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SPS ΔV REQUIREMENTS FOR THE APOLLO 10 (MISSION F) MAY AND JUNE LAUNCH WINDOWS

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PROJECT APOLLO

SPS ΔV REQUIREMENTS FOR THE APOLLO 10 (MISSION F) MAY AND JUNE LAUNCH WINDOWS

By James Rotter
Lunar Mission Analysis Branch

May 12, 1969

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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Approved: D H Owen
for John P. Mayer, Chief
Mission Planning and Analysis Division

FOREWORD

The purpose of this document is to describe the service propulsion system (SPS) ΔV requirements associated with several possible transearth flight times for Apollo 10 (Mission F). Four cases are considered with the following flight time ranges.

a. Case 1 - 34 hours to 55 hours

b. Case 2 - 59 hours to 79 hours

c. Case 3 - 83 hours to 104 hours

d. Case 4 - 107 hours to 128 hours

For all cases considered, the return is to the Pacific at 165° W longitude; therefore, the flight times differ by approximately 1 day from case to case. The lunar parking orbit (LPO) stay time for launch on May 18 is 61.5 hours. Data for all other days were computed with a 51.5-hour LPO time which has since been increased to 53.5 hours for all days except June 17. The LPO time for launch on June 17 has beee increased to 61.5 hours. The transearth trajectories for May 18 and May 20 and for June 17 and June 19 do not reflect the recent changes in LPO orientation for these launch dates.

The increase in LPO time (51.5 hr to 53.5 hr) will decrease the transearth flight times for these days by approximately 2 hours. The effect of this change on the ΔV requirements and ΔV reserves can be approximated from figure 3.

Each plot for each day has the nominal transearth flight time range for that day noted; the shortest flight time is for a launch on a 108° launch azimuth, second injection opportunity, and the longest flight time is for a launch on a 72° launch azimuth, first injection opportunity. The curves for the nominal flight times are labeled. The 1-, 2-, and 3-day longer flight time curves are labeled P+1, P+2, and P+3, respectively. The 1-day earlier flight time curves are labeled P-1. These data are in the format requested by the Flight Control Division.

The SPS ΔV reserves associated with the cases considered are presented in figure 1. The three major SPS burns are the first lunar orbit insertion maneuver (LOI-1), the circularization maneuver (LOI-2), and the

transearth injection maneuver (TEI). Allowance is made for a translunar midcourse ΔV of 120 fps. The LM rescue ΔV is not included. During transearth coast, 700 pounds of SPS propellant is deducted to allow for dispersions and other uncertainties. Flight times and TEI ΔV's were computed by use of a conic simulation. The TEI ΔV's were biased to be consistent with integrated simulations. The biases were determined by plotting the differences between conic and integrated TEI ΔV's versus transearth flight times from previous launch windows.

The SPS ΔV required above nominal for the different cases is presented in figure 2. The nominal flight time missions are indicated by the 0 fps lines on the figures. The additional ΔV is negative for the longer flight time missions, which indicates the ΔV savings associated with these missions.

The approximate TEI ΔV's required as a function of flight time for the total May and June launch windows are presented in figure 3.

The nominal transearth flight times and TEI ΔV's generated are presented in table I.

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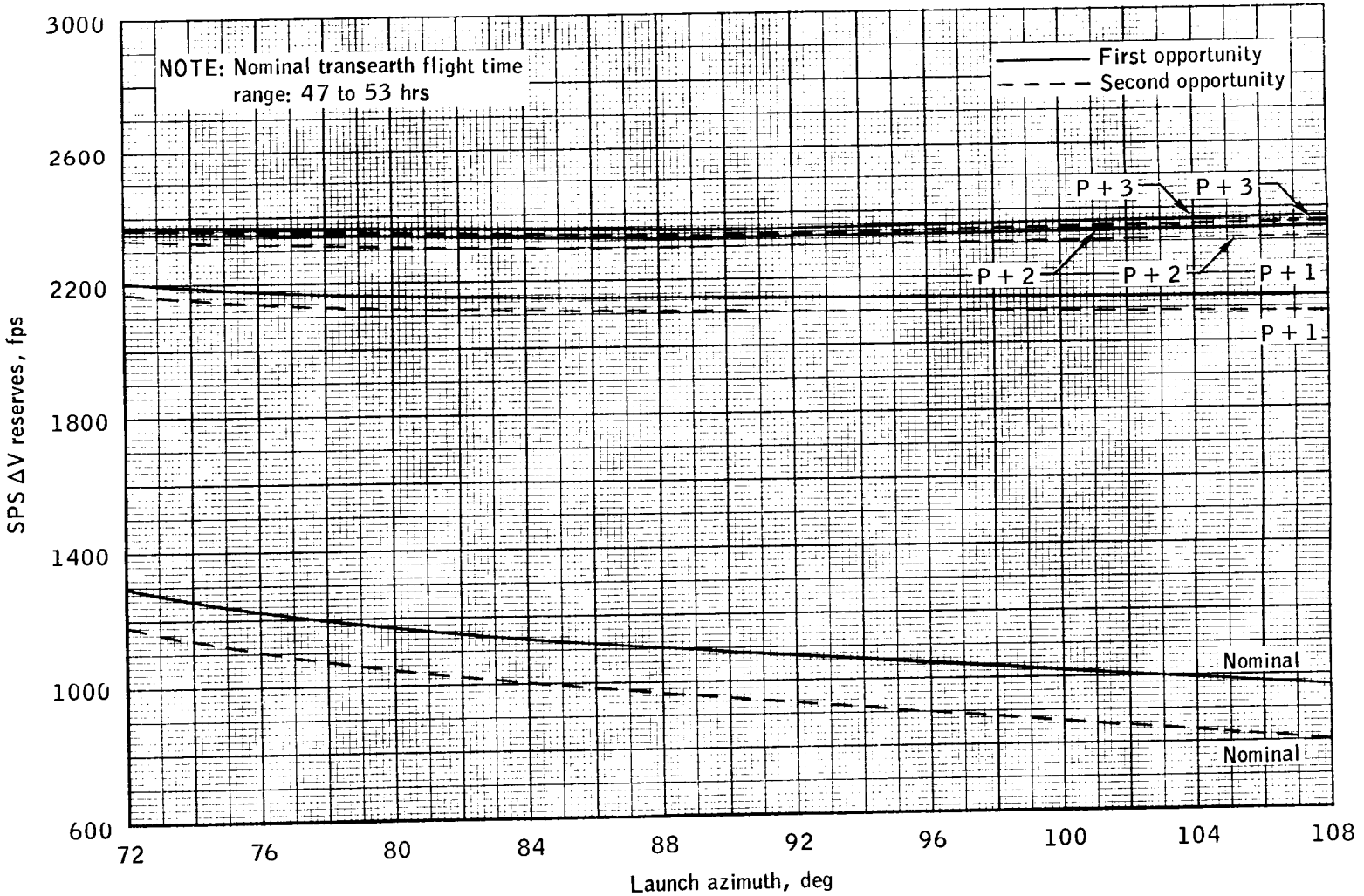
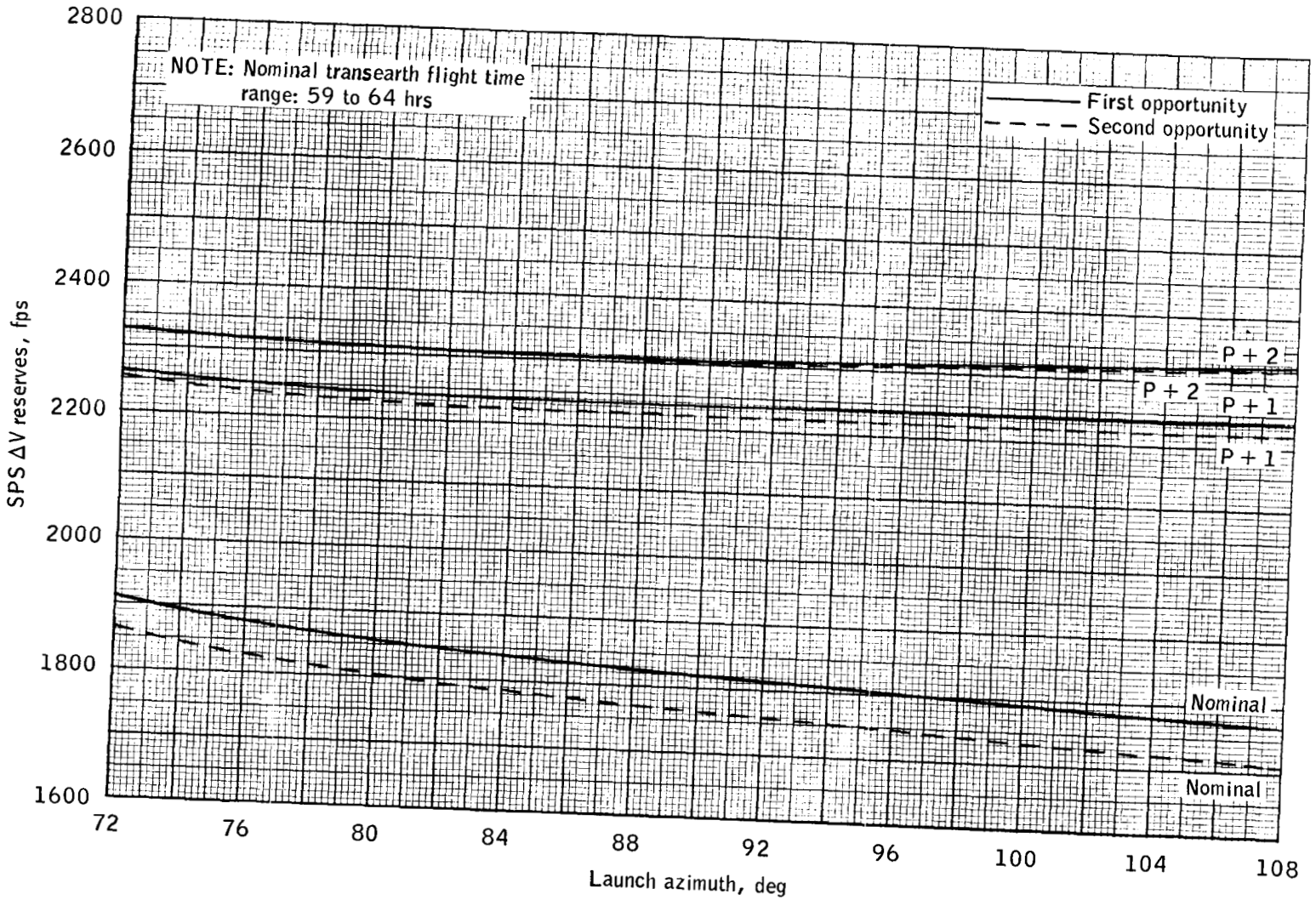
TABLE I.- NOMINAL TRANSEARTH FLIGHT TIMES AND TEI ΔV'S

