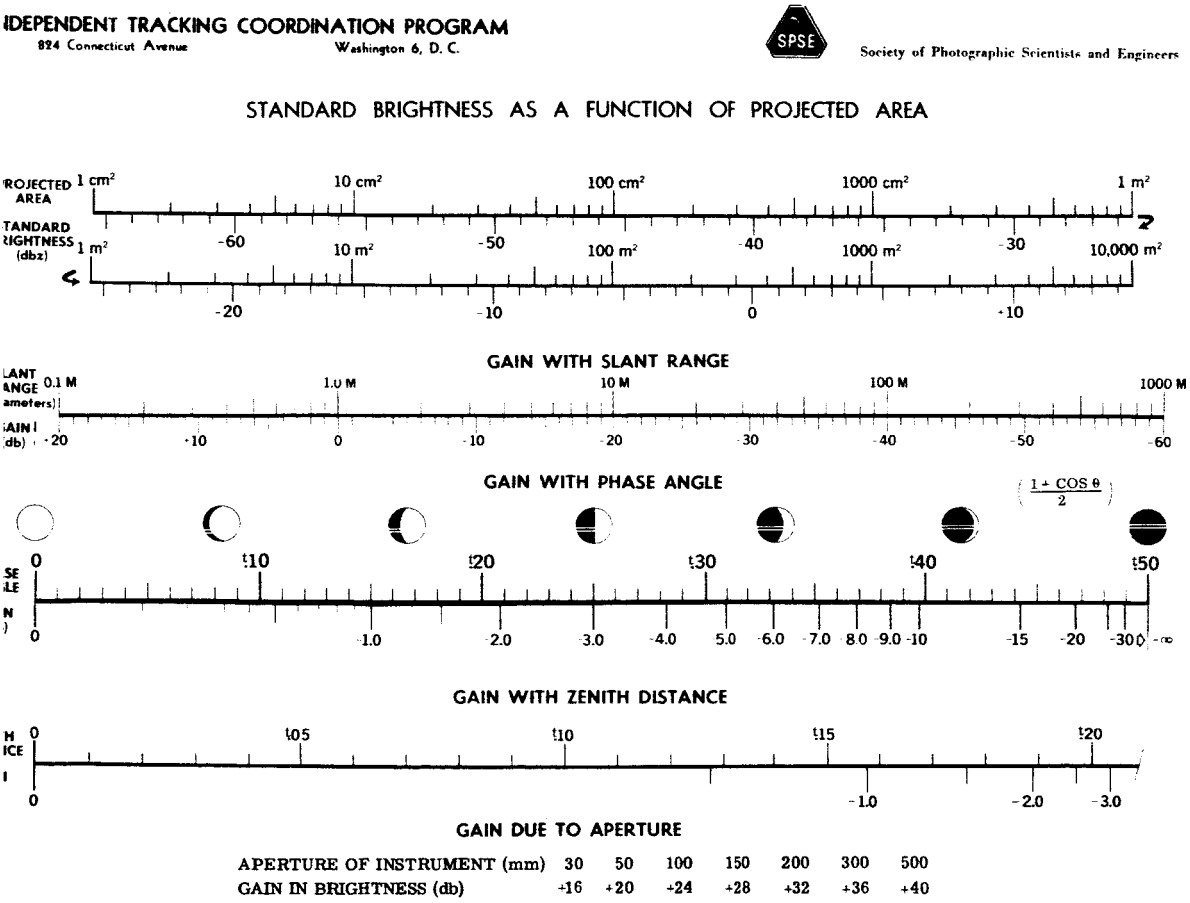
Gain with phase angle, (14e), is found by entering Gain Chart at (14c).

Gain with slant range, (14f), is found by entering Gain Chart at (11k).

Gain with zenith distance, (14g), is found by entering Gain Chart at (11m).

Apparent brightness in decibels, (14j), is evaluated above or below the brightness of a zero magnitude star. Apparent brightness is found by adding net gain (14h) and standard brightness (14i). ITCP lists Standard Brightness Tables as the information becomes available.

Apparent magnitude, (14n), is found by dividing apparent brightness (14j) by -4.0.



PART 15: FIND APPARENT POSITION AND MOTION FOR MAPPING IN STAR CHART.

15a	N @ pole draw N-tan @ X	
15b	RNX from net	.126
15c	+ QNR (5q)	.363
15d	= QNX	.237
15e	- 1/4 turn	.250
15f	= R. A. in days	.987
15g	* 24H/day	23 H688
15h	+ fract*60M/H	41 M
15i	= R. A.	23 H41 M
15j	NGX on merid.	.103
15k	.250 - NGX =	.147
15m	Decl. = 15k*360°	53 °
15n	R@pole draw R-tan @ X	
15p	NXR protractor	.692

Longitude of apparent satellite, RNX (15b), is the right-handed polar angle measured from the orbit pole, R, around the north pole, N, to the apparent satellite, X. RNX is found, as shown in Fig. 14.

Apparent longitude from ecliptic pole, QNX (15d), is found by adding QNR and RNX (15c + 15b).

Apparent right ascension, R.A. in days (15f), is found by subtracting .250 turn from QNX (15d - 15e). Right ascension is a polar angle measured from the first point of Aries, the longitude of which is always .250.

Apparent right ascension in hours and minutes, R.A. (15i), is found by multiplying days times 24 hours/day and then multiplying remainder by 60 min/hr. (15g, 15h).

Apparent polar distance, NGX (15j), is found as shown in Fig. 14.

Apparent declination, Decl. (15m), is measured positively northward from the equator. Decl. is found by subtracting NGX from .250 (15k), and then multiplying by 360°/turn.

Perpendicular to the apparent path at culmination, NXR (15p) is found as shown in Figs. 14 and 15.

R.A., Decl. and NXR may be used to plot the predicted position and motion of the satellite in the star field, as shown in Fig. 16.

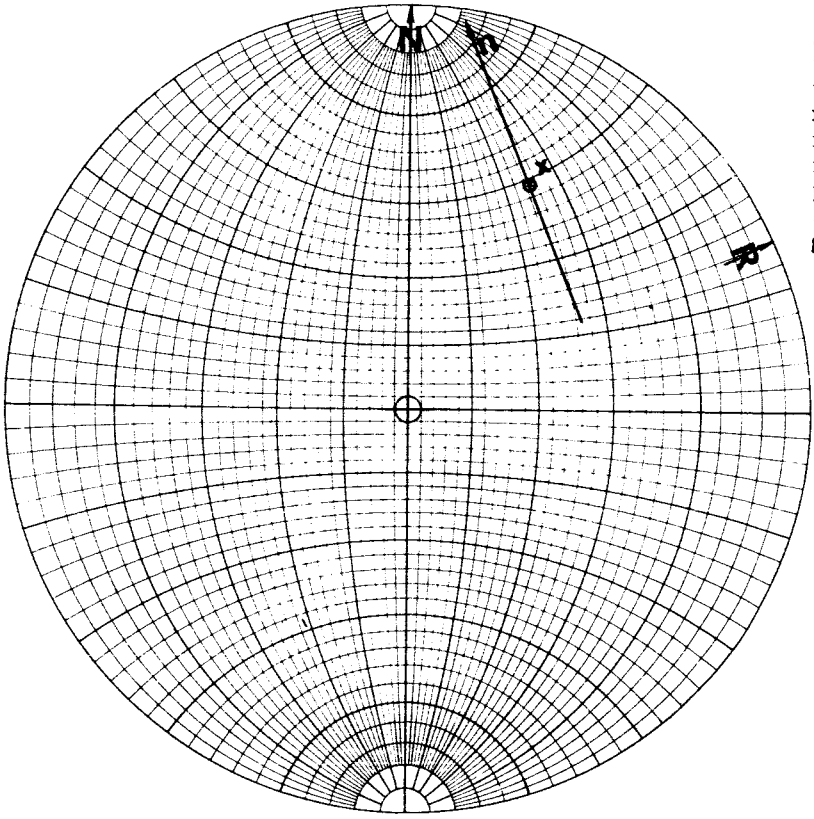


Fig. 14. Overlay positioned with N at the pole of the net. A tangent to the X meridian is constructed at X, the northward terminal of which is marked with the letter N. RNX is found to be -.126 (15b) by counting meridians from R to X. The polar distance, NGX, is found to be .103 (15j) by counting small circle graduations along the meridian.

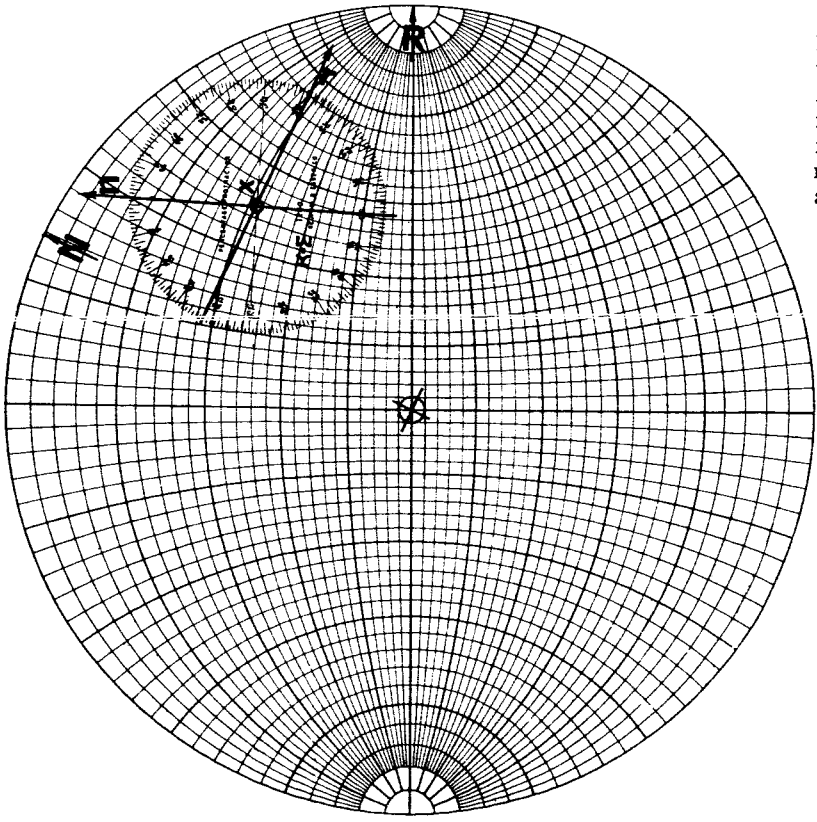


Fig. 15. Overlay is positioned with R at the pole of the net. A tangent to the X meridian is constructed at X. The R-ward terminal of which is marked with the letter, R. The right-handed polar angle, NXR, is measured at X with a protractor and found to be .692 (15p).

