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OPTIMUM SOLAR ELECTRIC INTERPLANETARY MISSION OPPORTUNITIES FROM 1975 TO 1990

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SUMMARY

A collection of optimum trajectory and spacecraft data is presented for unmanned interplanetary missions from 1975 to 1990 using solar electric propulsion. Data are presented for one-way flyby and orbiter missions from Earth to Venus, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. The solar system model assumes planetary ephemerides which very closely approximate the true motion of the planets. Direct and indirect flight profiles are investigated. Data are presented for two representative flight times for each mission. The launch vehicle is the Titan III B (core)/Centaur, and a constant jet exhaust speed solar electric propulsion system having a specific mass of 30 kg/kw is completely optimized in terms of power level and jet exhaust speed to yield maximum net spacecraft mass. The hyperbolic excess speeds at departure and arrival and the launch date are optimized for each mission. For orbiter missions, a chemical retro stage is used to brake the spacecraft into a highly eccentric capture orbit about the target planet.

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TABLE OF CONTENTS

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INTRODUCTION

This report presents solar electric trajectory and performance data for one-way direct and indirect flyby and orbiter missions from Earth to Venus, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto in a format which displays the individual optimum launch opportunities (for the flight times considered) from 1975 to 1990. Closely related solar electric mission data have been presented previously in [1, 2, 3]. The data presented in [1] were generated under the assumption of circular, coplanar planetary orbits. The data presented in this report extend the results of [1] to the real solar system for missions using the Titan III B (core)/Centaur launch vehicle.

The data were generated by the HILTOP computer program [4], which generates trajectories by straightforward and accurate numerical integration. The HILTOP output was processed by the ADMAP computer program [5] to generate the graphical presentation of this report.

BASIC ASSUMPTIONS

The basic assumptions involved in the generation of these data are identical to those used in [3]. Some of the more pertinent basic assumptions are repeated here for the sake of completeness.

All missions investigated involve three-dimensional trajectories, and the simulated motion of the planets very closely matches their true motion. The thrust vector is optimally oriented along each trajectory, and the solar array is held normal to the sun-spacecraft line at solar distances greater than 0.67 AU and is tilted to maintain maximum power for solar distances less than that distance. The solar electric propulsion (SEP) spacecraft model is defined in [1]. The propulsion system is assumed to operate at constant jet exhaust speed c with a thrust subsystem efficiency given by $\eta = bc^2/(c^2 + d^2)$, where $b = 0.76$ and $d = 13.0$. The efficiency and solar power law are discussed in greater detail in [3].

The SEP powerplant specific mass α is 30 kg/kw and tankage factor is 0.03. The spacecraft model does not contain solar cell degradation due to radiation, heating, or other effects, and this deficiency is assumed to be accounted for in the above value of α. For orbiter missions, a chemical retro stage having an inert factor $k_r = 0.11111$ performs an implicitly-optimal impulsive braking maneuver at the periapse of the capture orbit at a distance of 2 planet radii from the center of the target planet. The resulting capture orbit has an apoapse distance of 38 planet radii from the center of the target planet. For orbiter missions to Jupiter, Saturn, Uranus, Neptune, and Pluto, the SEP powerplant and tankage are jettisoned prior to orbit insertion, and for orbiter missions to Venus and Mars, these SEP components are carried into the capture orbit. The planetary gravitational constants and radii (except for Pluto) are given in [1]. Pluto's gravitational constant is taken to be 3.317819×10^5 km^3/sec^2 and Pluto's radius is assumed to be 6349 km.

The propulsion system jet exhaust speed and reference power, the hyperbolic excess speeds at departure and arrival, and the launch date are optimized for each mission to produce maximum net spacecraft mass. The propulsion time is optimized for all missions except Mode B Pluto orbiters, in which case the propulsion system was required to thrust throughout each mission in order to circumvent numerical difficulties with the computer program. This deviation from optimality for Mode B Pluto orbiters causes negligible net spacecraft mass penalties, amounting to about one tenth of one percent, and results in very small changes in other mission and spacecraft parameters.

The Mode A and Mode B missions correspond respectively to approximately $\frac{1}{2}$ and $1\frac{1}{2}$ revolutions around the sun, as defined in [1].

PRESENTATION FORMAT

Order of Presentation

The data are ordered according to ascending target planet distance from the sun. For each target planet, flyby missions precede orbiter missions; for each type of mission, Mode A precedes Mode B; and for each Mode, the smaller of the two flight times considered precedes the larger. For each flight time, five figures are presented. The first figure gives an over-all view of mission opportunities from 1975 to 1990, and the following four figures re-present the same data using an expanded time-scale so that the launch opportunity may be resolved to a specific calendar week.

Basic Layout

Following the basic format established in [1, 2, 3], each figure consists of four graphs, with two graphs situated on each of two opposing pages, so that the pertinent information corresponding to a given set of missions is available at a glance.

The first graph (upper left) presents the mass breakdown of the vehicle, in kilograms. This consists of (A) the net spacecraft mass, more commonly known as payload, (B) the initial spacecraft mass, which is equivalent to the payload of the launch vehicle, (C) the propulsion system mass, (D) the low-thrust propellant mass, and (E) the propellant mass of the retro-stage, which is present only for orbiter missions.

The second graph (lower left) presents the parameters which characterize the solar-electric propulsion system, and also the maximum power encountered along each trajectory and the total power-on time of the solar-electric propulsion system. These consist of (F) the propulsion system reference power (power at one astronomical unit from the sun), in kilowatts, (G) the maximum power which is required of the solar-electric propulsion system as the spacecraft travels along its trajectory, in kilowatts, (H) the solar-electric propulsion system jet exhaust speed, in meters per second, (I) the spacecraft thrust at one astronomical unit from the sun, in newtons, and (J) the total low-thrust propulsion time, in days.