Launch az, deg	72		90		108		72		108	
Opportunity	First		First		First		Second		Second	
Date, month-day	Flight time, hr	TEI ΔV, fps	Flight time, hr	TEI ΔV, fps	Flight time, hr	TEI ΔV, fps	Flight time, hr	TEI ΔV, fps	Flight time, hr	TEI ΔV, fps
5-18	52.9	3694	50.4	3874	48.6	4013	51.3	3799	47.1	4150
5-20	64.1	3074	61.9	3145	60.0	3212	62.7	3121	58.6	3271
5-23	70.1	2921	68.0	2961	66.4	2997	68.8	2944	65.1	3026
5-24	71.5	2884	69.8	2912	67.6	2951	70.1	2906	66.2	2980
5-25	72.9	2858	72.3	2880	70.1	2914	72.6	2876	68.8	2937
6-17	64.5	3079	62.2	3152	60.5	3214	63.0	3124	59.1	3270
6-19	67.5	2951	65.5	2999	63.7	3047	66.2	2981	62.3	3086
6-22	74.0	2848	72.4	2868	70.2	2901	72.7	2865	68.9	2923
6-23	76.8	2830	75.2	2846	73.0	2877	75.4	2844	71.6	2894
6-24	79.4	2821	78.0	2833	75.5	2861	78.0	2833	74.2	2875



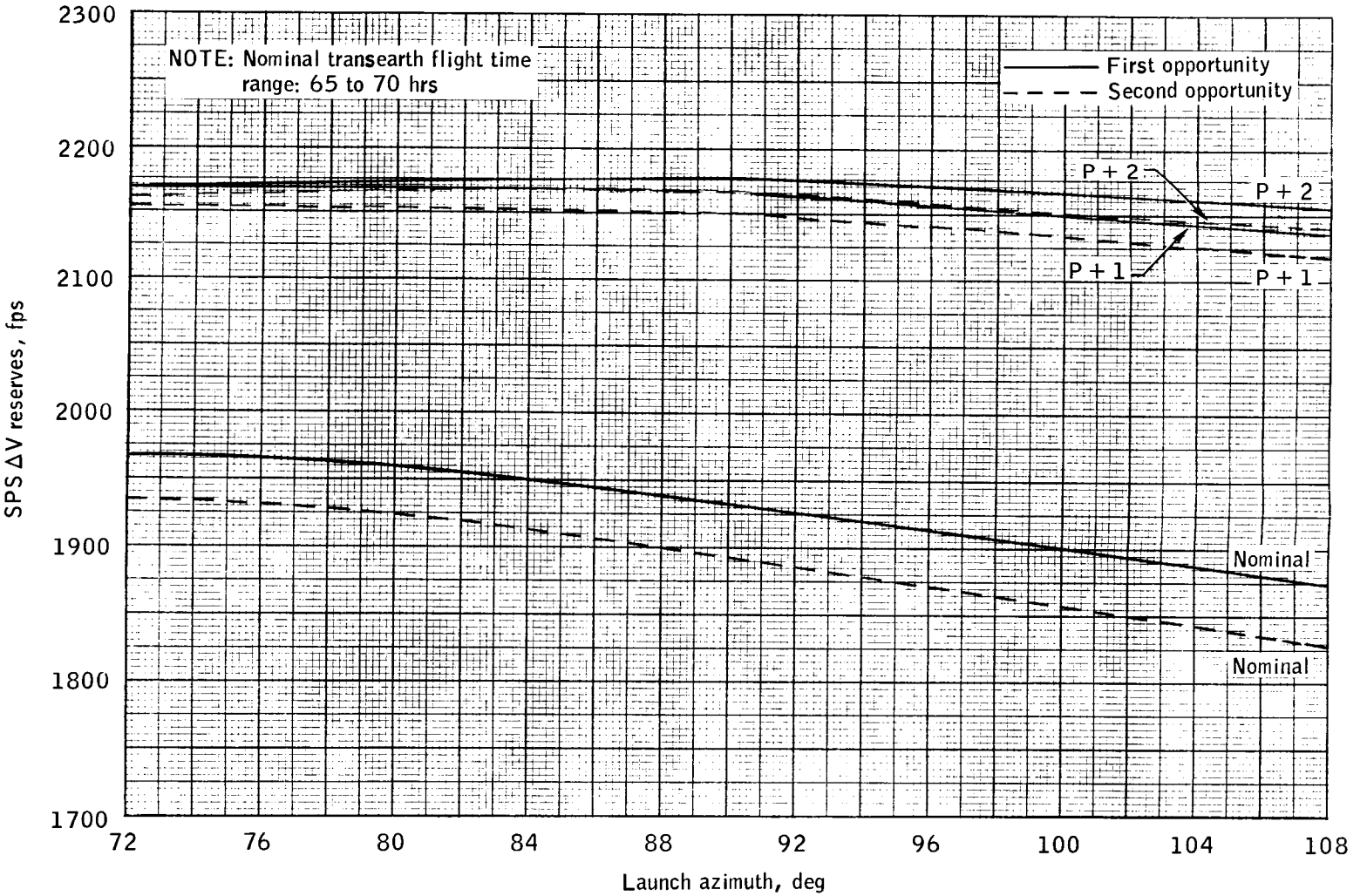
(a) May 18, 1969.

Figure 1.- SPS delta velocity reserves assuming various transearth flight times.



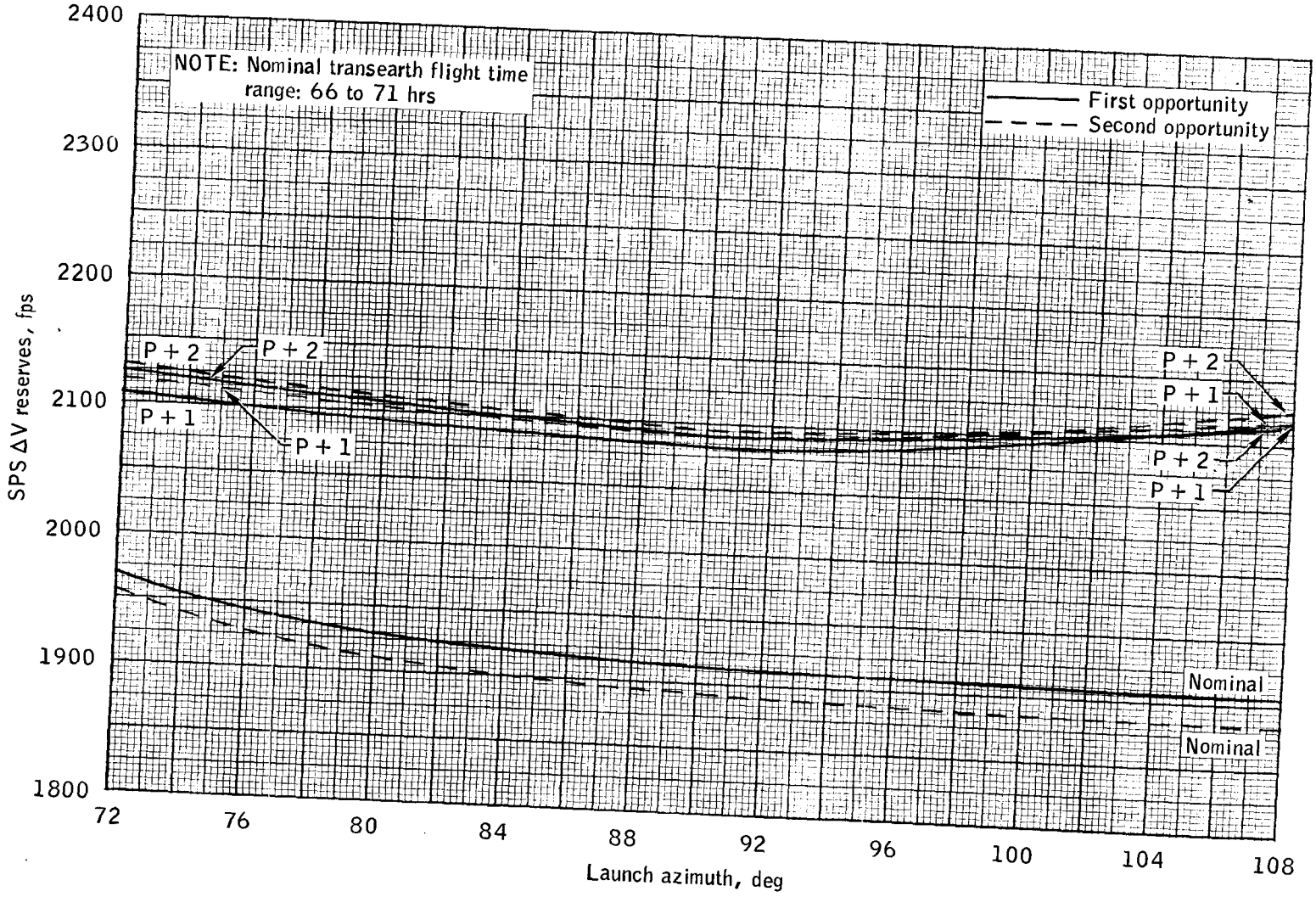
(b) May 20, 1969.

Figure 1.- Continued.