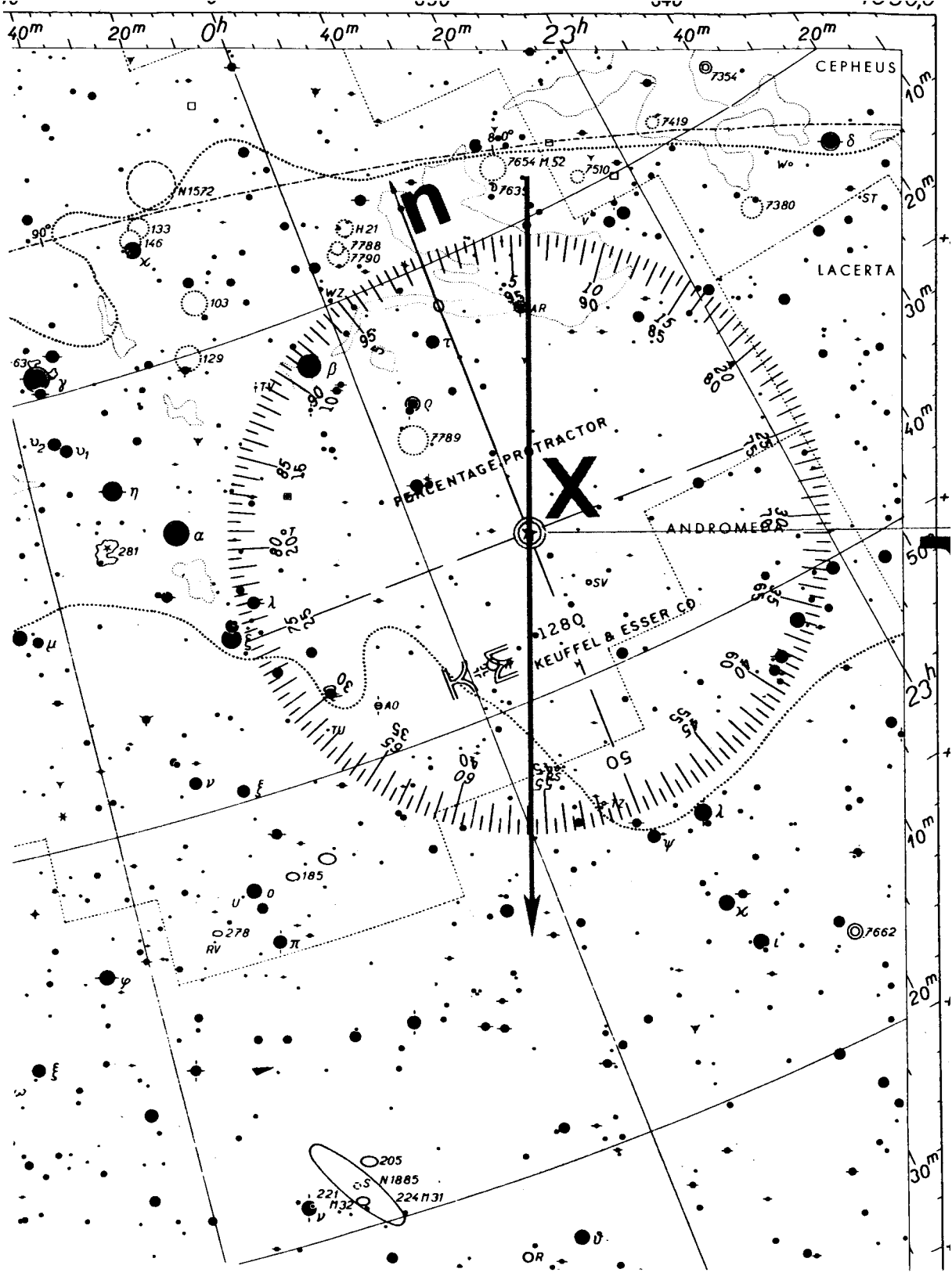


Fig. 16. Apparent satellite position and motion as plotted on a Skalnate Pleso Star Chart at R.A.=23H 41M (15i), Decl.=53° (15m), and NXR=.692 (15p). Apparent path at culmination is alway perpendicular to the direction of the orbit pole, NXR (15p). Apparent motion along path, indicated by arrowhead, will be away from North Pole if, and only if, ORN (8c) is negative (see note on Fig. 3, p. 11

APPENDIX A

Preparation of Orbit Schedule

A selection of current gear ratio elements of some of the brighter satellites is given below. The one-line element sets are reproduced in the same form in which they appeared in a routine ITCP Current Gear Ratio Element Announcement.

EXHIBIT 1

Current Gear Ratio Elements Derived by NASA GSFC from NORAD Data as of 39317.9

NCAT	JNE	AJNE	AQNR	ANRP	IPRM	APRM1	M2	ANGR	CP	CG	GR1	GR2
00049	9303	05930	0071164	836511	26812	12785752	0000	131201	0772481	036749	-0754937	0725664
00070	9303	88498	3737341	122426	29985	15214904	0014	270471	0688102	003616	0178923	-0640085
00527	9304	25148	2645306	764791	19182	15272714	0030	227497	0686363	003063	-0197565	-0631383
00613	9305	00476	1794002	146823	16657	15229147	0028	228706	0687672	001970	-0186296	-0636177
00740	9314	91918	9061630	703701	11898	13362057	0072	226381	0750297	009522	-0173524	-0522634
01085	9312	58918	1830742	399063	7498	14851965	0020	088188	0698928	011297	-1150276	1769077
01098	9313	72899	5527878	728710	7382	14868163	0016	180645	0698678	009832	-0571312	-0073843

The above data were used in filling in a Form for Calculating TNOn, TNOs, and 10*TNR1 (ITCP 5-66) as follows:

EXHIBIT 2

FORM FOR CALCULATING TNOn, TNOs, and 10*TNR1 @ NGO = .137 ITCP5-66

a	NCAT	49	70	527	613	740	1085	1098
b	NGR	.131	.270	.227	.228	.226	.088	.181
c	M1	1279+2	1521+2	1527+2	1523+2	1336+2	1485+2	1487+2
d	* GR1	-7549-3	1789-3	-1976-3	-1863-3	-1735-3	-1150-2	-5713-3
e	= QNR1	-9656-2	2721-2	-3017-2	-2837-2	-2318-2	-1708-1	-8495-2
f	JNL	330.000	330.000	330.000	330.000	330.000	330.000	330.000
g	- JNE	303.059	303.885	304.251	305.005	314.919	312.589	313.729
h	= ENL	26.941	26.115	25.749	24.995	15.081	17.411	16.271
i	= ENL	2694+2	2612+2	2575+2	2500+2	1508+2	1741+2	1627+2
j	i*e	-2601+0	7107-1	-7769-1	-7093-1	-3496-1	-2974+0	-1382+0
k	= dQNR	-.260	.071	-.078	-.071	-.035	-.297	-.138
m	- QNRo	.071	.737	.645	.794	.062	.831	.528
n	= QNR	.811	.808	.567	.723	.027	.534	.390
p	- QNT sched	.087	.087	.087	.087	.087	.087	.087
q	= TNR	.724	.721	.480	.636	.940	.447	.303
r	- RNOn net	.399	.233	.270	.268	.271	.500	.316
s	= TNOn	.123	.954	.750	.904	.211	.947	.619
t	TNOs = q-r	.325	.488	.210	.368	.669		.987
u	10*TNQ1	-.0274	-.0274	-.0274	-.0274	-.0274	-.0274	.0274
v	+ 10*e	-.0966	.0272	-.0302	-.0284	-.0232	-.1708	-.0850
w	= 10*TNR1	-.1240	-.0002	-.0576	-.0558	-.0506	-.1982	-.1124

The constant angle, RNOn (item r) in each case was determined by the method described on page 2 of the bulletin on SCHEDULING TIMES OF ORBIT APPROACH, (ITCP Bull. Mar. 27, 1966). Other items listed in the form are self-explanatory.

In ITCP Form 4-66 (below) the initial values of TNOn (item s), and TNOs (item t) are taken from items (s) and (t) above. Subsequent values are obtained by successively adding 10*TNR1 (item w).

ITCP 4-66

SCHEDULE OF LOCAL MEAN TIME OF ORBIT = TNO_n and TNO_s, for NGO = .137

JNL =		39320.0		39330.0		39340.0		39350.0		39360.0		39370.0		39380.0	
QNT =		.059485		.086864		.114243		.141622		.169002		.196381		.223760	
NGS =		.310524		.305699		.299132		.291334		.282438		.272686		.262327	
TNS =		+003937		+004445		+004287		+003435		+001945		+000056		-002392	
N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
#	49			123	325	999	201	876	078	752	954	628	830	505	707
#	70			954	488	954	488	954	488	953	487	953	487	953	487
#	527			760	210	692	152	635	095	577	037	520	980	462	922
#	613			904	368	848	312	792	256	737	201	681	145	625	089
#	740			211	669	160	618	110	568	059	517	009	467	958	416
#	1085			947		749		550		352		154		956	
#	1098			619	987	507	875	394	762	282	650	169	537	057	42

Note on Mounting Stereographic Net with Central Pivot. The Rationalized Meridional Stereographic Projection of the Hemisphere (ITCP 532) obtainable from the Independent Tracking Coordinating Program is printed on thin stock. To prevent damage and insure accuracy, it should be mounted on a stiff support with a central pivot. Bristol board or similar stiff paper will serve as a support, and a thumbtack can be used as a pivot. Before mounting, dig out a shallow recess at the center of the board just deep enough to accommodate the head of the thumbtack, and make a small registration hole at the center of the net. Glue the thumbtack point-up in the recess. Then coat the top of the board and the back of the net with a thin coat of rubber cement. When the surfaces are tacky, carefully register the net on the point without letting the surfaces come in contact, then press down to contact, working out from the center. To keep tissue overlays from tearing at the central pivot point, put a small patch of reinforcing tape on each side before making a pivot-hole.

Additional copies of ITCP forms are available upon request.

GRAPHIC PREDICTION OF CIRCUMSTANCES OF LOCAL CULMINATION

1a scale from map:
1b Sta. Lat. °
1c E. Long °
1d IF 1c > 180°, - 3 6 0 ° 0 0
1e = E. Long. °
1f UT @ Sta. noon H
1g GO (table 1) k m
1h Sta. elev. k m
1i NGO (table 1) .
1j LNO=1e/360°
1k GO=1g+1h k m
1m Zone=12H-1f H

2a NCAT
2b JNT . 0 0 0 0
2c TNE .
2d QNRo .
2e NRPo .
2f PRMo . 0 0 0 0
2g M1
2h M2
2i NGR .
2j CP k m
2k - CG k m
2m= GP k m
2n CG/CP = e .
2p GR1
2q GR2
2r Std. Brtns. d b z

3a date 1 9 Y M D
3b = JNT . 0 0 0 0
3c + TNO est. 0 0 0 .
3d = JNO .
3e - LNO (1j) .
3f = JNL .

4a - JNEq 0 . 0 0 0 0
4b = ENLq .
4c = ENLq
4d * QNT1 2 7 3 7 9 - 2
4e = dQNT
4f = dQNT .
4g + QNTo sched. .
4h = QNT .

5a JNL (3f)
5b - JNE (2b+c)
5c = ENL
5d = ENL
5e M1*ENL
5f ENL²
5g M2*ENL²
5h = M2*ENL²
5i + M1*ENL
5j = dPRM
5k = dPRM
5m dPRM*GR1
5n = dQNR
5p + QNRo (2d)
5q = QNR
5r dPRM*GR2
5s = dNRP
5t + NRPo (2e)
5u = NRP

6a PRM (5j)
6b IF abs. >.5 - 1 . 0 0 0 0 - 1 . 0 0 0 0
6c = PRM
6d + MRV chart
6e = PRV
6f + NRP (5u)
6g = NRV

7a RNQ = - (5q)
7b + QNT (4h)
7c = RNT
7d + TNL (5a)
7e = RNL
7f + LNO (1j)
7g = RNO
7h IF abs.>.5 ± 1 . 0 0 0 0 ± 1 . 0 0 0 0
7i = RNO

8a N @ pole, plot O @ NGO, RNO
8b R @ pole, measure ORN
8c ORN (8b)
8d + NRV (6g)
8e = ORV
8f go to 9a go to 9g

9a -ORV = -(8e)
9b 9a/2g
9c = dJNL 0 .
9d + JNL 5a
9e = JNL
9f carry to 5a'
9g -ORV = -(8e')
9h 9g/2g
9i = dJNL 0 .
9j + JNL 9e
9k = JNL

10a RNO (7i')
10b + (9i)
10c = RNO
10d N @ pole, plot O
@ RNO = 10c, NGO = 1j
10e draw N - tan at O
10f R @ pole, plot V
@ NRV = NRO, NGV = . 2 5
10g draw V - tan at O
10h measure OGV, NOV
10i OGV on merid. .
10j NOV prot. @ O .
10k 1.0 - NOV = .
10m az. = 10k*360° = °

11a PRM (6c')
11b - (8e')
11c = PRM
11d GV/GP chart
11e * GP (2m)
11f = GV
11g = GV k m
11h plot on finder O@GO = 1k,
11i V@GV = 11g, OGV = 10i
11j X@VX // GO, VX = GO
11k OV=GX finder k m
11m OGX finder .
11n .250 - 11m .
11p elev. = 11n*360° °

12a JNL (9k) .
12b = M D H M
12c + Zone H
12d = M D H M

13a RNT (7c)
13b + TNS sched
= RNS
IF abs.>.5 ± 1 . 0 0 0 0
13c = RNS
13d NGS sched .
13e N @ Pole, plot S
13f @ NGS = 13d, RNS = 13c
13g measure SGO on net
13h SGO on merid. .
13i MAX SGO . 2 0 0
13j SKY: Dark, Bright
13k measure SGV on net
13m SGV .
13n MIN SGV @ GV .
13p SAT. Dark, Bright

14a R @ pole, plot X on
O merid. @ OGX = 11m
14b measure SGX on net
14c SGX on merid .
14d enter and scale from
brightness charts:
14e phase @ 14c . db
14f + range @ 11k . db
14g + Z. dist @11m . db
14h = net gain . db
14i + Std. Brtn. . dbz
14j = App. Brtn. . dbz
14k ÷ db/m - 4 . 0
14m= App. Mag. . m

15a N @ pole draw N-tan @ X
15b RNX from net .
15c + QNR (5q) .
15d = QNX .
15e - 1/4 turn . 2 5 0
15f = R. A. in days .
15g * 24H/day H
15h + fract*60M/H M
15i = R. A. H M
15j NGX on merid. .
15k .250 - NGX = .
15m Decl. = 15k*360° °
15n R@pole draw R-tan @ X
15p NXR protractor .

GRAPHIC PREDICTION OF CIRCUMSTANCES OF LOCAL CULMINATION

1a scale from map:
1b Sta. Lat. °
1c E. Long °
1d IF 1c > 180°, - 3 6 0 ° 0 0
1e = E. Long. °
1f UT @ Sta. noon H
1g GO (table 1) k m
1h Sta. elev. k m
1i NGO (table 1) .
1j LNO=1e/360° .
1k GO=1g+1h k m
1m Zone=12H-1f H

2a NCAT
2b JNT . 0 0 0 0
2c TNE .
2d QNRo .
2e NRPo .
2f PRMo . 0 0 0 0
2g M1
2h M2
2i NGR .
2j CP k m
2k - CG k m
2m= GP k m
2n CG/CP = e .
2p GR1
2q GR2
2r Std. Brtns. d b z

3a date 1 9 Y M D
3b = JNT . 0 0 0 0
3c + TNO est. 0 0 0 .
3d = JNO .
3e - LNO (1j) .
3f = JNL .