The third graph (upper right) presents the basic parameters which characterize an interplanetary trajectory. These consist of (K) the maximum distance which the spacecraft recedes from the sun, in astronomical units, (L) the closest approach which the spacecraft makes to the sun, also in AU, (M) the total angle through which the spacecraft travels around the sun from the Earth to its destination, in degrees, (N) the hyperbolic excess speed of the spacecraft at Earth departure, in meters per second, (O) the hyperbolic excess speed of the spacecraft at the destination planet, in meters per second, and (P) the incremental speed performed by the retro-stage at the periapse of the capture orbit, in meters per second, and which is present only for orbiter missions.

The fourth graph (lower right) presents the initial Lagrange multipliers which are required to start a given optimum trajectory. Their magnitudes correspond to an initial mass-ratio Lagrange multiplier which is normalized to unity. For the performance index of maximum net spacecraft mass, the primer has units kilogram-tau/AU and its derivative has units kilogram/AU, where tau is the normalizing unit of time equal to approximately 58.13244 days. These two vectors are expressed in a coordinate system such that the x-axis points toward the vernal equinox, the z-axis lies along the Earth's orbital angular momentum vector, and the y-axis completes the right-handed system.

Standardization of Scales

Due to the wide range of magnitudes among the many parameters which are plotted, it was deemed necessary to choose standard scales for the ordinates of the four graphs. This in turn requires the presence of scaling factors for each plotted quantity (assumed to be unity when not present), which appear, following a slash (/), with the letter-code above each figure. These scaling factors are very easy to interpret; for example, if a quantity has an apparent value of 4 and a scaling factor of 1000, then its true value is 4 times 1000, or 4000.

Interpretation of Code Letter Positions

Since the launch date is optimized for each mission, the data presented represent the optimum points of the opportunities, or mission windows, for the particular fixed value of flight time considered. The data are therefore presented by plotting the respective code-letters in a column above the optimum launch date. The actual value of each plotted quantity is represented by the center of its code-letter. Often code-letters will overlap, but these can usually be discerned by the process of elimination. Since the reference power (F) and maximum power (G) often have the same value, the code letter G is displaced to the right.

REMARKS

The Titan III B (core)/Centaur launch vehicle was chosen for this study because it leads to optimum SEP reference power levels which are generally less than 20 kw, representing spacecraft which are likely to be considered in the 1975 to 1990 time period. Only two flight times are considered for each type of mission presented here. Since the launch vehicle assumed here and the Titan III X/Centaur have similar performance characteristics, the variations of the mission parameters as functions of flight time may be found in the Titan III X/Centaur data which are presented in [1]. The approximate variations of the mission parameters as functions of launch vehicle may also be found in [1].

Although the data presented here were generated for a specific launch vehicle and SEP parameters, their general form is felt to be representative of the general trends which most SEP missions will follow regardless of the launch vehicle and SEP parameters assumed. The most obvious trend to be noted is the periodic nature of the data as functions of mission opportunity. The Lagrange multipliers generally have the same period as the Earth-target synodic period because the primer and its derivative are expressed in Cartesian coordinates. The periodicity of other parameters is attributed to the fact that the Earth's and target planets' orbits are noncircular and noncoplanar, resulting in crudely-periodic variations in the transfer energy requirements, with periods approximately equal to the respective Earth-target synodic periods.

Perhaps the most important aspects of this work are the determination of net spacecraft mass sensitivities to mission opportunities and the identification of a broad range of optimum SEP launch opportunities, representing the best time to launch within a given mission window. No attempt is made here to draw conclusions from the data, the basic purpose of this work and [1, 2, 3] being merely the presentation of data. It is a major task to generate basic conclusions with regard to SEP spacecraft design, mission planning, and launch pad availability considerations from this report and other published works, and such is beyond the scope of this study.

REFERENCES

[1] J. L. Horsewood and F. I. Mann, "Optimum Solar Electric Interplanetary Trajectory and Performance Data," NASA CR 1524, April 1970.

[2] J. L. Horsewood and F. I. Mann, "Solar Electric Interplanetary Trajectory and Performance Data for Sub-Optimal Powered Spacecraft," NASA CR 112840, April 1970.

[3] J. L. Horsewood, F. I. Mann and P. F. Flanagan, "Solar Electric Performance Data for Extra-Ecliptic and Solar Probes and Ceres, D'Arrest, and Encke Rendezvous Missions," NASA CR 118312, December 1970.

[4] J. L. Horsewood, P. F. Flanagan, and F. I. Mann, "HILTOP: Heliocentric Interplanetary Low Thrust Trajectory Optimization Program," Analytical Mechanics Associates, Inc., Report No. 71-38, November 1971.

[5] F. I. Mann, "ADMAP (Automatic Data Manipulation Program) Computer Program Utilization Report," Analytical Mechanics Associates, Inc., Report No. 71-1, January 1971.