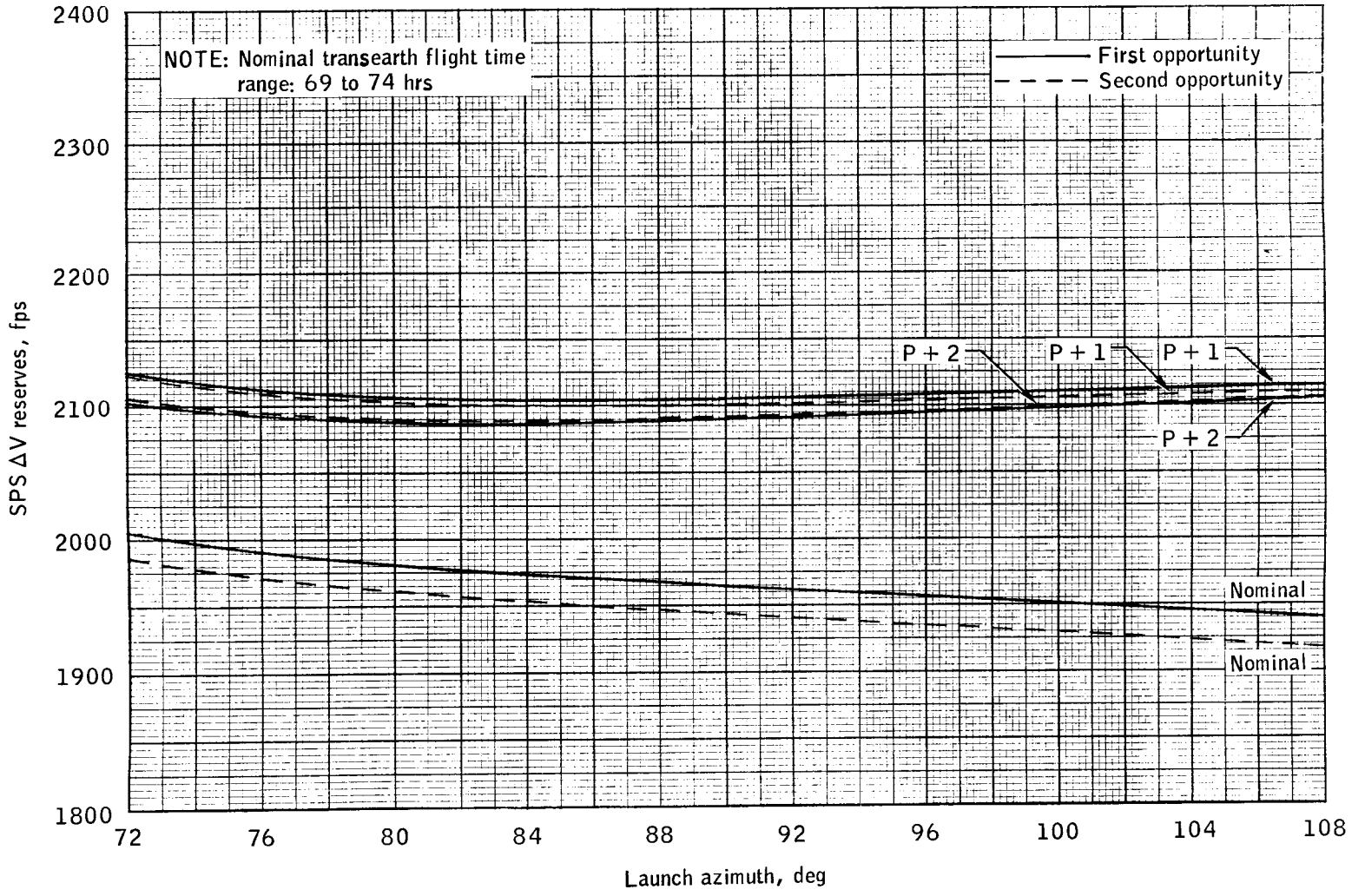


(c) May 23, 1969.

Figure 1.- Continued.

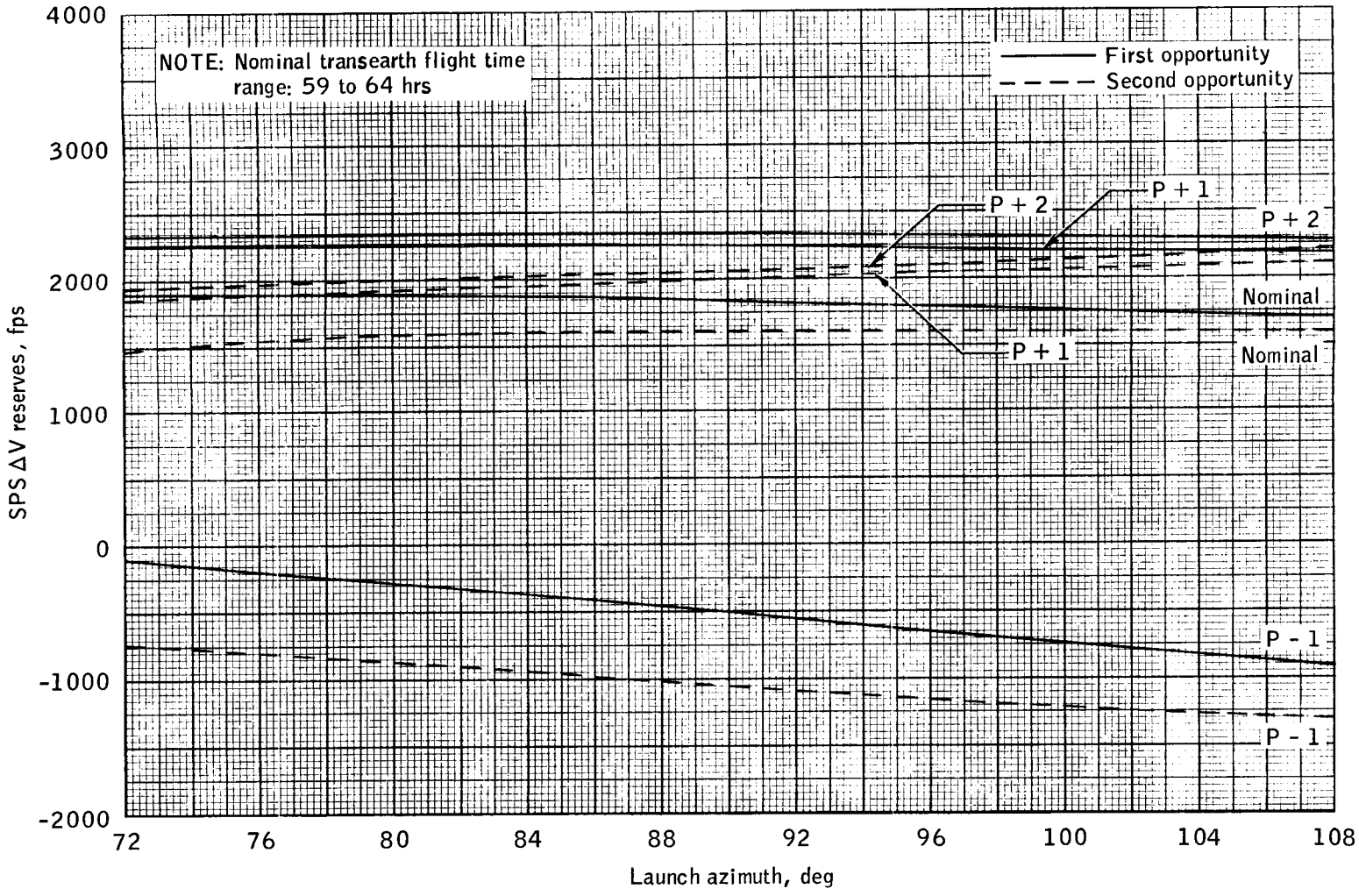

NOTE: Nominal transearth flight time range: 66 to 71 hrs
First opportunity
Second opportunity
P + 2
P + 1
Nominal
SPS ΔV reserves, fps
2400
2300
2200
2100
2000
1900
1800
72
76
80
84
88
92
96
100
104
108
Launch azimuth, deg

(d) May 24, 1969.



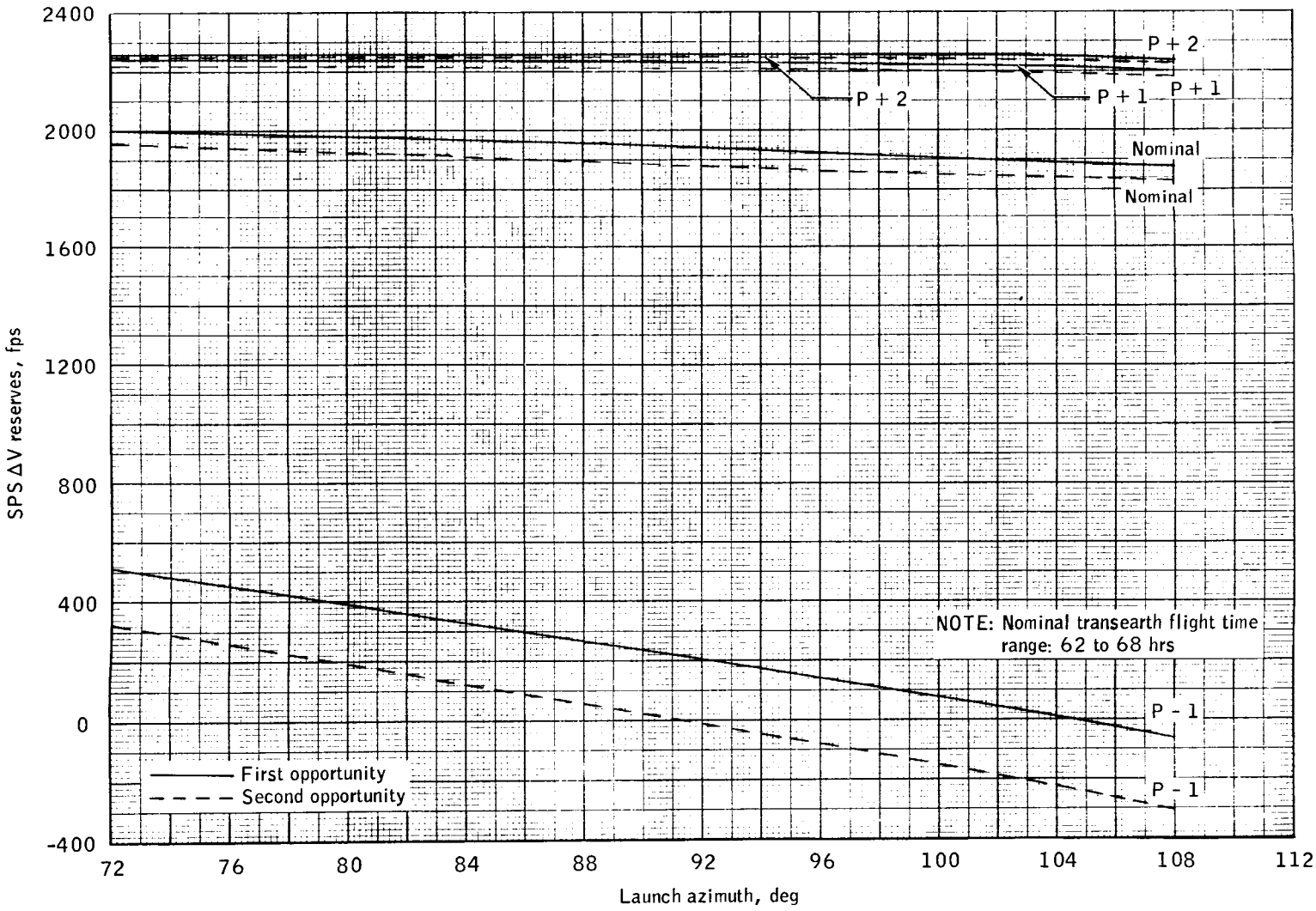
(e) May 25, 1969.

Figure 1.- Continued.