4a - JNEq 0 . 0 0 0 0
4b = ENLq .
4c = ENLq
4d * QNT1 2 7 3 7 9 - 2
4e = dQNT
4f = dQNT .
4g + QNTo sched. .
4h = QNT .

5a JNL (3f) . .
5b - JNE (2b+c) . .
5c = ENL . .
5d = ENL
5e M1*ENL
5f ENL²
5g M2*ENL²
5h = M2*ENL² . .
5i + M1*ENL . .
5j = dPRM . .
5k = dPRM
5m dPRM*GR1
5n = dQNR .
5p + QNRo (2d) .
5q = QNR .
5r dPRM*GR2
5s = dNRP .
5t + NRPo (2e) .
5u = NRP .

6a PRM (5j) . .
6b IF abs. >.5 - 1 . 0 0 0 0 - 1 . 0 0 0 0
6c = PRM . .
6d + MRV chart . .
6e = PRV . .
6f + NRP (5u) . .
6g = NRV . .

7a RNQ = - (5q) .
7b + QNT (4h) .
7c = RNT . .
7d + TNL (5a) . .
7e = RNL . .
7f + LNO (1j) . .
7g = RNO . .
7h IF abs.>.5 ± 1 . 0 0 0 0 ± 1 . 0 0 0 0
7i = RNO . .

8a N @ pole, plot O @ NGO, RNO
8b R @ pole, measure ORN
8c ORN (8b) . .
8d + NRV (6g) . .
8e = ORV . .
8f go to 9a go to 9g

9a -ORV = -(8e)
9b 9a/2g
9c = dJNL 0 .
9d + JNL 5a .
9e = JNL .
9f carry to 5a'
9g -ORV = -(8e')
9h 9g/2g
9i = dJNL 0 .
9j + JNL 9e .
9k = JNL .

10a RNO (7i') .
10b + (9i) .
10c = RNO .
10d N @ pole, plot O
@ RNO = 10c, NGO = 1j
10e draw N - tan at O
10f R @ pole, plot V
@ NRV = NRO, NGV = . 2 5
10g draw V - tan at O
10h measure OGV, NOV
10i OGV on merid. .
10j NOV prot. @ O .
10k 1.0 - NOV = .
10m az. = 10k*360° = °

11a PRM (6c') .
11b - (8e') .
11c = PRM .
11d GV/GP chart
11e * GP (2m)
11f = GV
11g = GV k m
11h plot on finder O@GO = 1k,
11i V@GV = 11g, OGV = 10i
11j X@VX // GO, VX = GO
11k OV=GX finder k m
11m OGX finder .
11n .250 - 11m .
11p elev. = 11n*360° °

12a JNL (9k) .
12b = M D H M
12c + Zone H
12d = M D H M

13a RNT (7c) .
13b + TNS sched .
= RNS
IF abs.>.5 ± 1 . 0 0 0 0
13c = RNS .
13d NGS sched .
13e N @ Pole, plot S
13f @ NGS = 13d, RNS = 13c
13g measure SGO on net
13h SGO on merid. .
13i MAX SGO . 2 0 0
13j SKY: Dark, Bright
13k measure SGV on net
13m SGV .
13n MIN SGV @ GV .
13p SAT. Dark, Bright

14a R @ pole, plot X on
O merid. @ OGX = 11m
14b measure SGX on net
14c SGX on merid .
14d enter and scale from
brightness charts:
14e phase @ 14c . db
14f + range @ 11k . db
14g + Z. dist @11m . db
14h = net gain . db
14i + Std. Brtn. . dbz
14j = App. Brtn. . dbz
14k ÷ db/m - 4 . 0
14m = App. Mag. . m

15a N @ pole draw N-tan @ X
15b RNX from net .
15c + QNR (5q) .
15d = QNX .
15e - 1/4 turn . 2 5 0
15f = R. A. in days .
15g * 24H/day H
15h + fract*60M/H M
15i = R. A. H M
15j NGX on merid. .
15k .250 - NGX = .
15m Decl. = 15k*360° °
15n R@pole draw R-tan @ X
15p NXR protractor .

ADDITIONS TO LIST OF SATELLITES
ASSUMED TO BE TRANSMITTING
(List of Dec. 29, 1965)

C in place of Decimal = Transmits on COMMAND only

S in place of Decimal = Transmits in SUNLIGHT only.

IDENT	NAME	NCAT	MC/S		
1966 08A	ESSA-1	01982	136C230	136C920	
1966 16A	ESSA-2	02091	136C770	137C700	
1966 31A	OAO-1	02142	136.440	136C260	400C550
1966 40A	NIMBUS-2	02173	136.500	136C950	137.200
1966 44A	EXPLORER 32	02183	136C320	136C560	
1966 49A	OGO-3	02195	136C200	400C250	400C850
1966 51B	EGRS Y1	02205	136.800		
1966 51C	EGRS-16	02202	136S440		

EXHIBIT M

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington 6, D. C.

September 30, 1966

BULLETIN

PRACTICAL ARITHMETIC

A GREAT DEAL OF COMPUTATIONAL EFFORT in making satellite predictions can be avoided by first rationalizing all measurements, and then by using mixed rationalized numbers for addition and by using equivalent indexed numerators for multiplication and division. The purpose of this bulletin is to suggest rules for arithmetic operations on rational numbers that lend themselves to slide-rule computation and shortened forms of digital multiplication and division.

A RATIONAL NUMBER is defined as any number that can be completely expressed as the ratio of two whole numbers. Pi, the ratio of the circumference of a circle divided by its diameter is a real number, but can only be approximated by a rational number to as many significant digits as are needed.

REDUCTION OF PROPER FRACTIONS TO RATIONALIZED FORM greatly simplifies arithmetic operations. Addition of two mixed numbers should automatically produce a number of the same kind. A mixed number is defined as a whole number plus a fraction of which the numerator is less than the denominator. (i.e. a proper fraction). The following sums are not mixed numbers:

$$\begin{array}{r} 1\ 5/8 \\ +\ 2\ 7/8 \\ \hline 3\ 12/8 \end{array} \qquad \begin{array}{rcl} 270^\circ & = & 270/360 \\ +\ 180^\circ & = & 180/360 \\ \hline 450^\circ & = & 450/360 \end{array}$$

A RATIONALIZED PROPER FRACTION is obtained by dividing the numerator of a proper fraction through by the denominator. When this is done prior to addition, the sums automatically become mixed numbers, as follows:

$$\begin{array}{rl} 1\ 5/8 = & 1.625 \\ +\ 2\ 7/8 = & \underline{2.875} \\ & 4.5000 = 4\ 500/1000 \end{array} \qquad \begin{array}{rcl} 270^\circ & = & 270/360 = 0.75 \\ +\ 180^\circ & = & 180/360 = \underline{0.50} \\ & & 1.25 = 1\ 25/100 \end{array}$$

NOTE: A rationalized fraction in decimal notation has an integral power of ten as the denominator. In binary notation, a rationalized fraction has an integral power of two as the denominator. In either system of notation, a rationalized expression is obtained by dividing the numerator of a fraction through by the denominator.

ARITHMETIC OPERATIONS WITH SIGNED NUMBERS obey the following rules:

Negative numbers are prefixed with a minus (-) sign;

Positive numbers may be prefixed with a plus (+) sign;

Unsigned numbers are assumed to be positive;

The absolute value of a number is the value of that number taken without regard to its sign;

A minus B is found by changing the sign of B and adding;

The sum of any two numbers of like sign is the sum of their absolute values prefixed by their common sign;

The sum of any two numbers of unlike sign is the difference between their absolute values prefixed by the sign of whichever has the greater absolute value;

The sign of A times B (A*B) will be negative if, and only if, A and B have unlike signs; and

The sign of A divided by B (A/B) will be negative if, and only if, A and B have unlike signs.

ANY MIXED RATIONALIZED NUMBER can also be expressed as the product of a proper fraction with as many zeros in the denominator as there are digits in the numerator (not counting initial zeros) times the base raised to an integral number of powers. In decimal notation, the base is ten; in the binary number system used in most computers, the base is two. In either system, the number of powers is defined as the index. The numerator of such an expression, followed by its index, completely defines the number. Conversion from mixed rationalized numbers to such indexed numerators and vice versa is illustrated by the following:

Mixed Rationalized Number				Indexed Numerator
37.2	=	$(372/1000) * 10^{2}$	=	372+2
0.00372	=	$(372/1000) * 10^{-2}$	=	372-2
- -372.0	=	$-(372/1000) * 10^{3}$	=	-372+3
0.372	=	$(372/1000) * 10^{0}$	=	372+0

INDEXED NUMERATORS are used to store rational numbers in scientific computers. Some sort of numerator indexing scheme is essential to practical use of slide rules and shortened forms of digital multiplication and division. Rules for finding the product index and the quotient index work as well with desk calculators as they do with slide rules. They are as follows:

> The product index is the multiplicand index plus the multiplier index less 1 unit if, and only if, the absolute value of the product numerator is greater* than that of the multiplier.
>
> The quotient index is the dividend index less the divisor index plus 1 unit if, and only if, the absolute value of the dividend numerator is greater* than that of the divisor.

*In testing which of two numerators has the greater absolute value, let each have the same number of digits.

SLIDE RULES CANNOT REGISTER MIXED NUMBERS. Examination of the outer scale of the Atlas† slide rule disc shows numbered divisions from 10 through 99 and back to 10. Unnumbered subdivisions permit registration of numerator values to at least three significant digits on this outer scale. There is no way in which a number beginning with zero can be registered. The spiral scale of the Atlas rule consists in a continuous spiral of 25 turns with numbered divisions from 1000 through 999, and unnumbered subdivisions permitting registration of numerators with an uncertainty of 1 unit in the fifth significant digit.

TO MULTIPLY WITH THE ATLAS SLIDE RULE, first set the long transparent indicator opposite the multiplicand numerator; then set the short transparent indicator to 10 = 100 = 1000. Holding the long indicator with thumb and forefinger, and without disturbing the relative position of the short indicator, move the circular disk until the multiplier numerator appears opposite the short indicator. The product numerator is found under the long indicator. To find a product numerator to more than three significant figures, first use the outer scale to find the most significant digits of the product numerator. Then use this value to determine which turn on the spiral from which to read the more precise product numerator, following the same procedure for entering the multiplicand and multiplier numerators on the long spiral scale. The product index is determined by the rule given above.

TO DIVIDE WITH THE ATLAS SLIDE RULE, first set the long indicator opposite the dividend numerator, then set the short indicator opposite the divisor numerator. Holding the long indicator between thumb and forefinger, and without disturbing the relative position of the short indicator, move the circular disc until the short indicator appears opposite 10 = 100 = 1000. The quotient numerator is found under the long indicator. To find a quotient numerator to more than three significant figures, first use the outer scale to find the most significant digits of the quotient numerator. Then use this value to determine from which turn on the spiral to read the more precise quotient numerator, following the same procedure for entering dividend and division numerators in the long spiral scale. The quotient index is determined by the rule given above.

†Atlas Slide Rule, No. 1797A, Eugene Deitzgen Co., Chicago, ($15.75)

SHORTENED DIGITAL MULTIPLICATION by the method of progressive rounding is illustrated by the following example:

```
1486816+2                          1486816+2
1939770+2                          1939770+2
1486816=1*1486816.0                1486816
1338134=9*148681.6                 1338134
  44605=3*14868.2                    44605
  13381=9*1486.8                     13381
   1041=7*148.7                       1041
    104=7*14.9                         104
2884081+3                          2884081+3
```

Note that multiplicand and multiplier are entered as indexed numerators. The screened figures in the above example illustrate operations normally carried in the head. The right hand set of figures shows the completed algorithm as it would normally appear on paper. The first partial product is obtained by multiplying the entire multiplicand numerator by the most significant digit in the multiplier numerator. On completion of the first partial product, the first digit in the multiplier numerator is marked off, and a decimal point is inserted just before the last digit in the multiplicand numerator. The second partial product is obtained by multiplying the reduced multiplicand numerator by the second digit of the multiplier numerator, and rounding to the nearest integer. On completion of the second partial product, the second digit of the multiplier numerator is stricken, and the decimal point in the multiplicand numerator is moved one place further to the left, and so on until there are no remaining digits. In obtaining a partial product, the value to the right of the decimal point is rounded to the most significant digit, and its product with the multiplier digit is rounded to determine the digit, if any, to be carried into the units column. The product index is determined by the rule given above.