NUMERICAL RESULTS

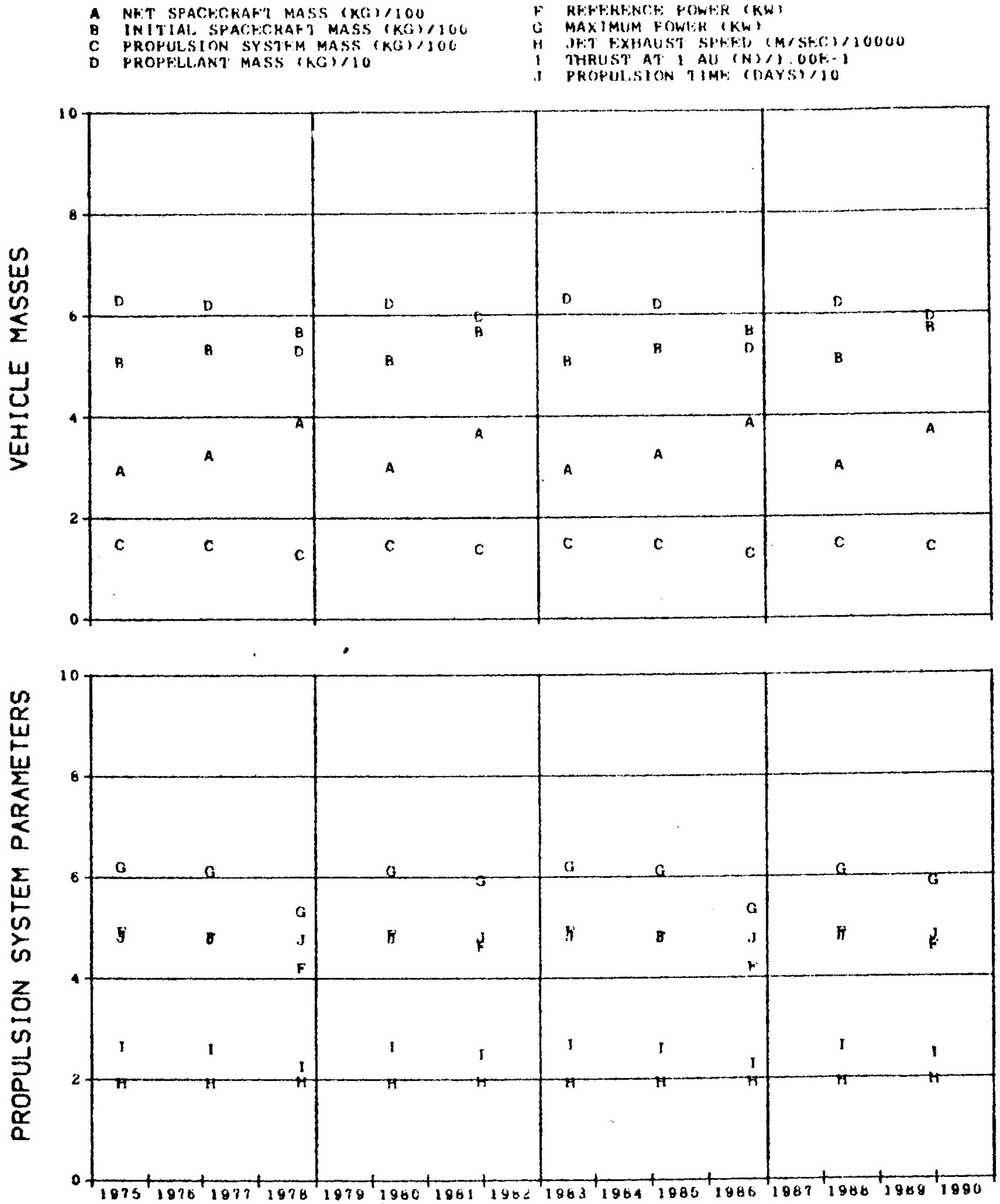
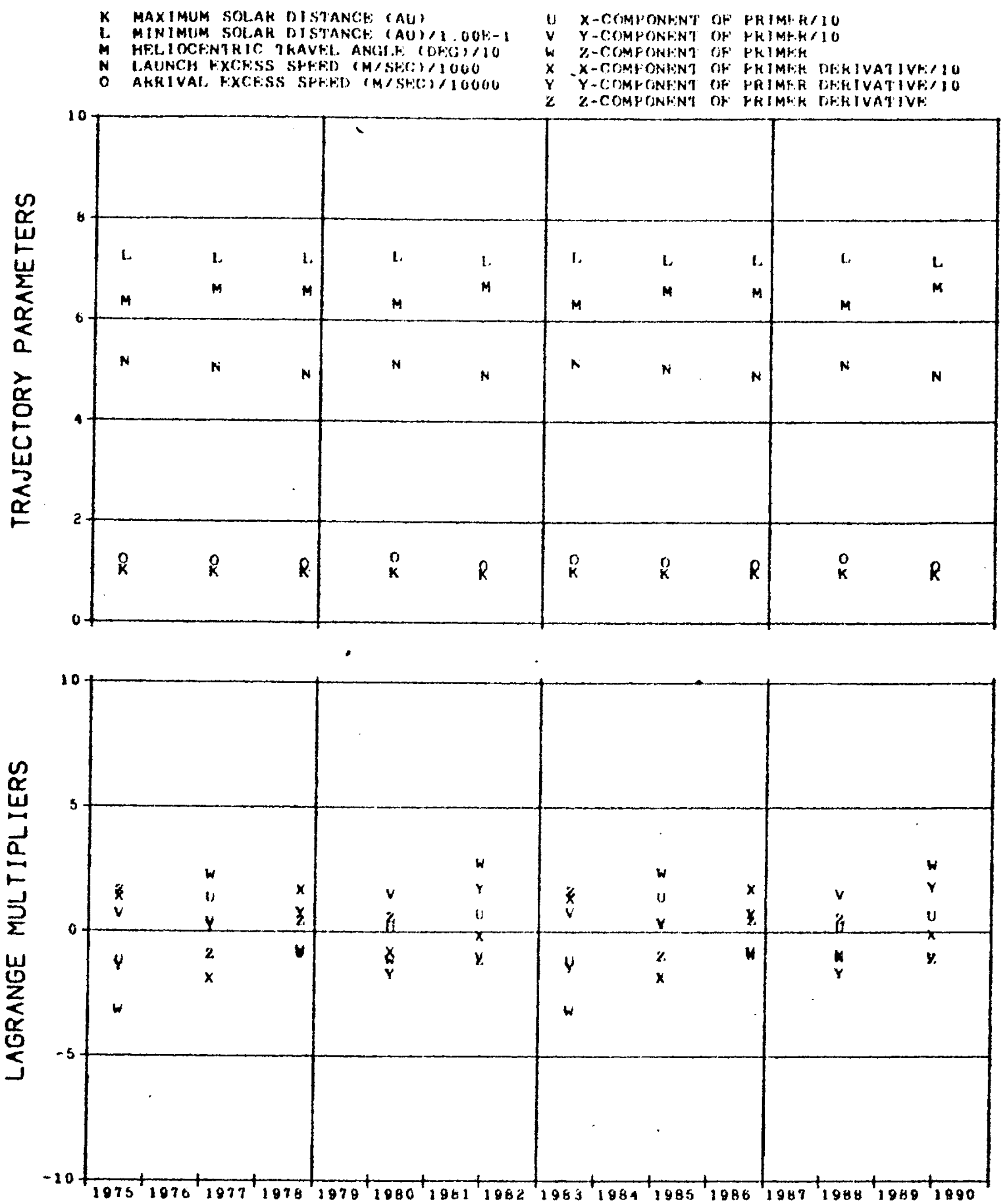