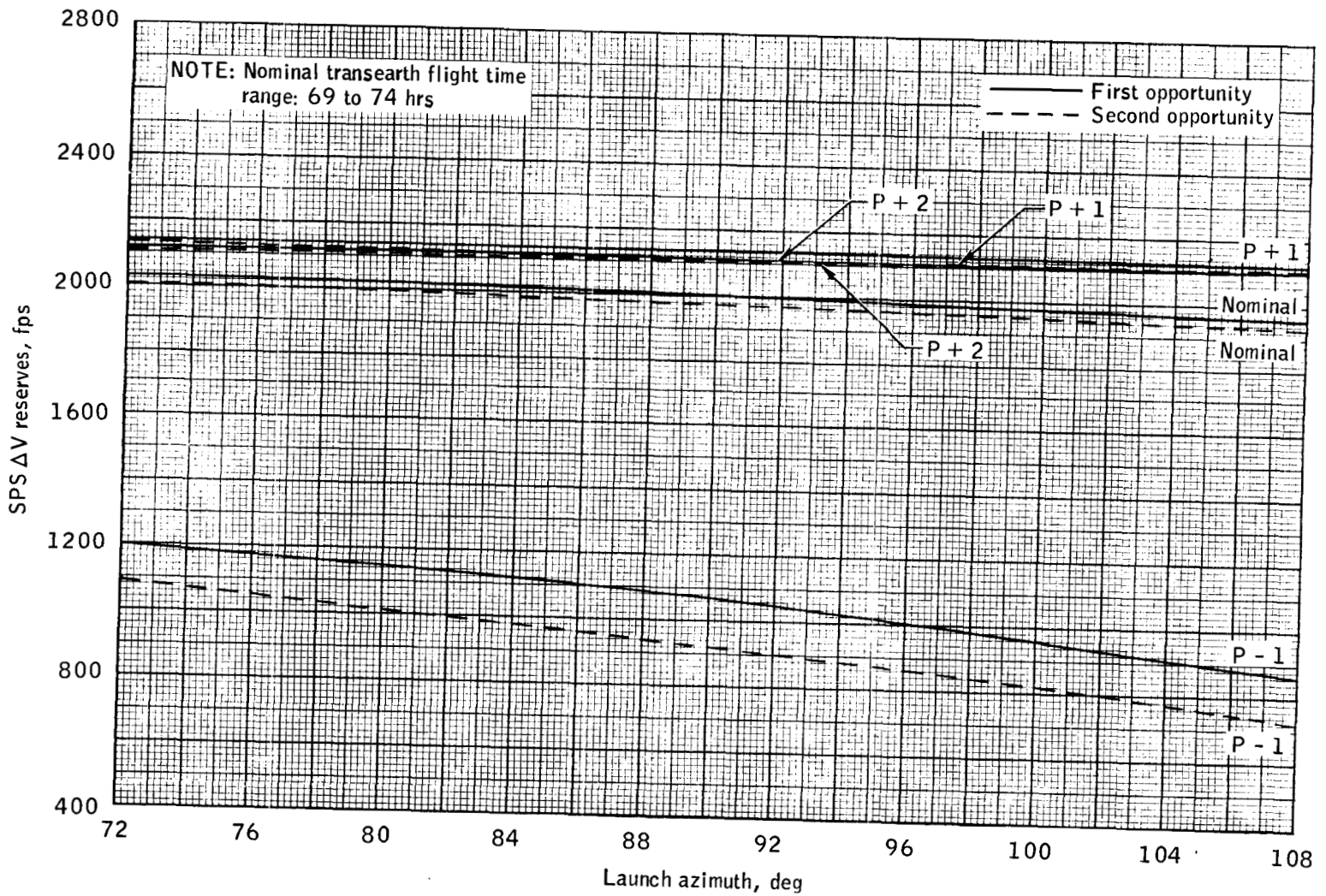
(f) June 17, 1969.

Figure 1.- Continued.



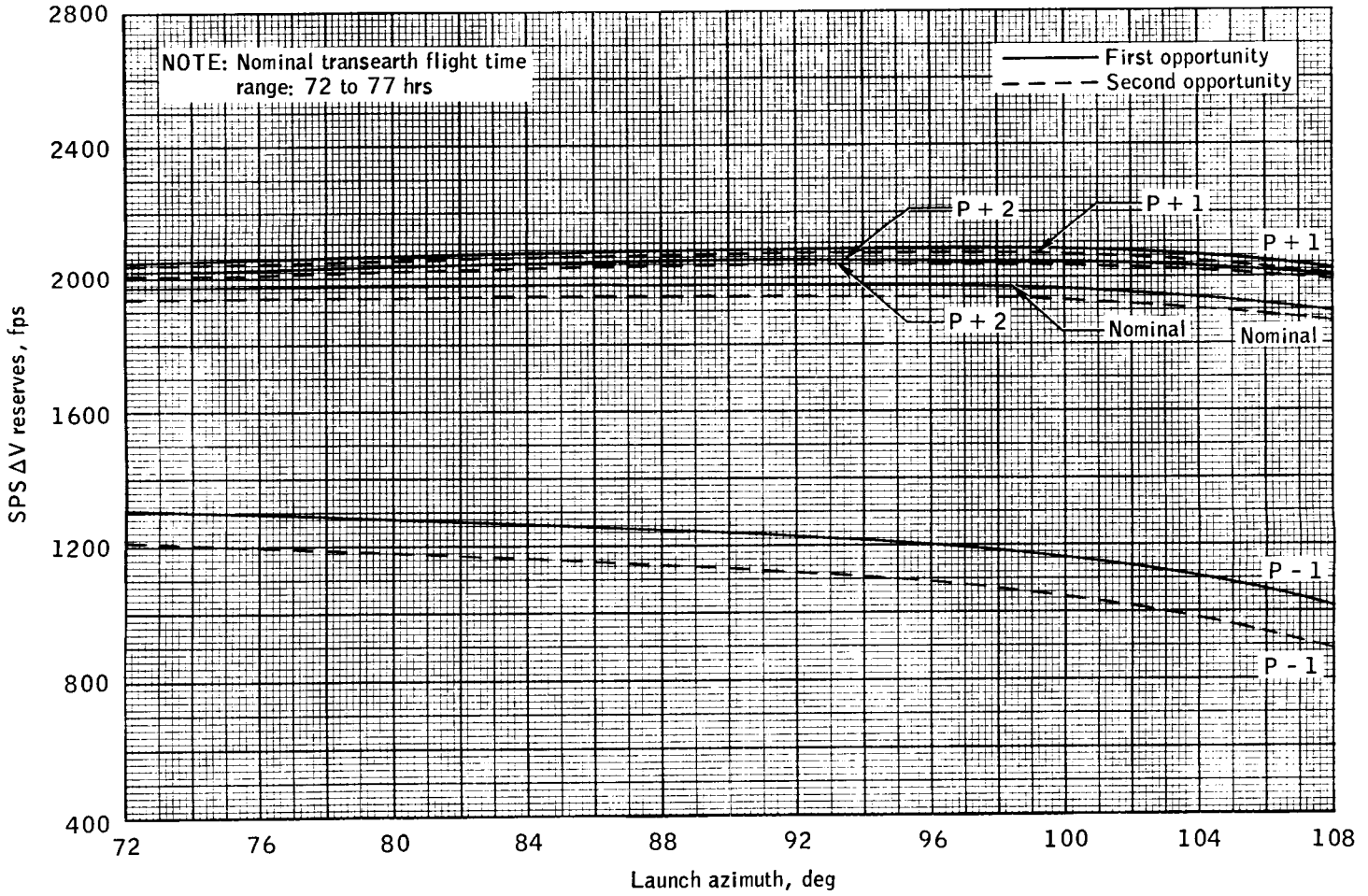
(g) June 19, 1969.

Figure 1.- Continued.



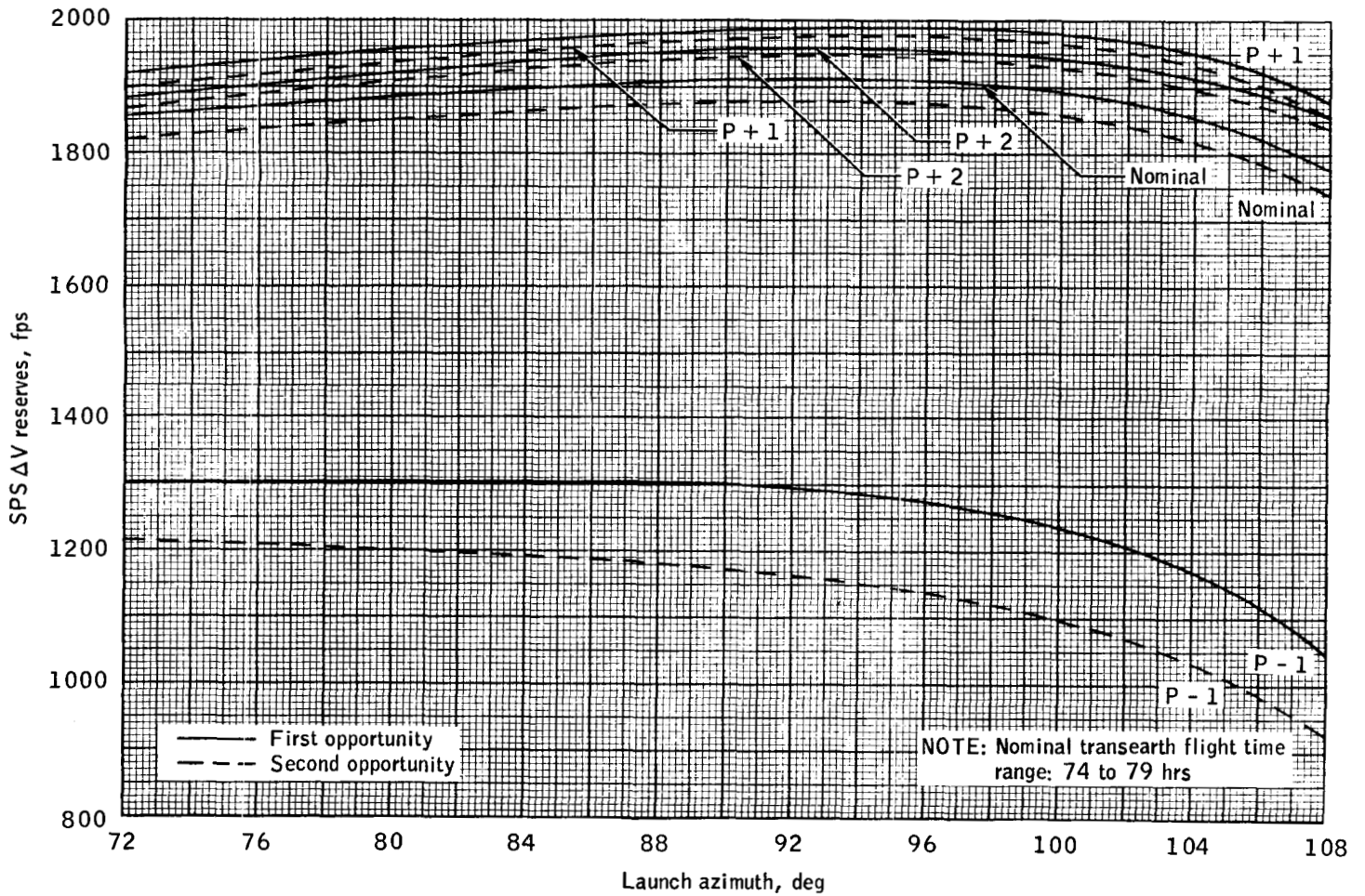
(h) June 22, 1969.