SHORTENED DIGITAL DIVISION by the method of progressive rounding is illustrated by the following example:

```
357942+2) 538498+3 (150443+2          357942+2) 538498+3 (150443+2
          357942  1*357942.0                      357942
          180556                                  180556
          178971  5*35794.2                       178971
            1585                                    1585
                  0*3579.4                          1432
            1432  4*357.9                            153
             153                                     143
             143  4*35.8                              10
              10                                       7
               7=2*3.6                                 3
               3 > 3.6/2
```

Note that dividend and divisor are entered as indexed numerators. The screened figures in the above example illustrate operations normally carried in the head. The right hand set of figures shows the algorithm as it would appear on paper. After each attempt to subtract an integral product from the dividend or dividend remainder, the decimal point is moved one position to the left in the divisor. In obtaining each integral product, the value to the right of the decimal is rounded to the most significant digit whose product with the current quotient digit is then rounded to determine the digit, if any, to be "carried" to the digit column. If, and only if, the final remainder is greater than one-half the final divisor, add one unit to the absolute value of the quotient numerator. The quotient index is determined by the rule given above.

PRODUCT AND QUOTIENT NUMERATORS calculated by the method of progressive rounding may differ by a unit or so from those found with a desk calculator because of an excess or deficit of strengthened figures. In scientific applications, where calculations are customarily carried to one more decimal figure than the degree of accuracy of the data, such differences are insignificant.

EXHIBIT N

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington, D. C. 20006

BULLETIN

August 23, 1966

CATALOG NUMBERS (NCAT) AND POPULAR NAMES CORRESPONDING TO IDENT DESIGNATIONS OF UNCLASSIFIED EARTH SATELLITES IN ORBIT AS OF 39347.0 (August 10, 1966)

NOTE: Debris not listed in this index: (a) Fragments of 1961 Omicron rocket: NCAT 118-139; 141-142; 144-159; 161; 172; 175-179; 210-212; 216; 223-225; 230; 232-239; 243-246; 250; 252-254; 260-265; 268; 275; 299-301; 317-337; 350-358; 401-421; 461-480; 516; 530-531; 537-552; 556-561; 643-662; 1500-1501; 1942-1943; 2010; 2087; and (b) Fragments of Tital IIIC (1965 82A): 1640-1682; 1684-1700; 1709-1725; 1746-1770; 1819-1825; 1827-1837; 1861-2 1848-1853; 1855-1860; 1880-1900; 1912-1923; 1925-1930; 1956-1965; 1969-1981; 1984-1993; 1999; 2041-2054; 2079-2084; 2100-2103; 2158; 2333; 2340.

IDENT			NCAT
1958 01A		EXPLORER 1	00004
1958 02A	BETA 1	ROCKET BODY	00016
1958 02B	BETA 2	VANGUARD 1	00005
1958 02C	BETA 3	DEBRIS	01576
1959 01A		VANGUARD 2	00011
1959 01B		VANG 2 R	00012
1959 07A		VANGUARD 3	00020
1959 09A	IOTA 1	EXPLORER 7	00022
1959 09B	IOTA 2	ROCKET BODY	00023
1960 02A		TIROS 1 R	00028
1960 02B		TIROS 1	00029
1960 02C	BETA 3	DEBRIS	00101
1960 02D	BETA 4	DEBRIS	00115
1960 03B	GAMMA 2	TRANSIT 1B	00031
1960 03D	GAMMA 4	NONE	00099
1960 06A		MIDAS 2	00043
1960 07A		TRANSIT 2A	00045
1960 07B	ETA 2	GREB	00046
1960 07C		TRANS 2A R	00047
1960 07D	ETA 4	DEBRIS	00840
1960 07E	ETA 5	DEBRIS	00841
1960 09A	IOTA 1	ECHO 1	00049
1960 09B		ECHO 1 R	00050
1960 09C	IOTA 3	DEBRIS	00051
1960 09D	IOTA 4	DEBRIS	00052
1960 09E		DEBRIS	00053
1960 13A	NU 1	COURIER 1B	00058
1960 13B		COUR.1B R	00059
1960 14A		EXPLORER 8	00060
1960 14B	XI 2	ROCKET BODY	00062
1960 14C	XI 3	DEBRIS	00069
1960 14D	XI 4	DEBRIS	00105
1960 16A	PI 1	TIROS 2	00063
1960 16B		TIROS.2 R	00064
1960 16C	PI 3	DEBRIS	00074
1960 16D	PI 4	DEBRIS	00075
1961 01A		SAMOS 2	00070
1961 01B	ALPHA 2	ROCKET BODY	00079
1961 04B		ROCKET	00082
1961 04C	DELTA 3	DEBRIS	00085
1961 13A		EXPLORER11	00107
1961 15A		TRANSIT 4A	00116
1961 15B		INJUN-SR-3	00117
1961 17A		TIROS 3	00162
1961 17B		TIROS 3 R	00165
1961 17C	RHO 3	DEBRIS	00166
1961 17D	RHO 4	DEBRIS	00167
1961 18A		MIDAS 3	00163
1961 18C	SIGMA 3	DEBRIS	00188
1961 18D	SIGMA 4	DEBRIS	00196
1961 20A	UPSILON 1	EXPLORER 12	00170
1961 28A		MIDAS 4	00192
1961 28C	A DELTA 3	DEBRIS	00194
1961 28D	A DELTA 4	DEBRIS	00195
1961 28E	A DELTA 5	DEBRIS	02009
1961 28F	A DELTA 6	DEBRIS	02371
1961 31A		TRANSIT 4B	00202
1961 31B		TRAAC 1	00205
1961 31C		TRANS 4B R	00204
1962 02A	BETA 1	TIROS 4	00226
1962 02B	BETA 2	ROCKET BODY	00227
1962 02C	BETA 3	DEBRIS	00228
1962 02D	BETA 4	DEBRIS	00229
1962 06A	ZETA 1	ORB.SOL.OBS.1	00255
1962 06B		O.S.O.1R	00257
1962 10A		NONE	00271
1962 10C	KAPPA 3	NONE	00273
1962 10D	KAPPA 4	NONE	00274
1962 15A		ARIEL 1	00285
1962 15B		ARIEL 1R	00288
1962 25A		TIROS 5	00309
1962 25B		TIROS 5 R	00311
1962 25C	A ALPHA 3	DEBRIS	00312
1962 25D	A ALPHA 4	DEBRIS	00313
1962 29A		TELSTAR	00340
1962 29B		TELS 1 R	00341
1962 39A		NONE	00369
1962 39B	A OMICRON 2	NONE	00370
1962 39C		NONE	00378
1962 39D		ROCKET	00388
1962 47A		TIROS 6	00397
1962 47B		TIROS 6 R	00398
1962 47C	A PSI 3	DEBRIS	00399
1962 47D	A PSI 4	DEBRIS	00400
1962 49A		ALOUETTE	00424
1962 49B		ALOUET R	00426
1962 49C	B ALPHA 3	DEBRIS	00510
1962 49D	B ALPHA 4	DEBRIS	00511
1962 51A	B GAMMA 1	EXPLORER 14	00432
1962 58A		NONE	00444
1962 59A	B LAMBDA 1	EXPLORER 15	00445
1962 60A		ANNA 1B	00446
1962 60B		ANNA 1B R	00447
1962 67A	B TAU 1	DEBRIS	00502
1962 67B	B TAU 2	INJUN 3	00504
1962 67E	B TAU 5	DEBRIS	00513
1962 67F	B TAU 6	DEBRIS	00520
1962 68A		RELAY 1	00503
1962 68B		RELAY 1 R	00515
1962 70A		EXPLORER16	00506
1962 71A		TRANSIT 5A	00509
1962 71B	B PSI 2	DEBRIS	00514
1962 71C		TRANS 5A R	00519
1962 71D	B PSI 4	DEBRIS	00523

IDENT		NCAT
1963 03A	NONE	00527
1963 04A	SYNCOM 1	00553
1963 04B	ROCKET BOD	00532
1963 05A	DEBRIS	00533
1963 05B	NONE	00534
1963 05C	NONE	00535
1963 05D	NONE	00536
1963 09A	EXPL.17	00564
1963 13A	TELSTAR 2	00573
1963 13B	TELSTAR 2R	00575
1963 14A	NONE	00574
1963 14B	NONE	00579
1963 14C	NONE	00608
1963 14D	NONE	00589
1963 14E	NONE	00602
1963 14F	DEBRIS	00628
1963 14G	DEBRIS	00629
1963 14H	DEBRIS	00702
1963 14J	DEBRIS	02359
1963 14K	DEBRIS	02360
1963 14L	DEBRIS	02361
1963 14M	DEBRIS	02362
1963 14N	DEBRIS	02363
1963 14P	DEBRIS	02364
1963 14Q	DEBRIS	02365
1963 14R	DEBRIS	02366
1963 14S	DEBRIS	02367
1963 14T	DEBRIS	02372
1963 14U	DEBRIS	02373
1963 14V	DEBRIS	02374
1963 14W	DEBRIS	02375
1963 14X	DEBRIS	02377
1963 14Y	DEBRIS	02378
1963 14Z	DEBRIS	02379
1963 14AA	DEBRIS	02380
1963 14AB	DEBRIS	02381
1963 22A	TRANSIT A2	00594
1963 22B	TRANS A2 R	00603
1963 22C	DEBRIS	00610
1963 22D	DEBRIS	00611
1963 24A	TIROS 7	00604
1963 24B	TIROS 7 R	00605
1963 24C	DEBRIS	00606
1963 24D	DEBRIS	00607
1963 25B	NONE	00614
1963 26A	GEO RSCH	00612
1963 27A	NONE	00613
1963 30A	NONE	00622
1963 30B	NONE	00635
1963 30C	NONE	00630
1963 30D	BALLOON	00624
1963 30E	DEBRIS	00631
1963 31A	SYNCOM 2	00634
1963 31B	ROCKET BOD	00625
1963 38A	ROCKET	00669
1963 38B	NONE	00670
1963 38C	NONE	00671
1963 38D	DEBRIS	00672
1963 38E	DEBRIS	00745
1963 38F	DEBRIS	02097
1963 39A	NONE	00674
1963 39B	TETRA-2	00675
1963 39C	DEBRIS	00692
1963 43A	POLYOT 1	00683
1963 43B	DEBRIS	00684
1963 43D	DEBRIS	00686
1963 46A	EXPLORER 1	00693
1963 47A	CENTAUR 2	00694
1963 47B	DERBIS	00696
1963 47C	DERBIS	00697
1963 47D	DEBRIS	00698
1963 47E	DEBRIS	00699
1963 47F	DEBRIS	00700
1963 47G	DEBRIS	00701
1963 47H	DEBRIS	00739
1963 47J	DEBRIS	01994
1963 49A	ROCKET	00703
1963 49B	NONE	00704
1963 49C	NONE	00705
1963 49D	DEBRIS	00706
1963 49E	DEBRIS	00715
1963 49F	DEBRIS	00753
1963 53A	EXPLORER19	00714
1963 53B	EXPL 19R	00721
1963 53C	DEBRIS	00722
1963 53D	DEBRIS	00723

IDENT		NCAT
1963 53E	DEBRIS	00724
1963 53F	DEBRIS	00725
1963 53G	DEBRIS	00726
1963 53H	DEBRIS	00732
1963 54A	TIROS 8	00716
1963 54B	ROCKET BOD	00717
1963 54C	DEBRIS	00720
1963 54D	DEBRIS	00736
1964 01A	NONE	00727
1964 01B	GGSE	00728
1964 01C	EGRS	00729
1964 01D	SOLAR RAD	00730
1964 01E	NONE	00731
1964 02A	ROCKET	00733
1964 02B	NONE	00734
1964 02C	NONE	00735
1964 03A	RELAY 2	00737
1964 03B	ROCKET BOD	00738
1964 04A	ECHO 2	00740
1964 04B	ECHO 2 R	00741
1964 04C	DEBRIS	00742
1964 04D	DEBRIS	00743
1964 06A	ELEKTRON 1	00746
1964 06B	ELEKTR.2	00748
1964 06C	DEBRIS	00750
1964 06D	DEBRIS	00751
1964 11A	NONE	00759
1964 15A	ARIEL 2	00771
1964 15B	ROCKET BOD	00775
1964 15C	DEBRIS	00847
1964 26A	NONE	00801
1964 26B	DEBRIS	00805
1964 26C	DEBRIS	00806
1964 26D	DEBRIS	00809
1964 31A	NONE	00812
1964 31B	NONE	00813
1964 31C	DEBRIS	00815
1964 35A	NONE	00824
1964 38A	ELEKTR 3	00829
1964 38B	ELEKTR.4	00830
1964 38C	DEBRIS	00831
1964 38D	DEBRIS	00832
1964 40A	NONE	00836
1964 40B	NONE	00837
1964 40C	TRS II	00838
1964 45B	NONE	00851
1964 47A	SYNCOM 3	00858
1964 47B	ROCKET BOD	00862
1964 49D	COSMOS 41	00869
1964 49E	DEBRIS	00898
1964 51A	EXPLORER20	00870
1964 51B	EXPL.20 R	00871
1964 51C	DEBRIS	00873
1964 51D	DEBRIS	00874
1964 51E	DEBRIS	00875
1964 52A	NIMBUS 1	00872
1964 52B	ROCKET BOD	00878
1964 53A	COSMOS 44	00876
1964 53B	COS 44 R	00877
1964 54A	OGO I	00879
1964 60A	EXPL.21	00889
1964 63A	DEBRIS	00893
1964 63B	NONE	00897
1964 63C	NONE	00900
1964 63D	DEBRIS	00901
1964 63E	NONE	00902
1964 63F	DEBRIS	00903
1964 64A	EXPL.22	00899
1964 64B	EXPL 22 R	00907
1964 64C	DEBRIS	00976
1964 64D	DEBRIS	00977
1964 72A	NONE	00922
1964 72B	ROCKET BOD	00925
1964 74A	EXPLORER23	00924
1964 76A	EXPLORER24	00931
1964 76B	EXPLORER25	00932
1964 76C	EXPL 25 R	00933
1964 76D	DEBRIS	00934
1964 76E	DEBRIS	00935
1964 76F	DEBRIS	00936
1964 76G	DEBRIS	00937
1964 76H	DEBRIS	00939
1964 76I	DEBRIS	00940
1964 76J	DEBRIS	00941
1964 76K	DEBRIS	00960
1964 76L	DEBRIS	01411