FIG. 1. VENUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 60 DAYS

XXXX 004



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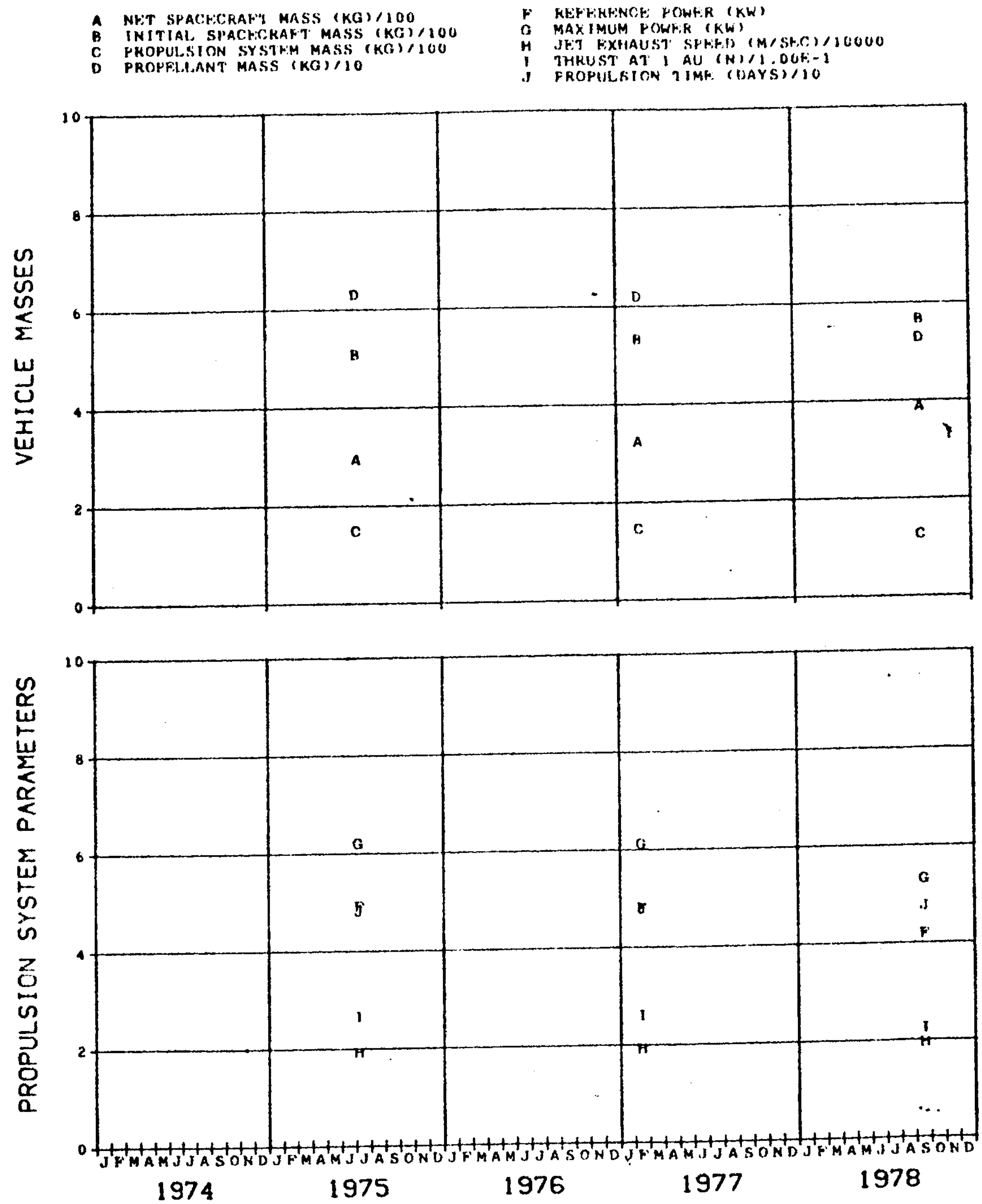