Figure 1.- Continued.



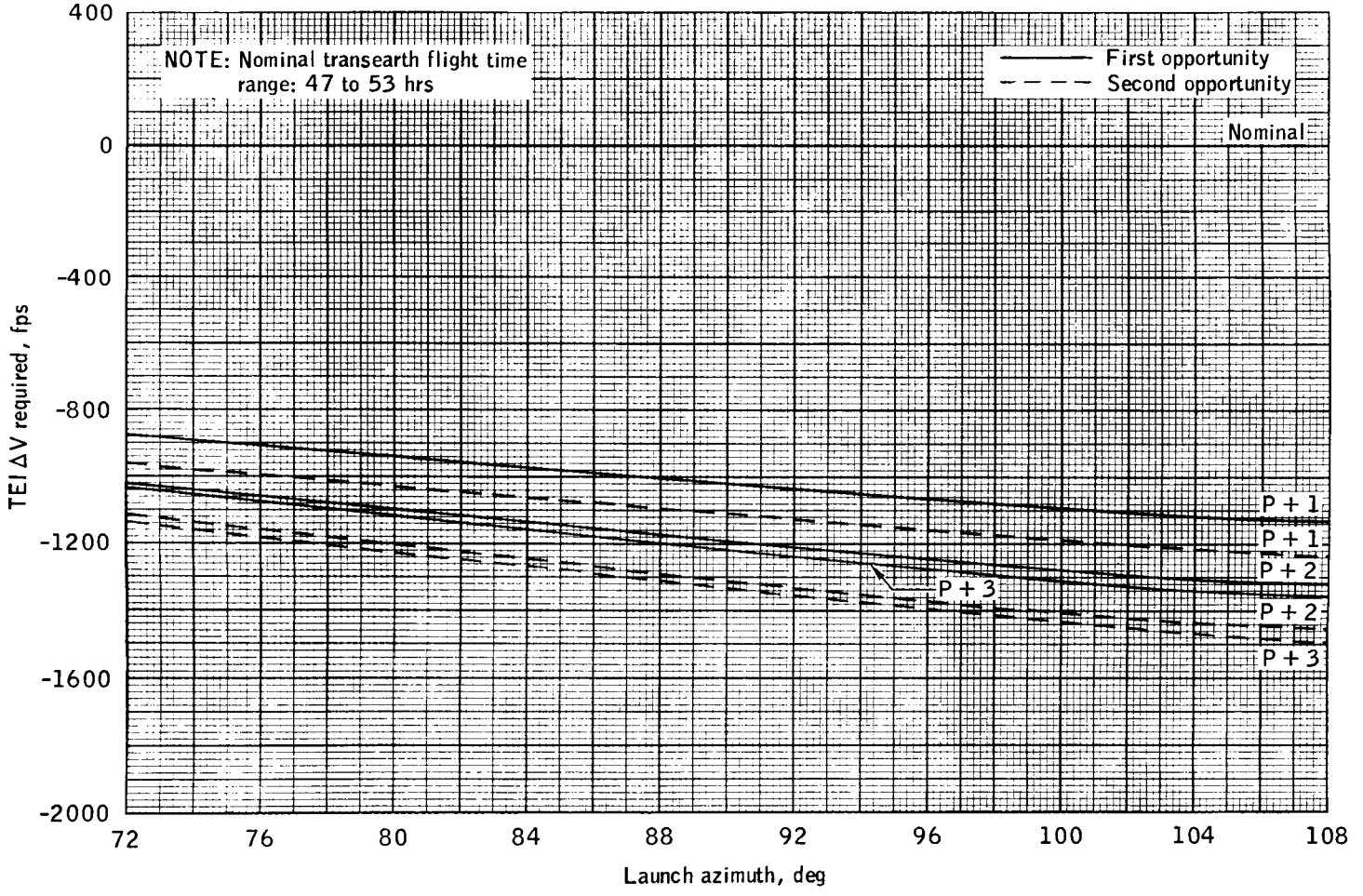
(i) June 23, 1969.

Figure 1.- Continued.



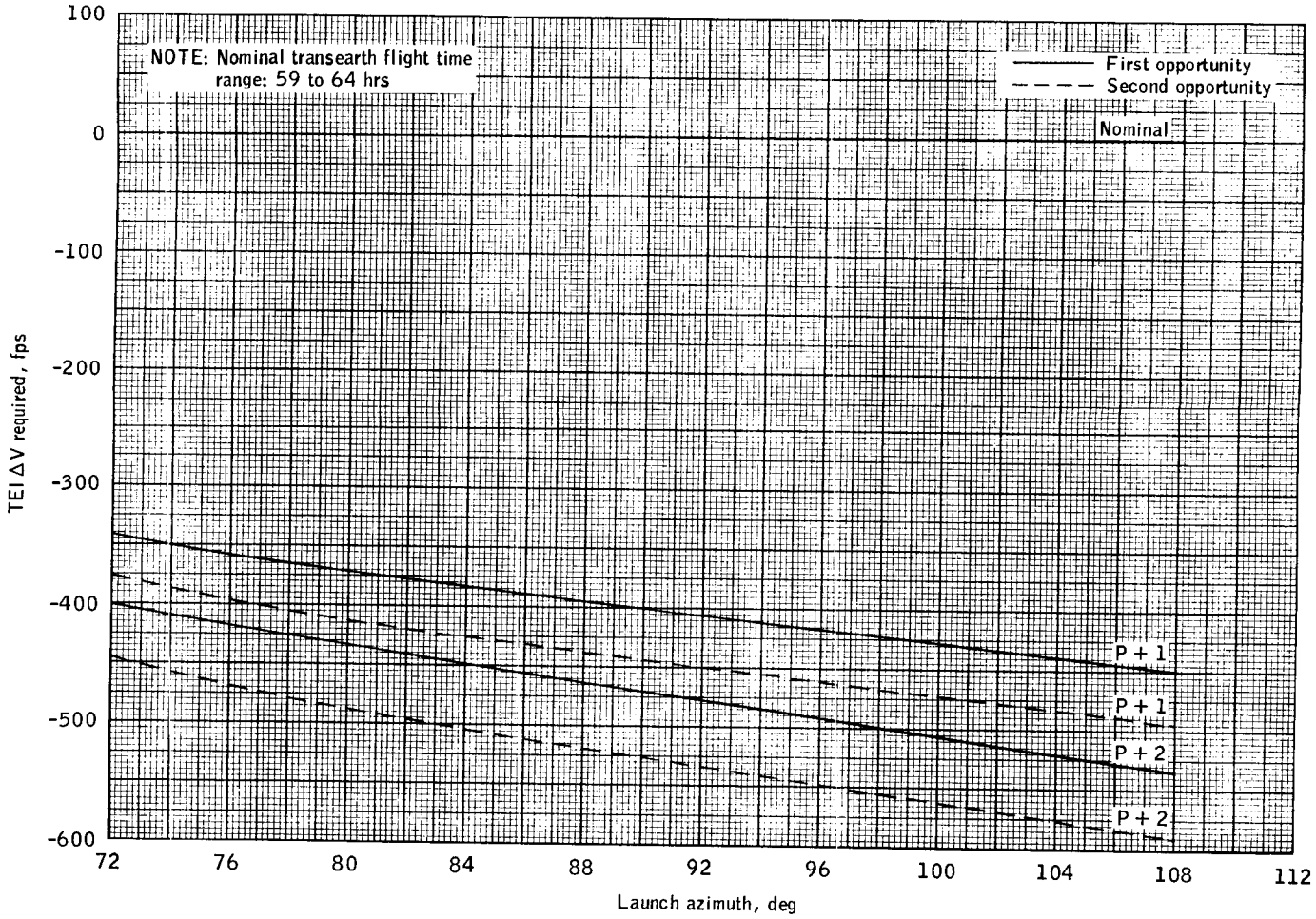
(j) June 24, 1969.

Figure 1.- Concluded.



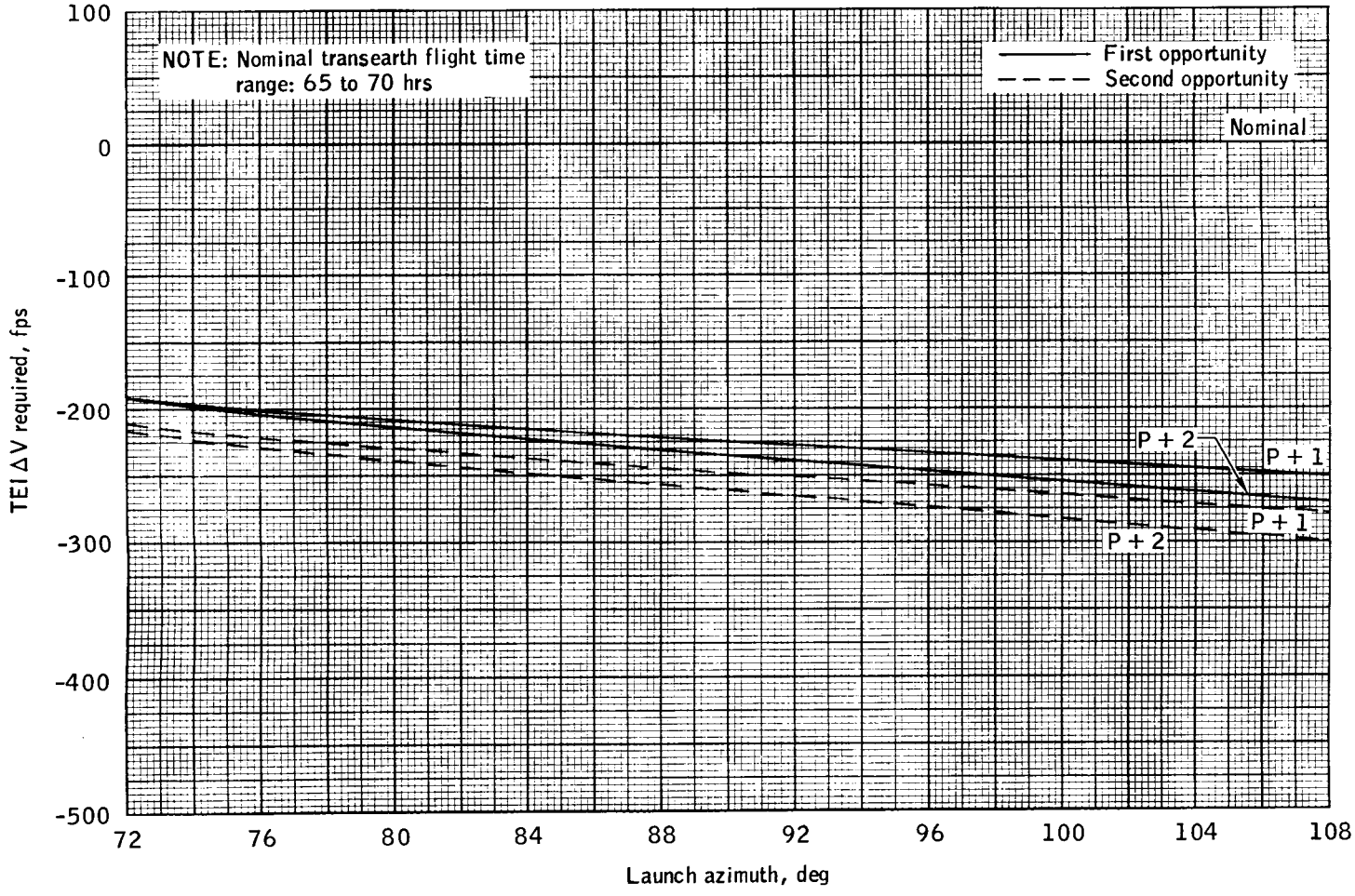
(a) May 18, 1969.