IDENT		NCAT
1964 83A	DEBRIS	00953
1964 83B	DEBRIS	00956
1964 83C	NONE	00959
1964 83D	NONE	00965
1964 83E	DEBRIS	00966
1964 83F	DEBRIS	00967
1964 83G	DEBRIS	01099
1964 83H	DEBRIS	01528
1964 83J	DEBRIS	01608
1964 86A	EXPL.26	00963
1965 03A	NONE	00973
1965 04A	TIROS 9	00978
1965 04B	TIROS 9 R	00979
1965 04C	DEBRIS	01312
1965 04D	DEBRIS	01313
1965 06A	COSMOS 53	00983
1965 07A	O.S.O.2	00987
1965 07B	O.S.O.2 R	00988
1965 08A	TITAN 3	01000
1965 08B	NONE	01001
1965 08C	NONE	01002
1965 09A	PEGASUS 1	01085
1965 09B	COMMD.MOD	01088
1965 11A	COSMOS 54	01089
1965 11B	COSMOS 55	01090
1965 11C	COSMOS 56	01091
1965 11D	DEBRIS	01092
1965 14A	COSMOS 58	01097
1965 14B	COS 58 R	01098
1965 16A	GREB 1	01271
1965 16B	GRV.GRD.2	01244
1965 16C	GR.GRD .3	01292
1965 16D	SOLAR RAD2	01291
1965 16E	EGRS 3	01208
1965 16F	OSCAR	01293
1965 16G	SURCAL	01310
1965 16H	DODECAHEDR	01272
1965 16J	ROCKET	01245
1965 17B	EGRS 2	01250
1965 17C	ROCKET	[illegible]28
1965 17D	DEBRIS	[illegible]48
1965 20A	COSMOS 61	01267
1965 20B	COSMOS 62	01268
1965 20C	COSMOS 63	01269
1965 20D	ROCKET BOD	01270
1965 20E	DEBRIS	01335
1965 20F	DEBRIS	01336
1965 20G	DEBRIS	01337
1965 20H	DEBRIS	01338
1965 20J	DEBRIS	01339
1965 20K	DEBRIS	01340
1965 20L	DEBRIS	01341
1965 20M	DEBRIS	01342
1965 20N	DEBRIS	01343
1965 20P	DEBRIS	01344
1965 20Q	DEBRIS	01345
1965 20R	DEBRIS	01346
1965 20S	DEBRIS	01347
1965 20T	DEBRIS	01348
1965 20U	DEBRIS	01349
1965 20W	DEBRIS	01351
1965 20X	DEBRIS	01352
1965 20Z	DEBRIS	01354
1965 20AA	DEBRIS	01355
1965 20AC	DEBRIS	01370
1965 20AD	DEBRIS	01371
1965 20AE	DEBRIS	01372
1965 20AF	DEBRIS	01373
1965 20AH	DEBRIS	01392
1965 20AJ	DEBRIS	01397
1965 20AK	DEBRIS	01398
1965 20AN	DEBRIS	01402
1965 20AR	DEBRIS	01410
1965 20AS	DEBRIS	01416
1965 20AY	DEBRIS	01438
1965 20AZ	DEBRIS	01439
1965 20BA	DEBRIS	01476
1965 20BB	DEBRIS	01477
1965 20BC	DEBRIS	01478
1965 20BD	DEBRIS	01479
1965 20BE	DEBRIS	01480
1965 20BF	DEBRIS	01481
1965 20BH	DEBRIS	[illegible]83
1965 20BJ	DEBRIS	[illegible]84
1965 20BK	DEBRIS	01485
1965 20BL	DEBRIS	01486

IDENT		NCAT
1965 20BMDEBRIS		01487
1965 20BNDEBRIS		01488
1965 20BPDEBRIS		01489
1965 20BRDEBRIS		01491
1965 20BTDEBRIS		01493
1965 20BVDEBRIS		01495
1965 20BWDEBRIS		01496
1965 20BXDEBRIS		01497
1965 20BZDEBRIS		01499
1965 20CADEBRIS		01530
1965 20CBDEBRIS		01531
1965 20CEDEBRIS		01534
1965 20CHDEBRIS		01537
1965 20CJDEBRIS		01538
1965 20CKDEBRIS		01539
1965 20CLDEBRIS		01540
1965 20CPDEBRIS		01543
1965 20CQDEBRIS		01544
1965 20CSDEBRIS		01546
1965 20CUDEBRIS		01548
1965 20CVDEBRIS		01549
1965 20CWDEBRIS		01550
1965 20CXDEBRIS		01551
1965 20CYDEBRIS		01552
1965 20DADEBRIS		01554
1965 20DBDEBRIS		01555
1965 20DCDEBRIS		01556
1965 20DDDEBRIS		01557
1965 20DEDEBRIS		01558
1965 20DFDEBRIS		01559
1965 20DHDEBRIS		01561
1965 20DKDEBRIS		01563
1965 20DLDEBRIS		01564
1965 20DMDEBRIS		01565
1965 20DNDEBRIS		01566
1965 20DPDEBRIS		01567
1965 20DSDEBRIS		01592
1965 20DTDEBRIS		01593
1965 20DUDEBRIS		01594
1965 20DVDEBRIS		01595
1965 20DWDEBRIS		01596
1965 20DXDEBRIS		01597
1965 20DYDEBRIS		01598
1965 20DZDEBRIS		01599
1965 20EADEBRIS		01600
1965 20EBDEBRIS		01601
1965 20ECDEBRIS		01633
1965 20EDDEBRIS		01634
1965 20EEDEBRIS		01635
1965 20EFDEBRIS		02203
1965 20EGDEBRIS		02204
1965 20EHDEBRIS		02334
1965 20EJDEBRIS		02339
1965 21A	NONE	01273
1965 21C	DEBRIS	01289
1965 21E	DEBRIS	01376
1965 21F	DEBRIS	01463
1965 27A	SNAP SHOT	01314
1965 27B	EGRS 4	01315
1965 27C	DEBRIS	01316
1965 27D	DEBRIS	01389
1965 27E	DEBRIS	01399
1965 28A	EARLY BIRD	01317
1965 28B	ROCKET BOD	01318
1965 30A	MOLNIYA 1	01324
1965 30D	ROCKET BOD	01967
1965 31B	ROCKET BOD	01329
1965 32A	EXPLORER27	01328
1965 32B	EXPL.27 R	01358
1965 32C	DEBRIS	01995
1965 32D	DEBRIS	02011
1965 34A	TITAN 3	01359
1965 34B	LES 2	01360
1965 34C	R.C.S.	01361
1965 38A	NONE	01377
1965 38B	ROCKET	01378
1965 38C	DEBRIS	01379
1965 38E	DEBRIS	01461
1965 38F	DEBRIS	01462
1965 38G	DEBRIS	01475
1965 39A	PEGASUS 2	01381
1965 39B	PEG 2 R	01385
1965 42A	IMP C	01388
1965 48A	NONE	01420
1965 48B	ROCKET	01425
1965 48C	DEBRIS	01428

IDENT		NCAT
1965 48D	DEBRIS	01435
1965 50A	NONE	01422
1965 51A	TIROS 10	01430
1965 51B	DEBRIS	01433
1965 51C	DEBRIS	01440
1965 51D	DEBRIS	01529
1965 52A	COSMOS 70	01431
1965 53A	COSMOS 71	01441
1965 53B	COSMOS 72	01442
1965 53C	COSMOS 73	01443
1965 53D	COSMOS 74	01444
1965 53E	COSMOS 75	01445
1965 53F	COS 71-75R	01448
1965 53G	DEBRIS	01449
1965 53H	DEBRIS	01473
1965 53J	DEBRIS	02338
1965 55A	NONE	01447
1965 58A	NONE	01458
1965 58B	NONE	01459
1965 58C	ORS 3	01460
1965 60A	PEGASUS 3	01467
1965 60B	PEGASUS 3R	01468
1965 62B	ROCKET	01472
1965 63A	EGRS 5	01506
1965 63B	ROCKET BOD	01502
1965 65A	NONE	01504
1965 65B	ROCKET BOD	01508
1965 65C	NONE	01510
1965 65D	NONE	01511
1965 65E	NONE	01512
1965 65F	NONE	01514
1965 65G	NONE	01515
1965 65H	DEBRIS	01520
1965 65J	DEBRIS	01521
1965 65K	DEBRIS	01522
1965 65L	DEBRIS	01577
1965 65M	DEBRIS	02335
1965 70A	COSMOS 80	01570
1965 70B	COSMOS 81	01571
1965 70C	COSMOS 82	01572
1965 70D	COSMOS 83	01573
1965 70E	COSMOS 84	01574
1965 70F	COS 80-84R	01575
1965 72A	NONE	01580
1965 72B	DEBRIS	01581
1965 72C	DEBRIS	01582
1965 72D	DEBRIS	01583
1965 72E	DEBRIS	01931
1965 72F	DEBRIS	01932
1965 73A	COSMOS 86	01584
1965 73B	COSMOS 87	01585
1965 73C	COSMOS 88	01586
1965 73D	COSMOS 89	01587
1965 73E	COSMOS 90	01588
1965 73F	COS 86-90R	01589
1965 73G	DEBRIS	01590
1965 73H	DEBRIS	01591
1965 73J	DEBRIS	01617
1965 73K	DEBRIS	01618
1965 78A	NONE	01613
1965 78B	DEBRIS	01616
1965 80A	MOLNIYA 2	01621
1965 81A	OGO C	01620
1965 81B	ROCKET BOD	01625
1965 82	SEE NOTE	01624
1965 84E	DEBRIS	02098
1965 89A	GEOS A	01726
1965 89B	ROCKET BOD	01729
1965 93A	EXPL 30	01738
1965 93B	EXPL. 30 R	01739
1965 93C	DEBRIS	02013
1965 93D	DEBRIS	02088
1965 95A	COSMOS 97	01777
1965 95B	COS 97 R	01779
1965 96A	FR. A-1	01778
1965 96B	FR. A-1R	01805
1965 96C	DEBRIS	01938
1965 96D	DEBRIS	01996
1965 98A	ALOUETTE 2	01804
1965 98B	EXPL. 31	01806
1965 98C	ROCKET	01807
1965 98D	DEBRIS	01808
1965 98E	DEBRIS	01944
1965 98F	DEBRIS	01948
1965 98G	DEBRIS	01951
1965 98H	DEBRIS	02092