FIG. 1A. VENUS MODE A FLYBY OPPORTUNITIES
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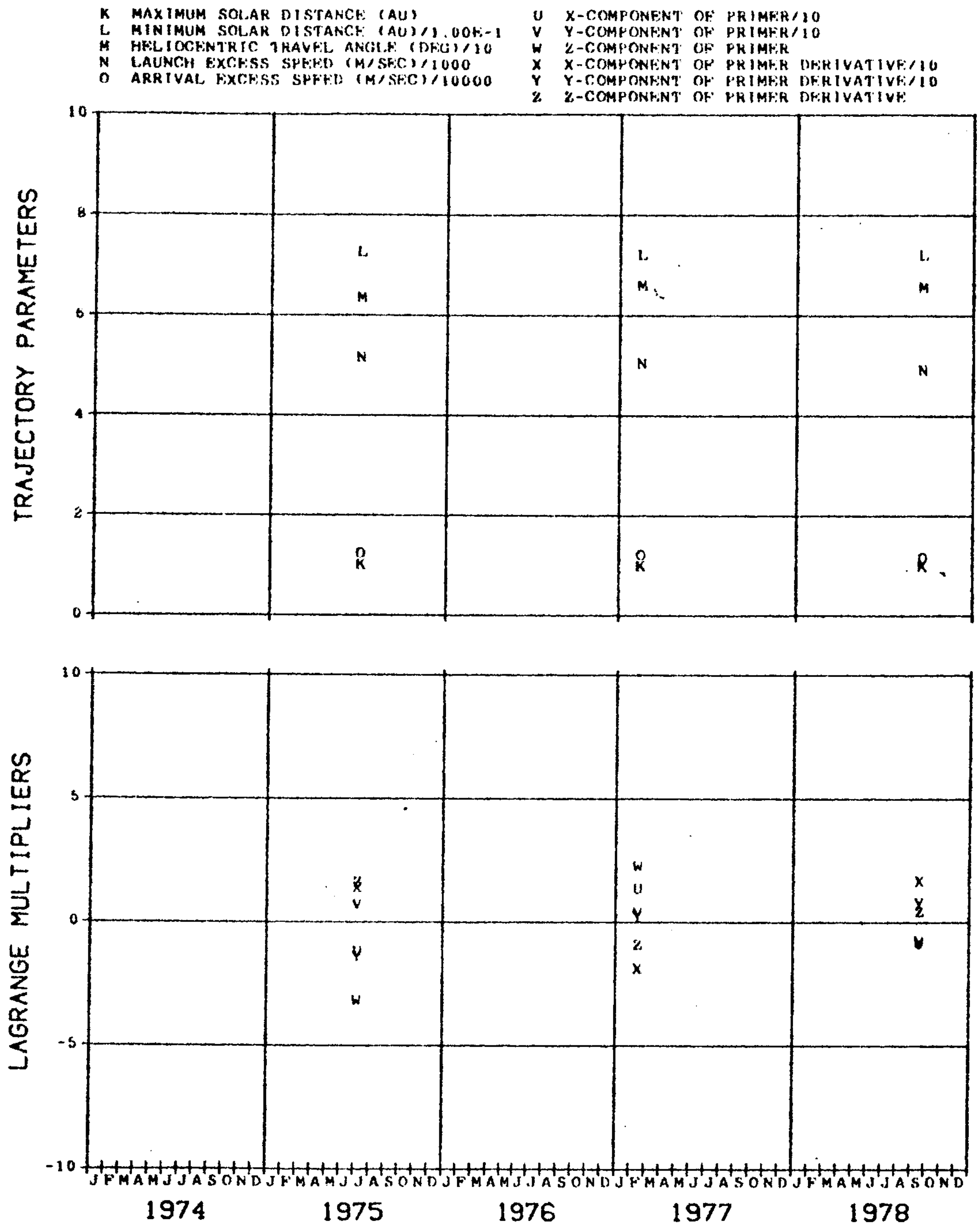