Figure 2.- TEI delta velocity above nominal required for various transearth flight times.



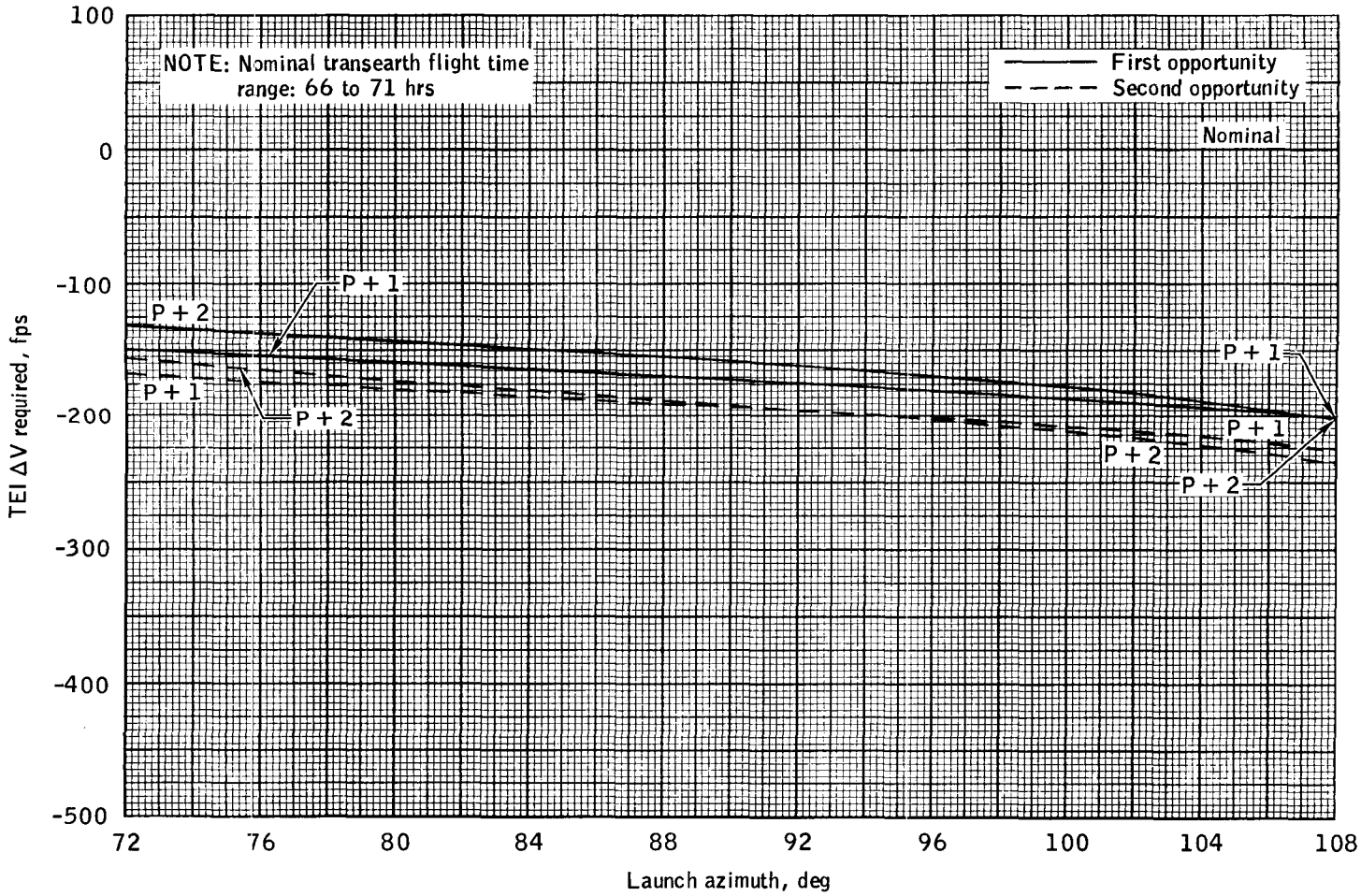
(b) May 20, 1969.

Figure 2.- Continued.



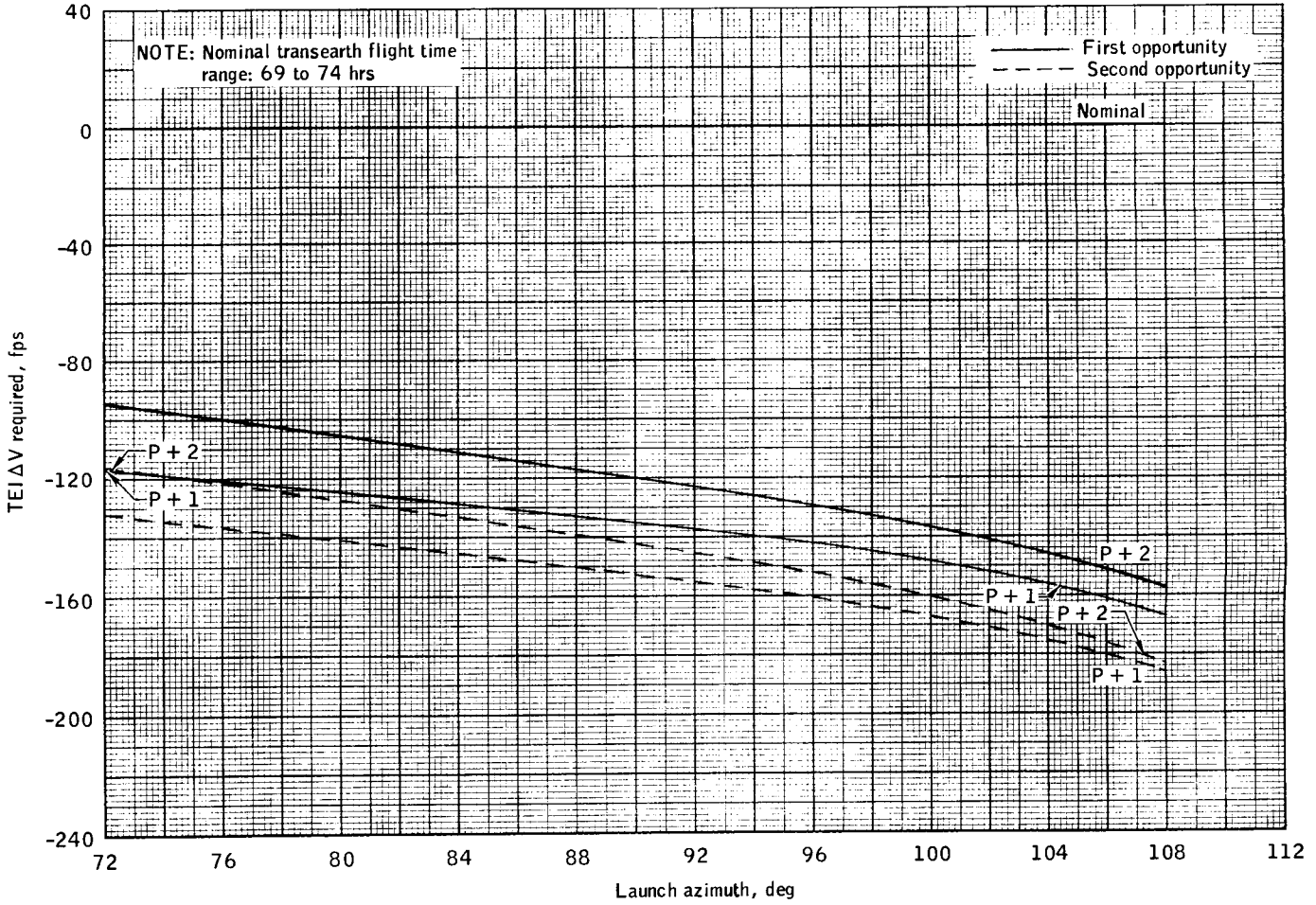
(c) May 23, 1969.

Figure 2.- Continued.