IDENT		NCAT
1965 98J	DEBRIS	02153
1965101A	FR. 1	01814
1965101B	FR 1R	01815
1965101C	DEBRIS	01934
1965101D	DEBRIS	01935
1965105A	PIONEER 6	01841
1965105B	PIONEER 6R	01842
1965106A	COSMOS 100	01843
1965106B	ROCKET	01844
1965108A	TITAN 3C	01863
1965108B	LES 4	01870
1965108C	OSCAR 4	01902
1965108D	LES 3	01941
1965109A	NONE	01864
1965109B	ROCKET BOD	01865
1965109C	DEBRIS	02086
1965109D	DEBRIS	02226
1965109E	DEBRIS	02353
1965112A	COSMOS 103	01868
1965112B	COS 103 R	01869
1965112C	DEBRIS	01871
1965112D	DEBRIS	01872
1965112E	DEBRIS	01873
1965112F	DEBRIS	01874
1965112G	DEBRIS	01875
1965112H	DEBRIS	01876
1965112J	DEBRIS	01877
1965112K	DEBRIS	01878
1965112L	DEBRIS	01906
1965112M	DEBRIS	01907
1965112N	DEBRIS	01933
1965112P	DEBRIS	01936
1965112Q	DEBRIS	01937
1966 04A	COSMOS 106	01949
1966 04B	ROCKET	01950
1966 05A	NONE	01952
1966 05B	ALTAIR RKT	01953
1966 05C	DEBRIS	02140
1966 05D	DEBRIS	02141
1966 08A	ESSA-1	01982
1966 08B	ESSA-1R	01983
1966 08C	DEBRIS	02085
1966 08D	DEBRIS	02118
1966 08E	DEBRIS	02154
1966 09A	NONE	01997
1966 09B	ROCKET BOD	02003
1966 09C	DEBRIS	02004
1966 11A	COSM. 108	02002
1966 13A	DIAPSSON	02016
1966 13B	DIAPSSON R	02017
1966 13C	DEBRIS	02018
1966 13D	DEBRIS	02020
1966 13E	DEBRIS	02021
1966 13F	DEBRIS	02023
1966 13G	DEBRIS	02161
1966 16A	ESSA 2	02091
1966 16B	ROCKET	02096
1966 16C	DEBRIS	02223
1966 16D	DEBRIS	02224
1966 19A	AGEN.GATV	02104
1966 24A	NONE	02119
1966 24B	ALTAIR RKT	02120
1966 25A	OV1-4	02121
1966 25B	OV1-5	02122
1966 25C	ROCKET	02123
1966 25D	ROCKET	02124
1966 26A	NONE	02125
1966 26B	ROCKET	02129
1966 26C	DEBRIS	02162
1966 26D	DEBRIS	02177
1966 26E	DEBRIS	02178
1966 26F	DEBRIS	02179
1966 31A	OAO-A1	02142
1966 31B	OAO-A1R	02144
1966 31C	DEBRIS	02145
1966 34A	OV3-1	02150
1966 34B	DEBRIS	02167
1966 34C	DEBRIS	02208
1966 34D	DEBRIS	02209
1966 35A	MOLNIYA 3	02151
1966 36A	COSMOS 116	02152
1966 36B	COS.116 R	02159
1966 38A	COSMOS 118	02168
1966 38B	COS 118 R	02169
1966 39B	NONE	02172
1966 40A	NIMBUS 2	02173

IDENT			NCAT
1966	40B	NIMBUS 2R	02174
1966	41A	NONE	02176
1966	41B	ALTAIR RKT	02180
1966	41C	DEBRIS	02225
1966	43A	COSMOS 119	02182
1966	44A	EXPL. 32	02183
1966	44B	EXPL. 32R	02184
1966	44C	DEBRIS	02336
1966	49A	OGO 3	02195
1966	51A	NONE	02200
1966	51B	EGRS V1	02205
1966	51C	ORS MK-11	02202
1966	52A	OV3-4	02201
1966	52B	ROCKET BOD	02206
1966	53A	TITAN3C	02207
1966	53B	NONE	02215
1966	53C	NONE	02216
1966	53D	NONE	02217
1966	53E	NONE	02218
1966	53F	NONE	02219
1966	53G	NONE	02220
1966	53H	NONE	02221
1966	53J	ROCKET	02222
1966	56A	PAGEOS A	02253
1966	56B	PAG A R	02255
1966	56C	DEBRIS	02256
1966	57A	COSMOS 122	02254
1966	57B	COS 122 R	02257
1966	58A	AIMP-D	02258
1966	58B	AIMP-D R	02259
1966	58C	ROCKET BOD	02260
1966	58D	DEBRIS	02262
1966	58E	DEBRIS	02263
1966	60A	PROTON 3	02290
1966	60B	PROTON 3 R	02293
1966	61A	COSMOS 123	02295
1966	61B	COS 123 R	02296
1966	63A	UV-8	02324
1966	63B	NONE	02327
1966	63C	UV-8 R	02328
1966	63D	DEBRIS	02329
1966	63E	DEBRIS	02337
1966	65A	AGENA 10 T	02348
1966	66C	DEBRIS	02354
1966	66D	DEBRIS	02355
1966	66E	DEBRIS	02356
1966	66F	DEBRIS	02357
1966	66G	DEBRIS	02358
1966	66H	DEBRIS	02382
1966	67A	COSMOS 125	02351
1966	68A	COSMOS 126	02368
1966	68B	COS 126 R	02369
1966	69A	USPAYLOAD	02376
1966	70A	UV-3-3	02389
1966	71A	COSMOS 127	02391
1966	71B	COS 127 R	02392
1966	72A	NONE	02393

EXHIBIT O

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington, D. C. 20006

BULLETIN

August 24, 1966

IDENT DESIGNATIONS CORRESPONDING TO CATALOG NUMBERS (NCAT) OF UNCLASSIFIED EARTH SATELLITES IN ORBIT AS OF 39347.0 (August 10, 1966)

NCAT	IDENT	NCAT	IDENT	NCAT	IDENT	NCAT	IDENT
00004	1958 01A	00313	1962 25D	00671	1963 38C	00831	1964 38C
00005	1958 02B	00340	1962 29A	00672	1963 38D	00832	1964 38D
00011	1959 01A	00341	1962 29B	00674	1963 39A	00836	1964 40A
00012	1959 01B	00369	1962 39A	00675	1963 39B	00837	1964 40B
00016	1958 02A	00370	1962 39B	00683	1963 43A	00838	1964 40C
00020	1959 07A	00378	1962 39C	00684	1963 43B	00840	1960 07D
00022	1959 09A	00388	1962 39D	00686	1963 43D	00841	1960 07E
00023	1959 09B	00397	1962 47A	00692	1963 39C	00847	1964 15C
00028	1960 02A	00398	1962 47B	00693	1963 46A	00851	1964 45B
00029	1960 02B	00399	1962 47C	00694	1963 47A	00858	1964 47A
00031	1960 03B	00400	1962 47D	00696	1963 47B	00862	1964 47B
00043	1960 06A	00424	1962 49A	00697	1963 47C	00869	1964 49D
00045	1960 07A	00426	1962 49B	00698	1963 47D	00870	1964 51A
00046	1960 07B	00432	1962 51A	00699	1963 47E	00871	1964 51B
00047	1960 07C	00444	1962 58A	00700	1963 47F	00872	1964 52A
00049	1960 09A	00445	1962 59A	00701	1963 47G	00873	1964 51C
00050	1960 09B	00446	1962 60A	00702	1963 14H	00874	1964 51D
00051	1960 09C	00447	1962 60B	00703	1963 49A	00875	1964 51E
00052	1960 09D	00502	1962 67A	00704	1963 49B	00876	1964 53A
00053	1960 09E	00503	1962 68A	00705	1963 49C	00877	1964 53B
00058	1960 13A	00504	1962 67B	00706	1963 49D	00878	1964 52B
00059	1960 13B	00506	1962 70A	00714	1963 53A	00879	1964 54A
00060	1960 14A	00509	1962 71A	00715	1963 49E	00889	1964 60A
00062	1960 14B	00510	1962 49C	00716	1963 54A	00893	1964 63A
00063	1960 16A	00511	1962 49D	00717	1963 54B	00897	1964 63B
00064	1960 16B	00513	1962 67E	00720	1963 54C	00898	1964 49E
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00070	1961 01A	00515	1962 68B	00722	1963 53C	00900	1964 63C
00074	1960 16C	00519	1962 71C	00723	1963 53D	00901	1964 63D
00075	1960 16D	00520	1962 67F	00724	1963 53E	00902	1964 63E
00079	1961 01B	00523	1962 71D	00725	1963 53F	00903	1964 63F
00082	1961 04B	00527	1963 03A	00726	1963 53G	00907	1964 64B
00085	1961 04C	00532	1963 04B	00727	1964 01A	00922	1964 72A
00099	1960 03D	00533	1963 05A	00728	1964 01B	00924	1964 74A
00101	1960 02C	00534	1963 05B	00729	1964 01C	00925	1964 72B
00105	1960 14D	00535	1963 05C	00730	1964 01D	00931	1964 76A
00107	1961 13A	00536	1963 05D	00731	1964 01E	00932	1964 76B
00115	1960 02D	00553	1963 04A	00732	1963 53H	00933	1964 76C
00116	1961 15A	00564	1963 09A	00733	1964 02A	00934	1964 76D
00117	1961 15B	00573	1963 13A	00734	1964 02B	00935	1964 76E
00162	1961 17A	00574	1963 14A	00735	1964 02C	00936	1964 76F
00163	1961 18A	00575	1963 13B	00736	1963 54D	00937	1964 76G
00165	1961 17B	00579	1963 14B	00737	1964 03A	00939	1964 76H
00166	1961 17C	00589	1963 14D	00738	1964 03B	00940	1964 76I
00167	1961 17D	00594	1963 22A	00739	1963 47H	00941	1964 76J
00170	1961 20A	00602	1963 14E	00740	1964 04A	00953	1964 83A
00188	1961 18C	00603	1963 22B	00741	1964 04B	00956	1964 83B
00192	1961 28A	00604	1963 24A	00742	1964 04C	00959	1964 83C
00194	1961 28C	00605	1963 24B	00743	1964 04D	00960	1964 76K
00195	1961 28D	00606	1963 24C	00745	1963 38E	00963	1964 86A
00196	1961 18D	00607	1963 24D	00746	1964 06A	00965	1964 83D
00202	1961 31A	00608	1963 14C	00748	1964 06B	00966	1964 83E
00204	1961 31C	00610	1963 22C	00750	1964 06C	00967	1964 83F
00205	1961 31B	00611	1963 22D	00751	1964 06D	00973	1965 03A
00226	1962 02A	00612	1963 26A	00753	1963 49F	00976	1964 64C
00227	1962 02B	00613	1963 27A	00759	1964 11A	00977	1964 64D
00228	1962 02C	00614	1963 25B	00771	1964 15A	00978	1965 04A
00229	1962 02D	00622	1963 30A	00775	1964 15B	00979	1965 04B
00255	1962 06A	00624	1963 30D	00801	1964 26A	00983	1965 06A
00257	1962 06B	00625	1963 31B	00805	1964 26B	00987	1965 07A
00271	1962 10A	00628	1963 14F	00806	1964 26C	00988	1965 07B
00273	1962 10C	00629	1963 14G	00809	1964 26D	01000	1965 08A
00274	1962 10D	00630	1963 30C	00812	1964 31A	01001	1965 08B
00285	1962 15A	00631	1963 30E	00813	1964 31B	01002	1965 08C
00288	1962 15B	00634	1963 31A	00815	1964 31C	01085	1965 09A
00309	1962 25A	00635	1963 30B	00824	1964 35A	01088	1965 09B
00311	1962 25B	00669	1963 38A	00829	1964 38A	01089	1965 11A
00312	1962 25C	00670	1963 38B	00830	1964 38B	01090	1965 11B

NCAT	IDENT
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01092	1965 11D
01097	1965 14A
01098	1965 14B
01099	1964 83G
01208	1965 16E
01228	1965 17C
01244	1965 16B
01245	1965 16J
01248	1965 17D
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01268	1965 20B
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01272	1965 16H
01273	1965 21A
01289	1965 21C
01291	1965 16D
01292	1965 16C
01293	1965 16F
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01313	1965 04D
01314	1965 27A
01315	1965 27B
01316	1965 27C
01317	1965 28A
01318	1965 28B
01324	1965 30A
01328	1965 32A
01329	1965 31B
01335	1965 20E
01336	1965 20F
01337	1965 20G
01338	1965 20H
01339	1965 20J
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01361	1965 34C
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01377	1965 38A
01378	1965 38B
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01381	1965 39A
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01398	1965 20AK
01399	1965 27E
01402	1965 20AN
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01416	1965 20AS
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01428	1965 48C
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01433	1965 51B
01435	1965 48D
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01439	1965 20AZ
01440	1965 51C

NCAT	IDENT
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01442	1965 53B
01443	1965 53C
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01445	1965 53E
01447	1965 55A
01448	1965 53F
01449	1965 53G
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01461	1965 38E
01462	1965 38F
01463	1965 21F
01467	1965 60A
01468	1965 60B
01472	1965 62B
01473	1965 53H
01475	1965 38G
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01551	1965 20CX
01552	1965 20CY
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01555	1965 20DB
01556	1965 20DC
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01559	1965 20DF
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01564	1965 20DL
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01566	1965 20DN
01567	1965 20DP
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01571	1965 70B
01572	1965 70C
01573	1965 70D
01574	1965 70E
01575	1965 70F
01576	1958 02C
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NCAT	IDENT
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01581	1965 72B
01582	1965 72C
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01584	1965 73A
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01586	1965 73C
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01599	1965 20DZ
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01601	1965 20EB
01608	1964 83J
01613	1965 78A
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01624	1965 82
01625	1965 81B
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01778	1965 96A
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01804	1965 98A
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01807	1965 98C
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01843	1965106A
01844	1965106B
01863	1965108A
01864	1965109A
01865	1965109B
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01869	1965112B
01870	1965108B
01871	1965112C
01872	1965112D
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01874	1965112F
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01876	1965112H
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01902	1965108C
01906	1965112L
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01932	1965 72F
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01934	1965101C
01935	1965101D
01936	1965112P
01937	1965112Q
01938	1965 96C
01941	1965108D
01944	1965 98E
01948	1965 98F
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01950	1966 04B
01951	1965 98G
01952	1966 05A
01953	1966 05B
01967	1965 30D
01982	1966 08A