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XXXX 007

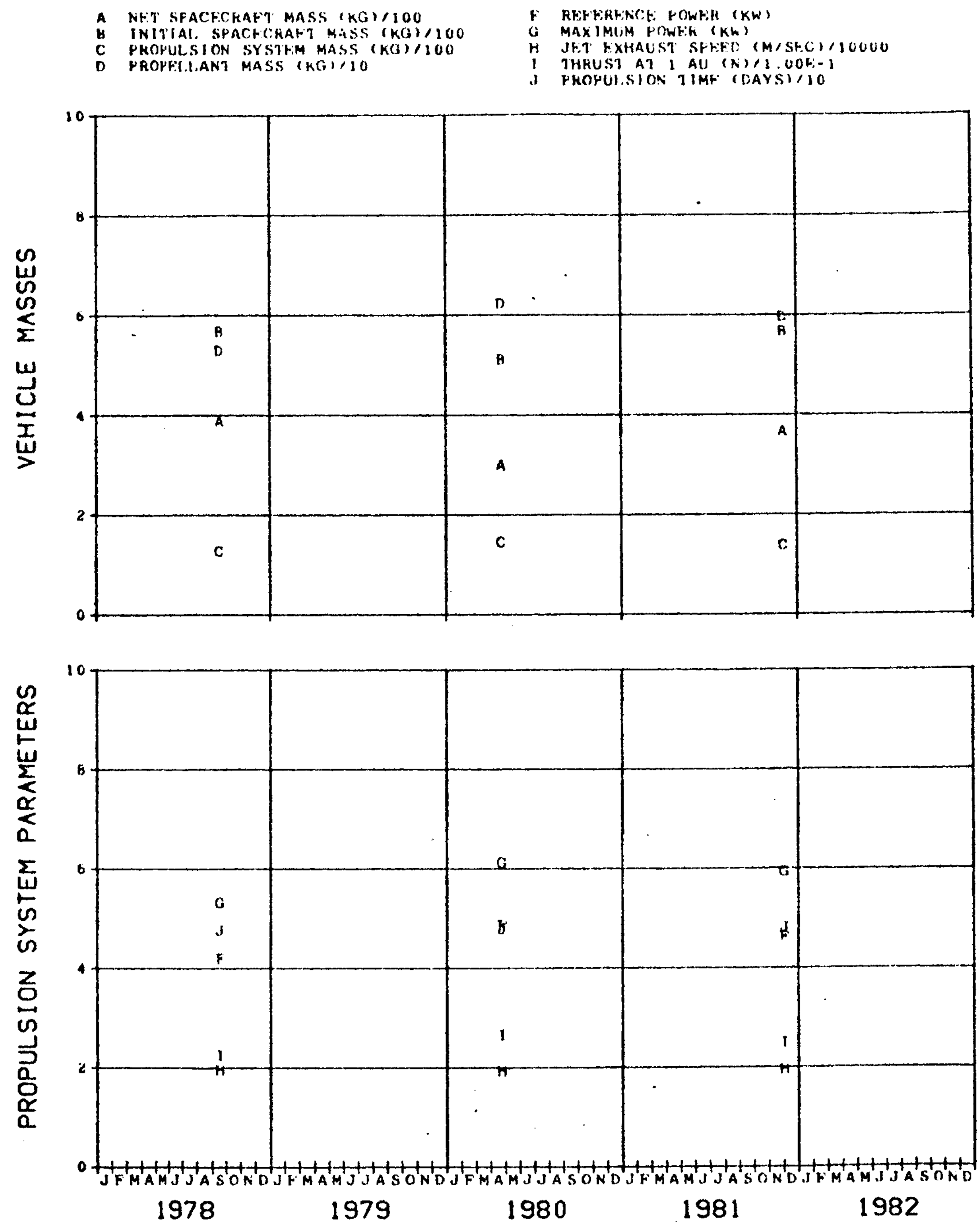
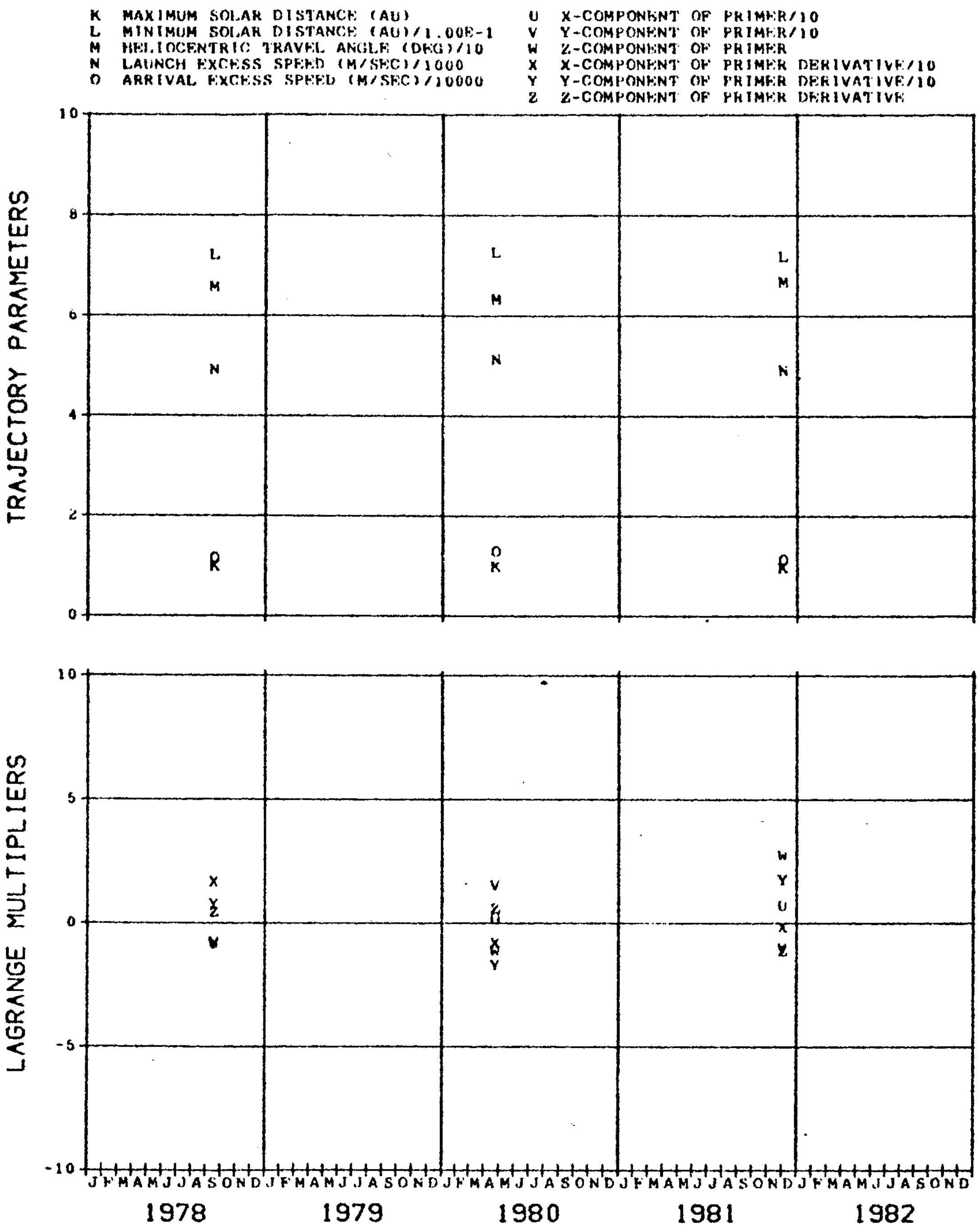