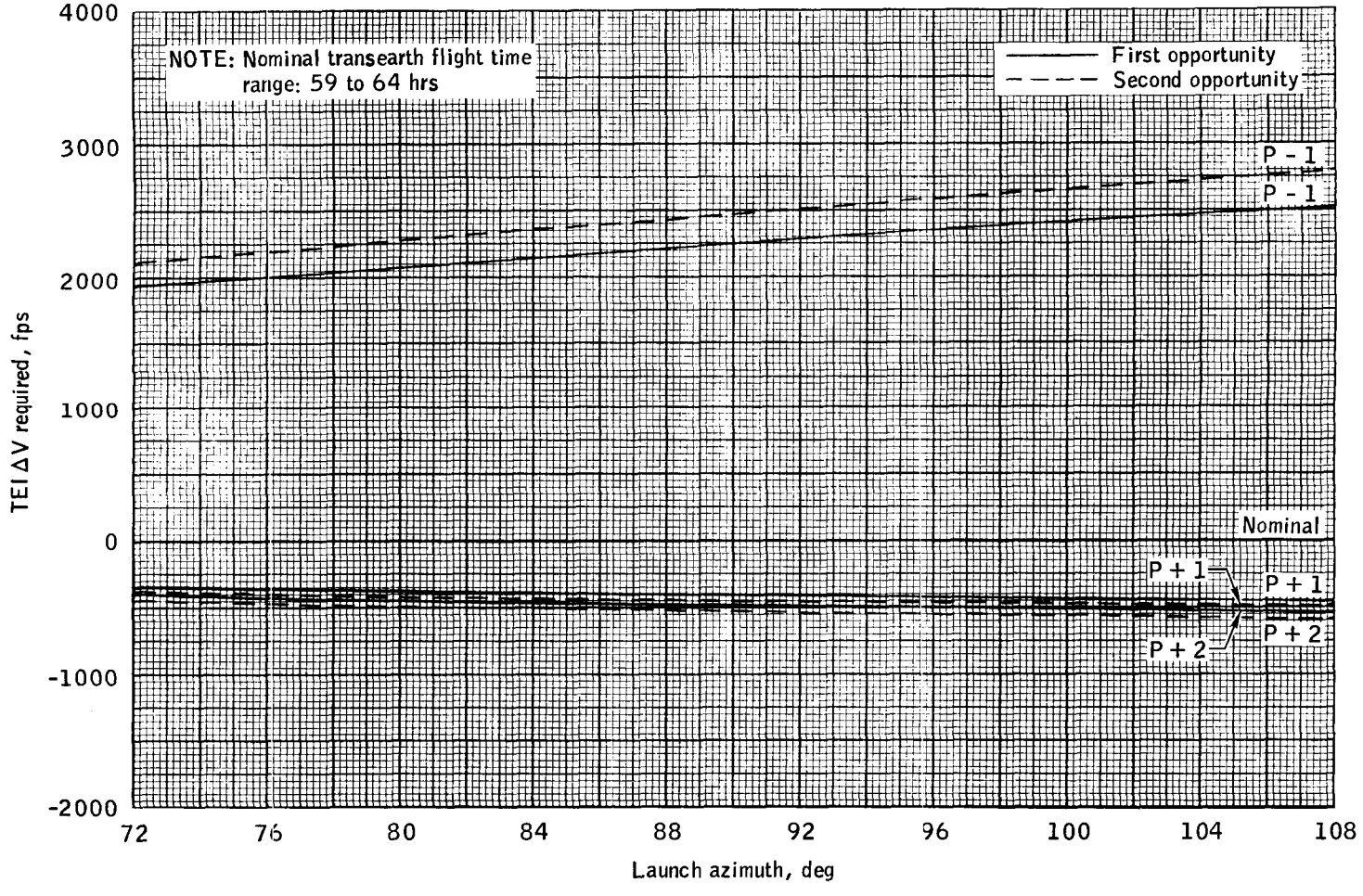
(d) May 24, 1969.

Figure 2.- Continued.



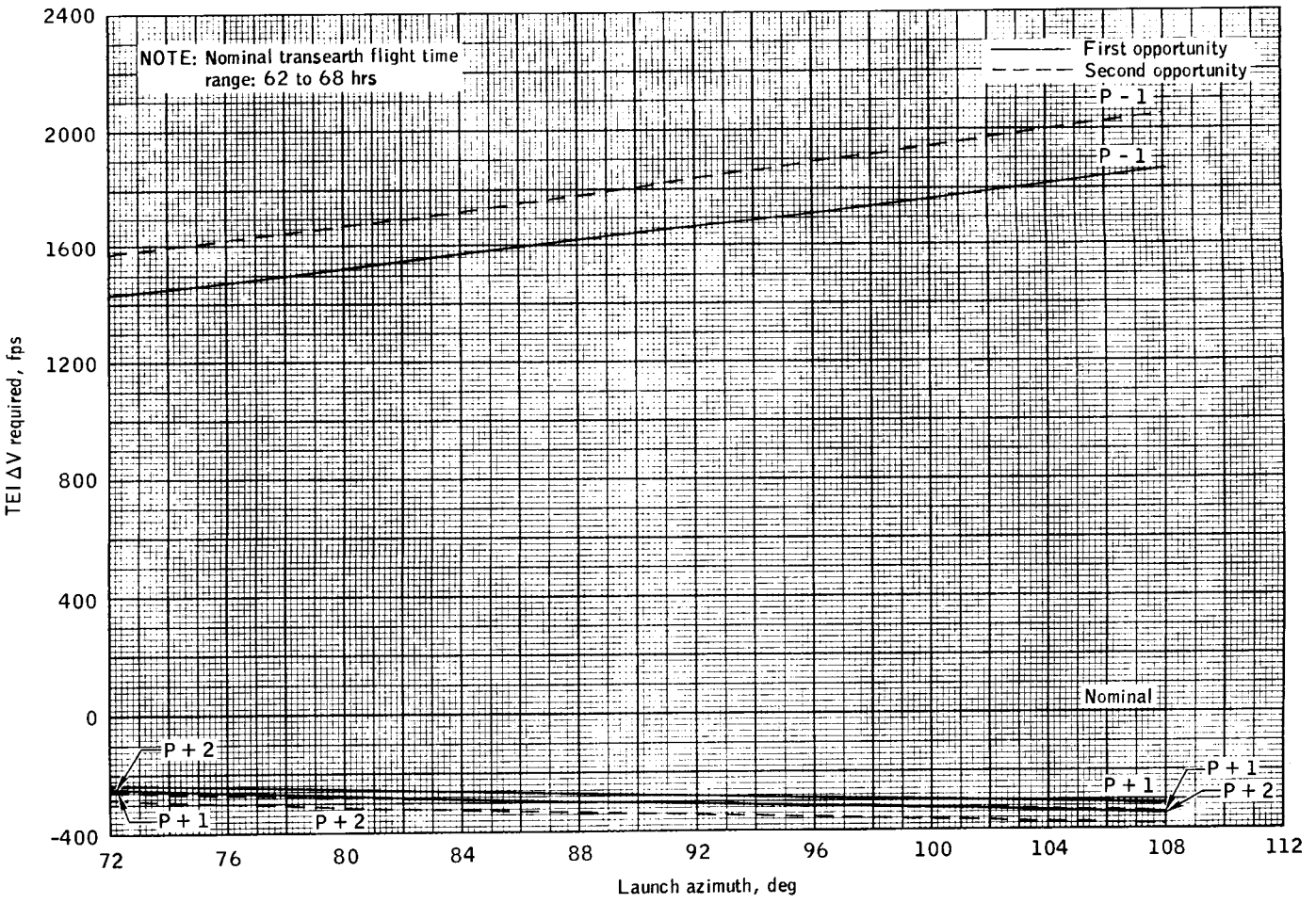
(e) May 25, 1969.

Figure 2.- Continued.



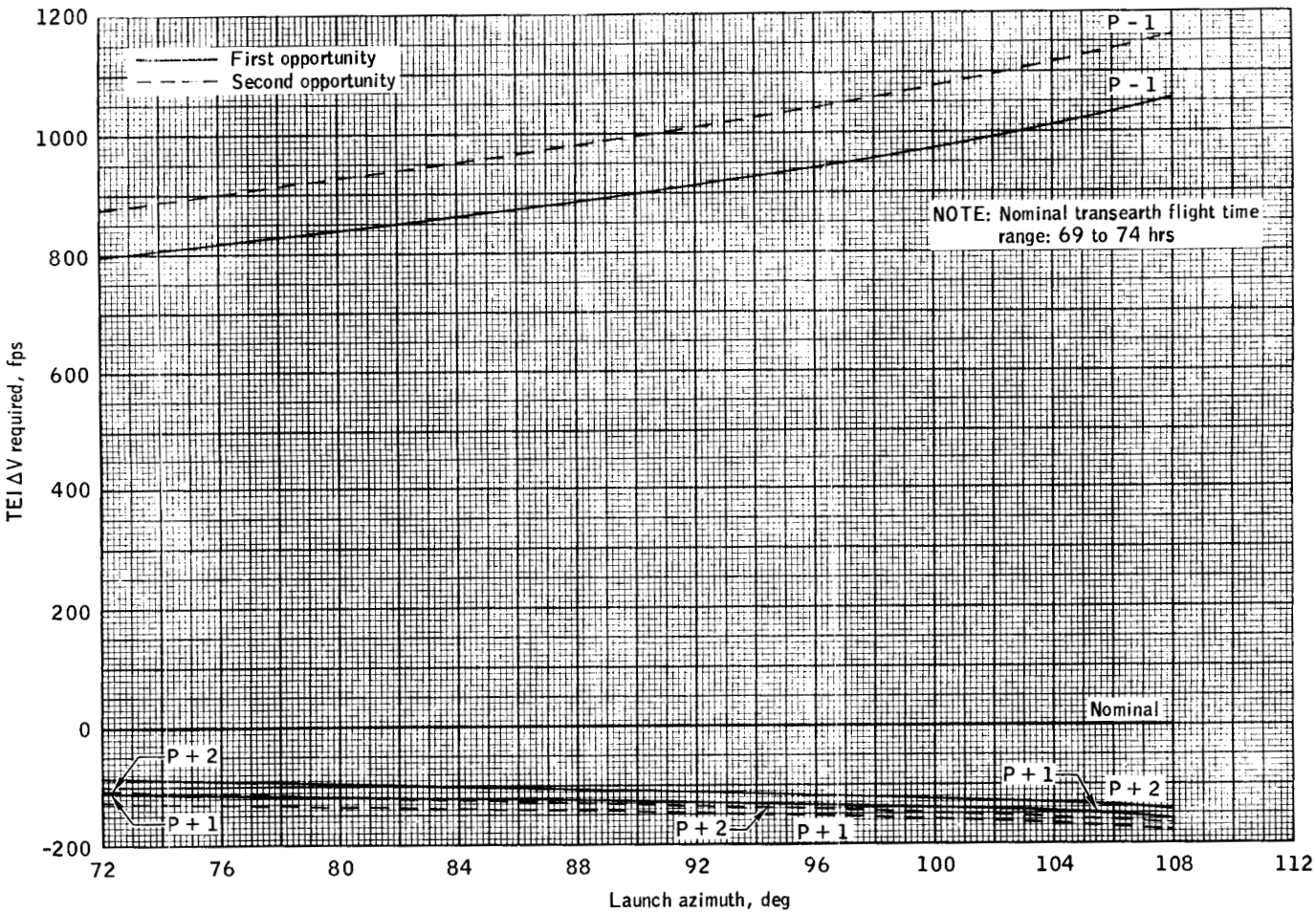
(f) June 17, 1969.

Figure 2.- Continued.