NCAT	IDENT
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01994	1963 47J
01995	1965 32C
01996	1965 96D
01997	1966 09A
02002	1966 11A
02003	1966 09B
02004	1966 09C
02009	1961 28E
02011	1965 32D
02013	1965 93C
02016	1966 13A
02017	1966 13B
02018	1966 13C
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02021	1966 13E
02023	1966 13F
02085	1966 08C
02086	1965109C
02088	1965 93D
02091	1966 16A
02092	1965 98H
02096	1966 16B
02097	1963 38F
02098	1965 84E
02104	1966 19A
02118	1966 08D
02119	1966 24A
02120	1966 24B
02121	1966 25A
02122	1966 25B
02123	1966 25C
02124	1966 25D
02125	1966 26A
02129	1966 26B
02140	1966 05C
02141	1966 05D
02142	1966 31A
02144	1966 31B
02145	1966 31C
02150	1966 34A
02151	1966 35A
02152	1966 36A
02153	1965 98J
02154	1966 08E
02159	1966 36B
02161	1966 13G
02162	1966 26C
02167	1966 34B
02168	1966 38A
02169	1966 38B
02172	1966 39B
02173	1966 40A
02174	1966 40B
02176	1966 41A
02177	1966 26D
02178	1966 26E
02179	1966 26F
02180	1966 41B
02182	1966 43A
02183	1966 44A
02184	1966 44B
02195	1966 49A
02200	1966 51A
02201	1966 52A
02202	1966 51C
02203	1965 20EF
02204	1965 20EG
02205	1966 51B
02206	1966 52B
02207	1966 53A
02208	1966 34C
02209	1966 34D
02215	1966 53B
02216	1966 53C
02217	1966 53D
02218	1966 53E
02219	1966 53F
02220	1966 53G
02221	1966 53H
02222	1966 53J
02223	1966 16C
02224	1966 16D
02225	1966 41C
02226	1965109D
02253	1966 56A
02254	1966 57A

NCAT	IDENT
02255	1966 58B
02256	1966 56C
02257	1966 57B
02258	1966 58A
02259	1966 58B
02260	1966 58C
02262	1966 58D
02263	1966 58E
02290	1966 60A
02293	1966 60B
02295	1966 61A
02296	1966 61B
02324	1966 63A
02327	1966 63B
02328	1966 63C
02329	1966 63D
02334	1965 20EH
02335	1965 65M
02336	1966 44C
02337	1966 63E
02338	1965 53J
02339	1965 20EJ
02348	1966 65A
02351	1966 67A
02353	1965109E
02354	1966 66C
02355	1966 66D
02356	1966 66E
02357	1966 66F
02358	1966 66G
02359	1963 14J
02360	1963 14K
02361	1963 14L
02362	1963 14M
02363	1963 14N
02364	1963 14P
02365	1963 14Q
02366	1963 14R
02367	1963 14S
02368	1966 68A
02369	1966 68B
02371	1961 [illegible]
02372	1963 [illegible]
02373	1963 14U
02374	1963 14V
02375	1963 14W
02376	1966 69A
02377	1963 14X
02378	1963 14Y
02379	1963 14Z
02380	1963 14AA
02381	1963 14AB
02382	1966 66H
02389	1966 70A
02391	1966 71A
02392	1966 71B
02393	1966 72A

EXHIBIT P

INDEPENDENT TRACKING COORDINATION PROGRAM

824 Connecticut Avenue
Washington, D. C. 20006

BULLETIN

August 25, 1966

CURRENT SPACE JUNK LIST

To keep "space junk" data from displacing potentially useful information, current gear ratio elements on the objects listed below are being routinely eliminated from the Independent Tracking Coordination Program's Airmail Announcement Services. Specific objects of interest will be deleted from the list and thus reinstated upon request to this office. Such request should indicate the observer's basis for his belief that he will be able to secure observation.

JUNK LIST AS OF JNL = 39347.0 (August 10, 1966)

00051	00156	00262	00403	00520	00655	00847	01352
00052	00157	00263	00404	00523	00656	00873	01354
00069	00158	00264	00405	00530	00657	00874	01355
00074	00159	00265	00406	00531	00658	00875	01358
00075	00161	00268	00407	00537	00659	00893	01370
00085	00166	00275	00408	00538	00660	00898	01371
00101	00167	00299	00409	00539	00661	00901	01372
00105	00172	00300	00410	00540	00662	00903	01373
00115	00175	00301	00411	00541	00672	00934	01376
00118	00176	00312	00412	00542	00684	00935	01379
00119	00177	00313	00413	00543	00686	00936	01389
00120	00178	00317	00414	00544	00692	00937	01392
00121	00179	00318	00415	00545	00696	00939	01397
00122	00188	00319	00416	00546	00697	00940	01398
00123	00194	00320	00417	00547	00698	00941	01399
00124	00195	00321	00418	00548	00699	00953	01402
00125	00196	00322	00419	00549	00700	00956	01410
00126	00210	00323	00420	00550	00701	00960	01411
00127	00211	00324	00421	00551	00702	00966	01416
00128	00212	00325	00461	00552	00706	00967	01433
00129	00216	00326	00462	00556	00715	00976	01435
00130	00223	00327	00463	00557	00720	00977	01438
00131	00224	00328	00464	00558	00722	00979	01439
00132	00225	00329	00465	00559	00723	00988	01440
00133	00228	00330	00466	00560	00724	01092	01449
00134	00229	00331	00467	00561	00725	01099	01461
00135	00230	00332	00468	00606	00726	01289	01462
00136	00232	00333	00469	00607	00732	01312	01463
00137	00233	00334	00470	00610	00736	01313	01473
00138	00234	00335	00471	00611	00739	01335	01475
00139	00235	00336	00472	00628	00741	01336	01476
00141	00236	00337	00473	00629	00742	01337	01477
00142	00237	00350	00474	00631	00743	01338	01478
00144	00238	00351	00475	00643	00745	01339	01479
00145	00239	00352	00476	00644	00750	01340	01480
00146	00243	00353	00477	00645	00751	01341	01481
00147	00244	00354	00478	00646	00753	01342	01483
00148	00245	00355	00479	00647	00805	01343	01484
00149	00246	00356	00480	00648	00806	01344	01485
00150	00250	00357	00502	00649	00809	01345	01486
00151	00252	00358	00510	00650	00815	01346	01487
00152	00253	00399	00511	00651	00831	01347	01488
00153	00254	00400	00513	00652	00832	01348	01489
00154	00260	00401	00514	00653	00840	01349	01491
00155	00261	00402	00516	00654	00841	01351	01493

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INDEPENDENT TRACKING COORDINATION PROGRAM

BULLETIN

824 Connecticut Avenue
Washington 6, D. C.

EXHIBIT Q

August 11, 1966

TABLE OF STANDARD BRIGHTNESS ORDERED BY NCAT

Values followed by symbol M are Measured values, normalized to standard viewing conditions specified in ITCP Bulletin of September 30, 1965. All others are calculated on the basis of projected area and standard reflectivity.

POPULAR NAME	NCAT	dbz
EXPLORER 1	00004	-30M
VANGUARD 1	00005	-42
VANGUARD 2	00011	-30M
VANG 2 R	00012	-26M
ROCKET BODY	00016	-29
VANGUARD 3	00020	-24M
EXPLORER 7	00022	-29
ROCKET BODY	00023	-33
TIROS 1 R	00028	-26M
TIROS 1	00029	-30M
TRANSIT 1B	00031	-27
MIDAS 2	00043	-16M
TRANSIT 2A	00045	-28M
GREB	00046	-32
TRANS 2A R	00047	-26M
ECHO 1	00049	03
ECHO 1 R	00050	-28M
DEBRIS	00053	-30M
COURIER 1B	00058	-24
COUR.1B R	00059	-16M
EXPLORER 8	00060	-28M
ROCKET BODY	00062	-33
TIROS 2	00063	-27
TIROS.2 R	00064	-32M
SAMOS 2	00070	-16M
ROCKET	00082	-26M
EXPLORER11	00107	-30M
TRANSIT 4A	00116	-24M
INJUN-SR-3	00117	-28M
TIROS 3	00162	-30M
MIDAS 3	00163	-14M
TIROS 3 R	00165	-30M
EXPLORER 12	00170	-37
M[illegible]S 4	00192	-16M
T[illegible]IT 4B	00202	-30M
T[illegible]S 4B R	00204	-26M
TRAAC 1	00205	-30M
TIROS 4	00226	-27
ROCKET BODY	00227	-29
ORB.SOL.OBS.1	00255	-25
O.S.O.1R	00257	-26M
NONE	00271	-14M
ARIEL 1	00285	-28M
ARIEL 1R	00288	-26M
TIROS 5	00309	-30M
TIROS 5 R	00311	-30M
TELSTAR	00340	-24M
TELS 1 R	00341	-22M
NONE	00369	-26M
NONE	00378	-28M
ROCKET	00388	-24M
TIROS 6	00397	-30M
TIROS 6 R	00398	-30M
ALOUETTE	00424	-28M
ALOUET R	00426	-22M
EXPLORER 14	00432	-27
NONE	00444	-16M
EXPLORER 15	00445	-27
ANNA 1B	00446	-24M
ANNA 1B R	00447	-22M
RELAY 1	00503	-26M
INJUN 3	00504	-31
EXPLORER16	00506	-26M
TRANSIT 5A	00509	-26M
RELAY 1 R	00515	-24M
TRANS 5A R	00519	-26M
NONE	00527	-16
ROCKET. BODY	00532	-29
DEBRIS	00533	-32M
NONE	00534	-28M
SYNCOM 1	00553	-30
EXPL.17	00564	-27
TELSTAR 2	00573	-27
NONE	00574	-16M
TELSTAR 2R	00575	-22M
NONE	00579	-41
TRANS A2 R	00603	-28M
TIROS 7	00604	-27
TIROS 7 R	00605	-28M
NONE	00608	-41
GEO RSCH	00612	-26M
NONE	00613	-14M
[illegible]	00614	-29
[illegible]	00622	-16M
[illegible]LOON	00624	-19
ROCKET BODY	00625	-29
SYNCOM 2	00634	-29
NONE	00635	-20M
ROCKET	00669	-20M
NONE	00670	-26M
NONE	00671	-26M
NONE	00674	-16
TETRA-2	00675	-40
POLYOT 1	00683	-22M
EXPLORER 18	00693	-29
CENTAUR 2	00694	-12M
ROCKET	00703	-24M
NONE	00704	-28M
NONE	00705	-28M
EXPLORER19	00714	-12M
TIROS 8	00716	-30M
ROCKET BODY	00717	-29
EXPL 19R	00721	-24M
NONE	00727	-24M
EGRS	00729	-37
SOLAR RAD	00730	-26M
ROCKET	00733	-14M
RELAY 2	00737	-26M
ROCKET BODY	00738	-29
ECHO 2	00740	06
ECHO 2 R	00741	-20M
ELEKTRON 1	00746	-20M
ELEKTR.2	00748	-17
NONE	00759	-24M
ARIEL 2	00771	-26M
ROCKET BODY	00775	-28
NONE	00801	-26M
NONE	00812	-16
NONE	00824	-16
ELEKTR 3	00829	-20M
ELEKTR.4	00830	-17
NONE	00836	-16
NONE	00837	-26
TRS II	00838	-42
SYNCOM 3	00858	-31
ROCKET BODY	00862	-29
EXPLORER20	00870	-28M
EXPL.20 R	00871	-28M
NIMBUS 1	00872	-21
COSMOS 44	00876	-24M
COS 44 R	00877	-22M
ROCKET BODY	00878	-17
OGO I	00879	-25
EXPL.21	00889	-29
DEBRIS	00893	-16M
NONE	00897	-30M
EXPL.22	00899	-35
NONE	00900	-32M
EXPL 22 R	00907	-24M
NONE	00922	-16M
EXPLORER23	00924	-32M
EXPLORER24	00931	-12M
EXPLORER25	00932	-28M
EXPL 25 R	00933	-16M
DEBRIS	00953	-20M
DEBRIS	00953	-20M
NONE	00959	-30M
NONE	00959	-30M
EXPL.26	00963	-29
NONE	00965	-26M
NONE	00973	-16
TIROS 9	00978	-30M
TIROS 9 R	00979	-30M
TIROS 9 R	00979	-30M
COSMOS 53	00983	-22M
O.S.O.2	00987	-24M
OSO 2 R	00988	-24M
O.S.O.2 R	00988	-24M
TITAN 3	01000	-22M
NONE	01001	-14M
NONE	01002	-30M
PEGASUS 1	01085	-04M
COMMD.MOD	01088	-10M
COSMOS 58	01097	-20M
COSMOS 58	01097	-20M
COS 58 R	01098	-20M
EGRS 3	01208	-36
ROCKET	01228	-18M
GRV.GRD.2	01244	-32M
ROCKET	01245	-20M
DEBRIS	01248	-20M
COSMOS 62	01268	-24M
GREB 1	01271	-28M
NONE	01273	-16
SOLAR RAD2	01291	-28M
GR.GRD .3	01292	-32M
SNAP SHOT	01314	-14M
EGRS 4	01315	-36
DEBRIS	01316	-28M
EARLY BIRD	01317	-29
ROCKET BODY	01318	-29
EXPLORER27	01328	-28M
EXPL.27 R	01358	-26M
TITAN 3	01359	-14M
R.C.S.	01361	-22M
NONE	01377	-24M
ROCKET	01378	-26M
PEGASUS 2	01381	-04M
PEG 2 R	01385	-10M
IMP C	01388	-42
NONE	01420	-24M
NONE	01422	-28M
ROCKET	01425	-28M
TIROS 10	01430	-30M
COSMOS 70	01431	-23
ROCKET BODY	01432	-14
COSMOS 71	01441	-28M
COSMOS 75	01445	-30M
NONE	01447	-16
COS 71-75R	01448	-18M
NONE	01459	-26
PEGASUS 3	01467	-04M
PEGASUS 3R	01468	-10M
ROCKET	01472	-28M
EGRS 5	01506	-31
ROCKET BODY	01508	-18
NONE	01510	-22M
COS 80-84R	01575	-18M
NONE	01580	-27
COSMOS 86	01584	-24M
COSMOS 87	01585	-24M
COSMOS 89	01587	-24M
COSMOS 90	01588	-22M
COS 86-90R	01589	-18M
NONE	01613	-14M
OGO C	01620	-23
ROCKET BODY	01625	-17
GEOS A	01726	-26
ROCKET BODY	01729	-28
EXPL 30	01738	-31
EXPL. 30 R	01739	-28M
COSMOS 97	01777	-24
FR. A-1	01778	-32
COS 97 R	01779	-14M
ALOUETTE 2	01804	-20M
FR. A-1R	01805	-25
EXPL. 31	01806	-31
ROCKET	01807	-20M
FR. 1	01814	-28
FR 1R	01815	-28
PIONEER 6R	01842	-22M
ROCKET	01844	-14
COSMOS 101	01846	-24
TITAN 3C	01863	-12
COS 103 R	01869	-20M
COSMOS 106	01949	-24M
ROCKET	01950	-14
ALTAIR RKT	01953	-29
ESSA-1	01982	-29
ESSA-1R	01983	-29
NONE	01997	-22M
COSM. 108	02002	-24
D-1A	02016	-37
DIAPSSON	02016	-26M
D-1AR	02017	-25
DIAPSSON R	02017	-24M
ESSA 2	02091	-24M
ALTAIR RKT	02120	-29
OV1-5	02122	-28M
ALTAIR RKT	02129	-29
ROCKET	02129	-28M
OAO-A1	02142	-17
OAO-A1R	02144	-17
OV3-1	02150	-28
COSMOS 116	02152	-26M
COS.116 R	02159	-18M
COSMOS 118	02168	-24M
COS 118 R	02169	-16M
NIMBUS 2	02173	-21
NIMBUS 2R	02174	-18
ALTAIR RKT	02180	-28
EXPL. 32	02183	-28
EXPL. 32R	02184	-28
OGO 3	02195	-25
ROCKET	02200	-18
TITAN 3C	02222	-15
PAGEOS-1	02253	-03
PAGEOS-1R	02255	-18
COSM. 122R	02257	-14
PROTON 3 R	02293	-06M
OV-8	02324	-20M
	02328	-24M