FIG. 1B. VENUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 60 DAYS

XXXX 008



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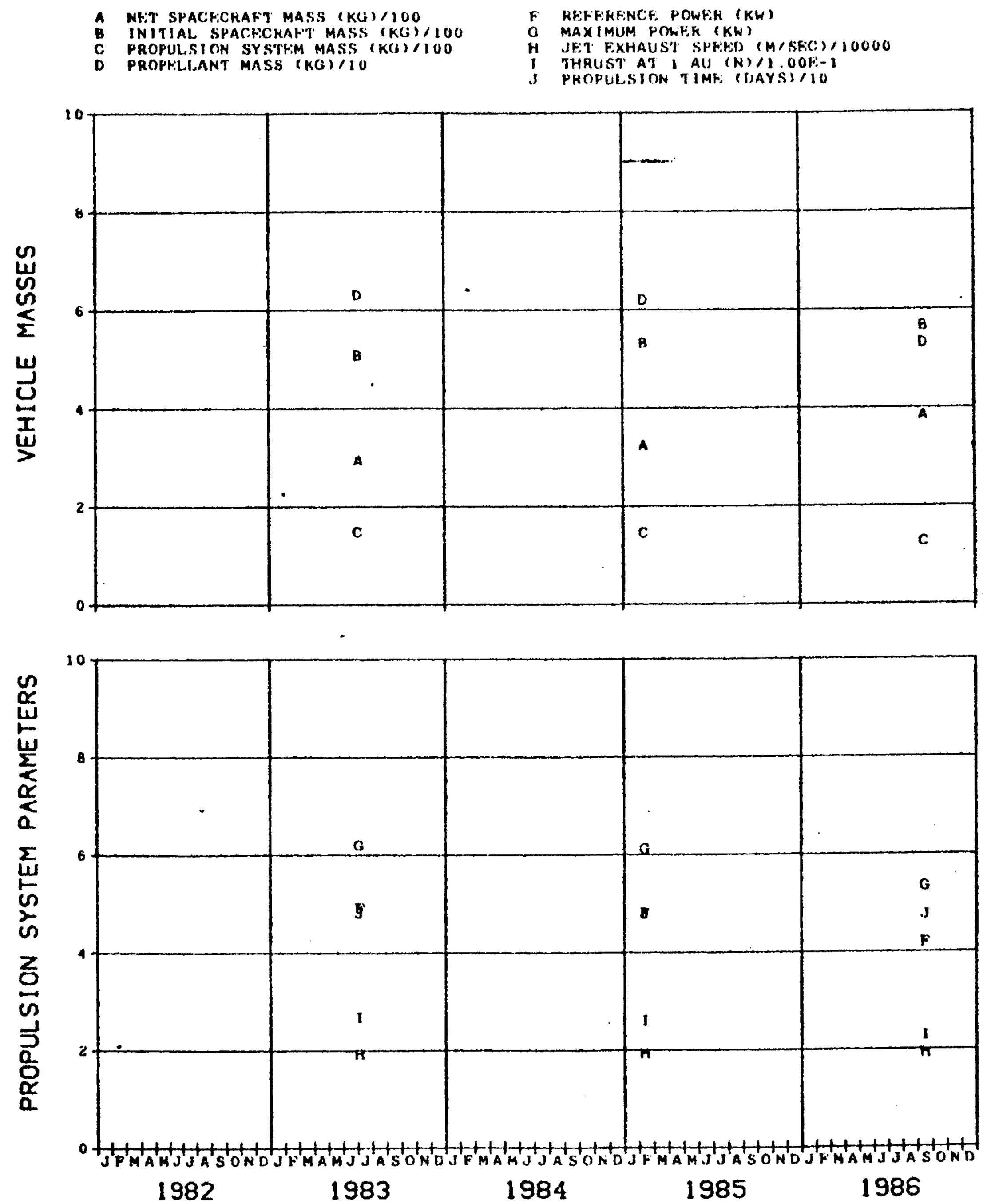

FIG. 1C. VENUS MODE A FLYBY OPPORTUNITIES
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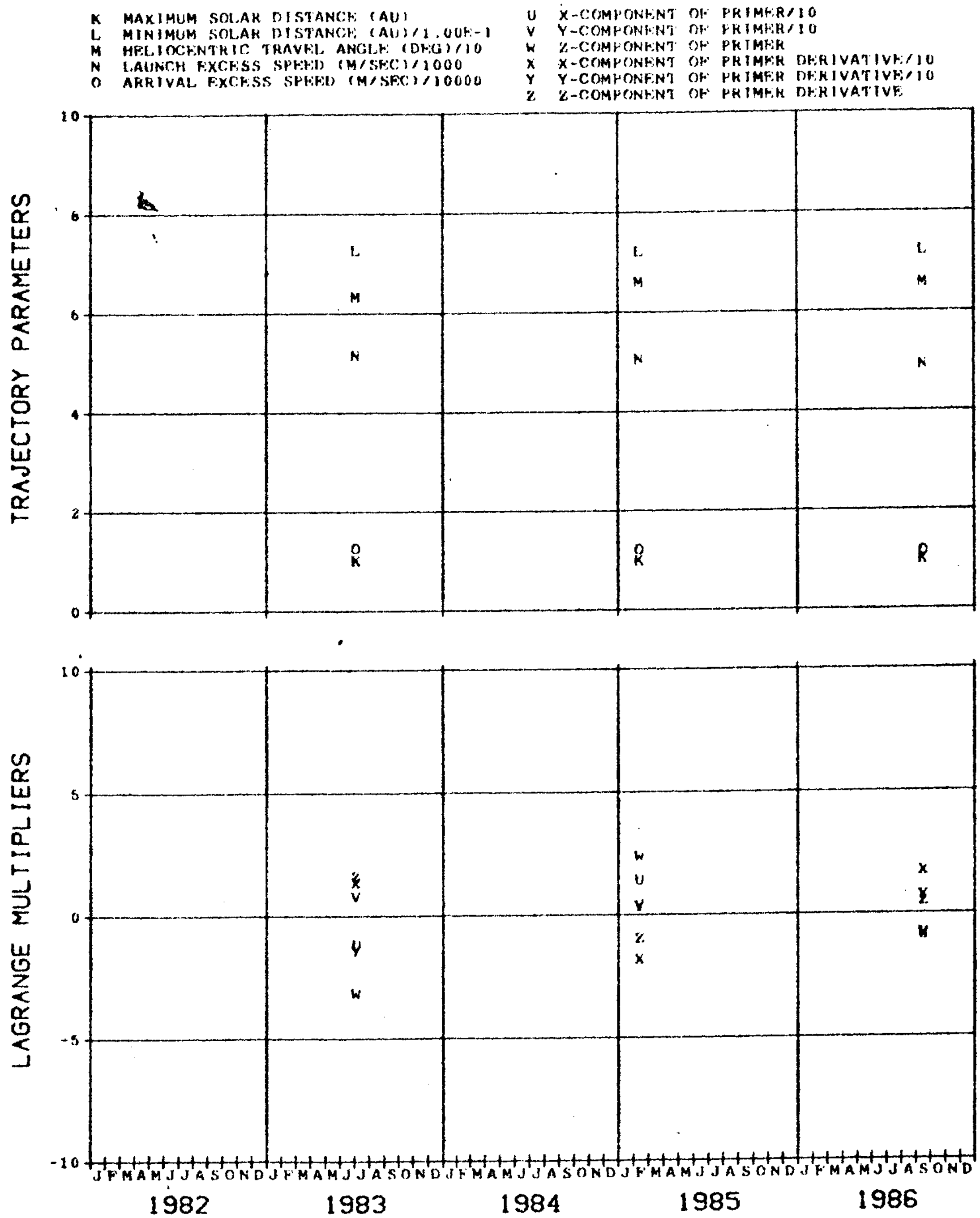