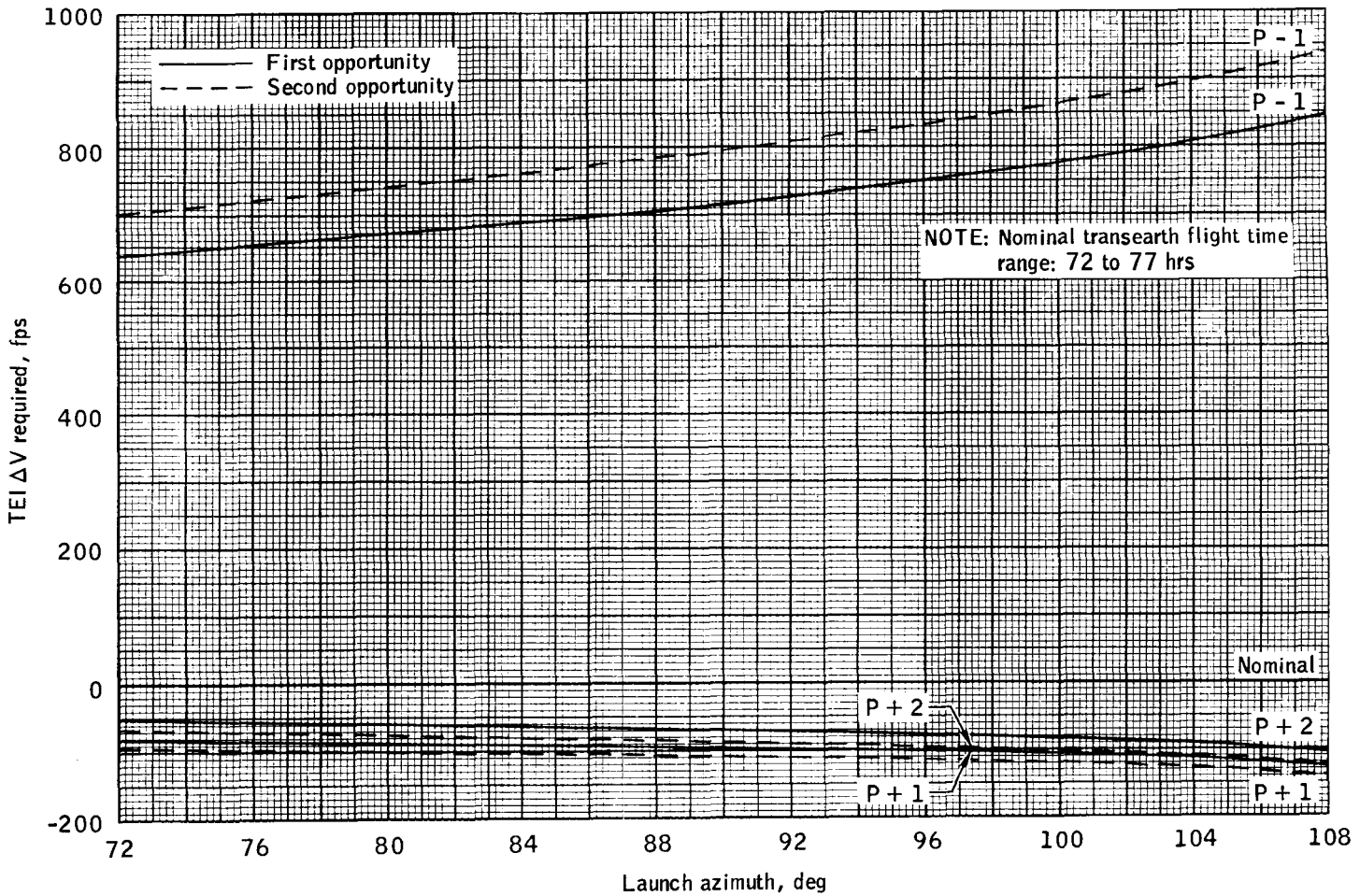
(g) June 19, 1969.

Figure 2.- Continued.



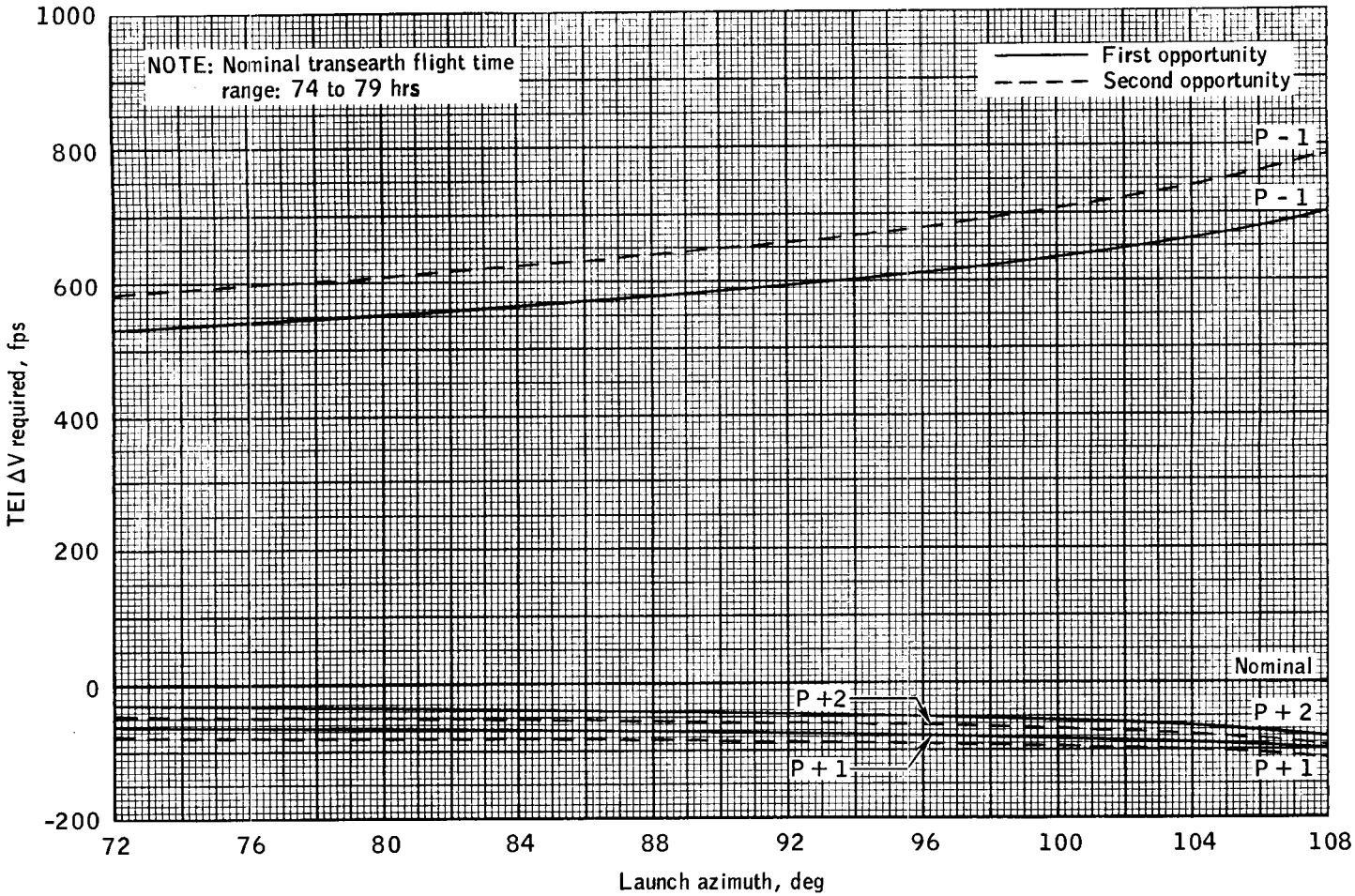
(h) June 22, 1969.

Figure 2.- Continued.



(i) June 23, 1969.

Figure 2.- Continued.



(j) June 24, 1969.

Figure 2.- Concluded.

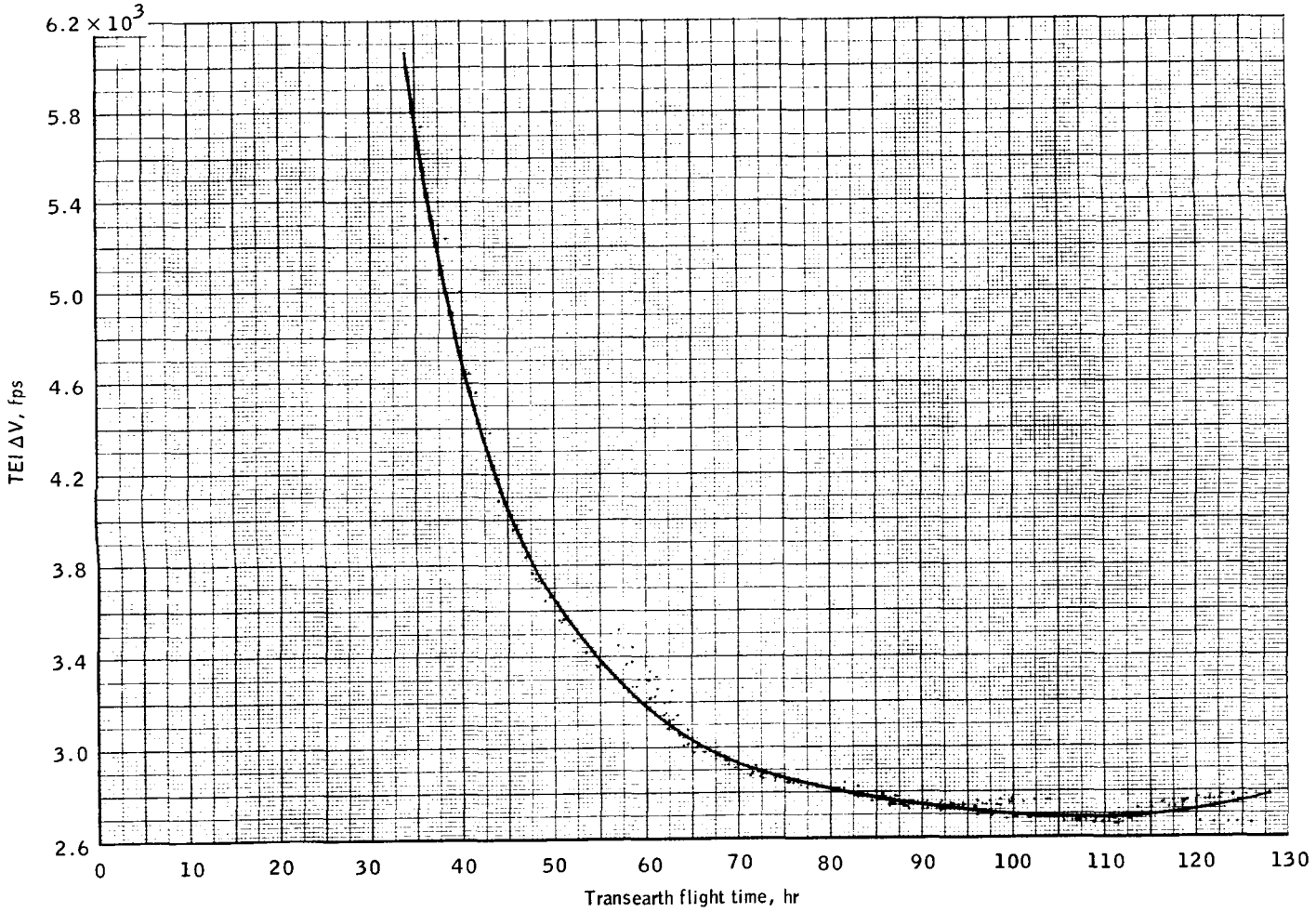


Figure 3.- TEI ΔV requirements as a function of transearth flight time for the Apollo 10 launch window.