TABLE OF STANDARD BRIGHTNESS ORDERED BY BRIGHTNESS

Values followed by symbol M are Measured values, normalized to standard viewing conditions specified in ITCP Bulletin of September 30, 1965. All others are calculated on the basis of projected area and standard reflectivity.

POPULAR NAME	NCAT	dbz
ECHO 2	00740	06
ECHO 1	00049	03
PAGEOS-1	02253	-03
PEGASUS 1	01085	-04M
PEGASUS 2	01381	-04M
PEGASUS 3	01467	-04M
PROTON 3 R	02293	-06M
COMMD.MOD	01088	-10M
PEG 2 R	01385	-10M
PEGASUS 3R	01468	-10M
CENTAUR 2	00694	-12M
EXPLORER19	00714	-12M
EXPLORER24	00931	-12M
TITAN 3C	01863	-12
MIDAS 3	00163	-14M
NONE	00271	-14M
NONE	00613	-14M
ROCKET	00733	-14M
NONE	01001	-14M
SNAP SHOT	01314	-14M
TITAN 3	01359	-14M
ROCKET BODY	01432	-14
NONE	01613	-14M
COS 97 R	01779	-14M
ROCKET	01844	-14
ROCKET	01950	-14
COSM. 122R	02257	-14
TITAN 3C	02222	-15
MIDAS 2	00043	-16M
COUR.1B R	00059	-16M
SAMOS 2	00070	-16M
MIDAS 4	00192	-16M
NONE	00444	-16M
NONE	00527	-16
NONE	00574	-16M
NONE	00622	-16M
NONE	00674	-16
NONE	00812	-16
NONE	00824	-16
NONE	00836	-16
DEBRIS	00893	-16M
NONE	00922	-16M
EXPL 25 R	00933	-16M
NONE	00973	-16
NONE	01273	-16
NONE	01447	-16
COS 118 R	02169	-16M
ELEKTR.2	00748	-17
ELEKTR.4	00830	-17
ROCKET BODY	00878	-17
ROCKET BODY	01625	-17
OAO-A1	02142	-17
OAO-A1R	02144	-17
ROCKET	01228	-18M
COS 71-75R	01448	-18M
ROCKET BODY	01508	-18
COS 80-84R	01575	-18M
COS 86-90R	01589	-18M
COS.116 R	02159	-18M
NIMBUS 2R	02174	-18
ROCKET	02200	-18
PAGEOS-1R	02255	-18
BALLOON	00624	-19
NONE	00635	-20M
ROCKET	00669	-20M
ECHO 2 R	00741	-20M
ELEKTRON 1	00746	-20M
ELEKTR 3	00829	-20M
DEBRIS	00953	-20M
DEBRIS	00953	-20M
COSMOS 58	01097	-20M
COSMOS 58	01097	-20M
COS 58 R	01098	-20M
ROCKET	01245	-20M
DEBRIS	01248	-20M
ALOUETTE 2	01804	-20M
ROCKET	01807	-20M
COS 103 R	01869	-20M
OV-8	02324	-20M
NIMBUS 1	00872	-21
NIMBUS 2	02173	-21
TELS 1 R	00341	-22M
ALOUET R	00426	-22M
ANNA 1B R	00447	-22M
TELSTAR 2R	00575	-22M
POLYOT 1	00683	-22M
COS 44 R	00877	-22M
COSMOS 53	00983	-22M
TITAN 3	01000	-22M
R.C.S.	01361	-22M
NONE	01510	-22M

POPULAR NAME	NCAT	dbz
COSMOS 90	01588	-22M
PIONEER 6R	01842	-22M
NONE	01997	-22M
COSMOS 70	01431	-23
OGO C	01620	-23
VANGUARD 3	00020	-24M
COURIER 1B	00058	-24
TRANSIT 4A	00116	-24M
TELSTAR	00340	-24M
ROCKET	00388	-24M
ANNA 1B	00446	-24M
RELAY 1 R	00515	-24M
ROCKET	00703	-24M
EXPL 19R	00721	-24M
NONE	00727	-24M
NONE	00759	-24M
COSMOS 44	00876	-24M
EXPL 22 R	00907	-24M
O.S.O.2	00987	-24M
OSO 2 R	00988	-24M
O.S.O.2 R	00988	-24M
COSMOS 62	01268	-24M
NONE	01377	-24M
NONE	01420	-24M
COSMOS 86	01584	-24M
COSMOS 87	01585	-24M
COSMOS 89	01587	-24M
COSMOS 97	01777	-24
COSMOS 101	01846	-24
COSMOS 106	01949	-24M
COSM. 108	02002	-24
DIAPSSON R	02017	-24M
ESSA 2	02091	-24M
COSMOS 118	02168	-24M
	02328	-24M
ORB.SOL.OBS.1	00255	-25
OGO I	00879	-25
FR. A-1R	01805	-25
D-1AR	02017	-25
OGO 3	02195	-25
VANG 2 R	00012	-26M
TIROS 1 R	00028	-26M
TRANS 2A R	00047	-26M
ROCKET	00082	-26M
TRANS 4B R	00204	-26M
O.S.O.1R	00257	-26M
ARIEL 1R	00288	-26M
NONE	00369	-26M
RELAY 1	00503	-26M
EXPLORER16	00506	-26M
TRANSIT 5A	00509	-26M
TRANS 5A R	00519	-26M
GEO RSCH	00612	-26M
NONE	00670	-26M
NONE	00671	-26M
SOLAR RAD	00730	-26M
RELAY 2	00737	-26M
ARIEL 2	00771	-26M
NONE	00801	-26M
NONE	00837	-26
NONE	00965	-26M
EXPL.27 R	01358	-26M
ROCKET	01378	-26M
NONE	01459	-26
GEOS A	01726	-26
DIAPSSON	02016	-26M
COSMOS 116	02152	-26M
TRANSIT 1B	00031	-27
TIROS 2	00063	-27
TIROS 4	00226	-27
EXPLORER 14	00432	-27
EXPLORER 15	00445	-27
EXPL.17	00564	-27
TELSTAR 2	00573	-27
TIROS 7	00604	-27
NONE	01580	-27
TRANSIT 2A	00045	-28M
ECHO 1 R	00050	-28M
EXPLORER 8	00060	-28M
INJUN-SR-3	00117	-28M
ARIEL 1	00285	-28M
NONE	00378	-28M
ALOUETTE	00424	-28M
NONE	00534	-28M
TRANS A2 R	00603	-28M
TIROS 7 R	00605	-28M
NONE	00704	-28M
NONE	00705	-28M
ROCKET BODY	00775	-28
EXPLORER20	00870	-28M
EXPL.20 R	00871	-28M

POPULAR NAME	NCAT	dbz
EXPLORER25	00932	-28M
GREB 1	01271	-28M
SOLAR RAD2	01291	-28M
DEBRIS	01316	-28M
EXPLORER27	01328	-28M
NONE	01422	-28M
ROCKET	01425	-28M
COSMOS 71	01441	-28M
ROCKET	01472	-28M
ROCKET BODY	01729	-28
EXPL. 30 R	01739	-28M
FR. 1	01814	-28
FR 1R	01815	-28
OV1-5	02122	-28M
ROCKET	02129	-28M
OV3-1	02150	-28
ALTAIR RKT	02180	-28
EXPL. 32	02183	-28
EXPL. 32R	02184	-28
ROCKET BODY	00016	-29
EXPLORER 7	00022	-29
ROCKET BODY	00227	-29
ROCKET BODY	00532	-29
NONE	00614	-29
ROCKET BODY	00625	-29
SYNCOM 2	00634	-29
EXPLORER 18	00693	-29
ROCKET BODY	00717	-29
ROCKET BODY	00738	-29
ROCKET BODY	00862	-29
EXPL.21	00889	-29
EXPL.26	00963	-29
EARLY BIRD	01317	-29
ROCKET BODY	01318	-29
ALTAIR RKT	01953	-29
ESSA-1	01982	-29
ESSA-1R	01983	-29
ALTAIR RKT	02120	-29
ALTAIR RKT	02129	[illegible]
EXPLORER 1	00004	[illegible]M
VANGUARD 2	00011	[illegible]M
TIROS 1	00029	-30M
DEBRIS	00053	-30M
EXPLORER11	00107	-30M
TIROS 3	00162	-30M
TIROS 3 R	00165	-30M
TRANSIT 4B	00202	-30M
TRAAC 1	00205	-30M
TIROS 5	00309	-30M
TIROS 5 R	00311	-30M
TIROS 6	00397	-30M
TIROS 6 R	00398	-30M
SYNCOM 1	00553	-30
TIROS 8	00716	-30M
NONE	00897	-30M
NONE	00959	-30M
NONE	00959	-30M
TIROS 9	00978	-30M
TIROS 9 R	00979	-30M
TIROS 9 R	00979	-30M
NONE	01002	-30M
TIROS 10	01430	-30M
COSMOS 75	01445	-30M
INJUN 3	00504	-31
SYNCOM 3	00858	-31
EGRS 5	01506	-31
EXPL 30	01738	-31
EXPL. 31	01806	-31
GREB	00046	-32
TIROS.2 R	00064	-32M
DEBRIS	00533	-32M
NONE	00900	-32M
EXPLORER23	00924	-32M
GRV.GRD.2	01244	-32M
GR.GRD .3	01292	-32M
FR. A-1	01778	-32
ROCKET BODY	00023	-33
ROCKET BODY	00062	-33
EXPL.22	00899	-35
EGRS 3	01208	-36
EGRS 4	01315	-36
EXPLORER 12	00170	-37
EGRS	00729	-37
D-1A	02016	-37
TETRA-2	00675	-40
NONE	00579	-41
NONE	00608	-41
VANGUARD 1	00005	[illegible]
TRS II	00838	[illegible]
IMP C	01388	[illegible]