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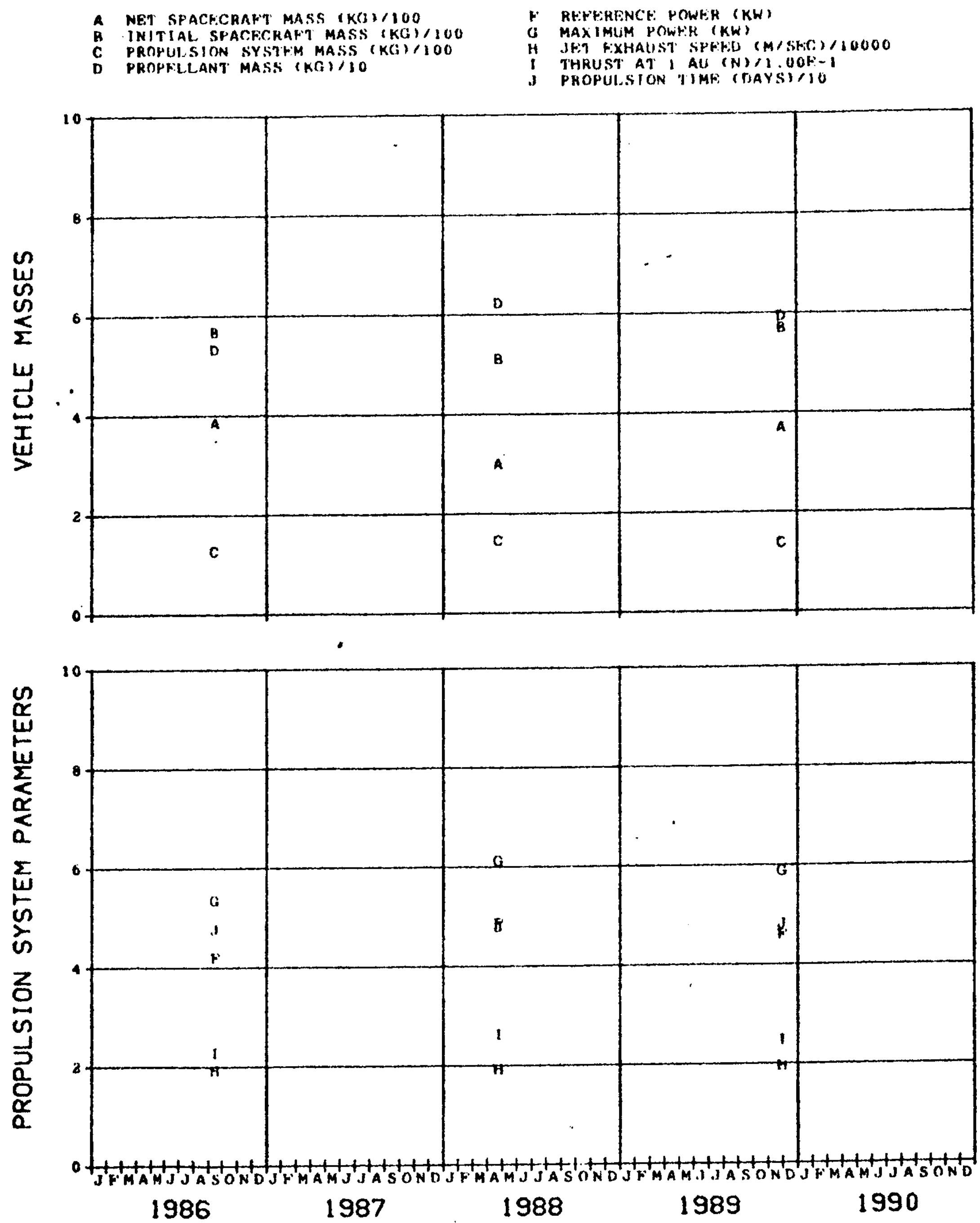

FIG. 1D. VENUS MODE A FLYBY OPPORTUNITIES
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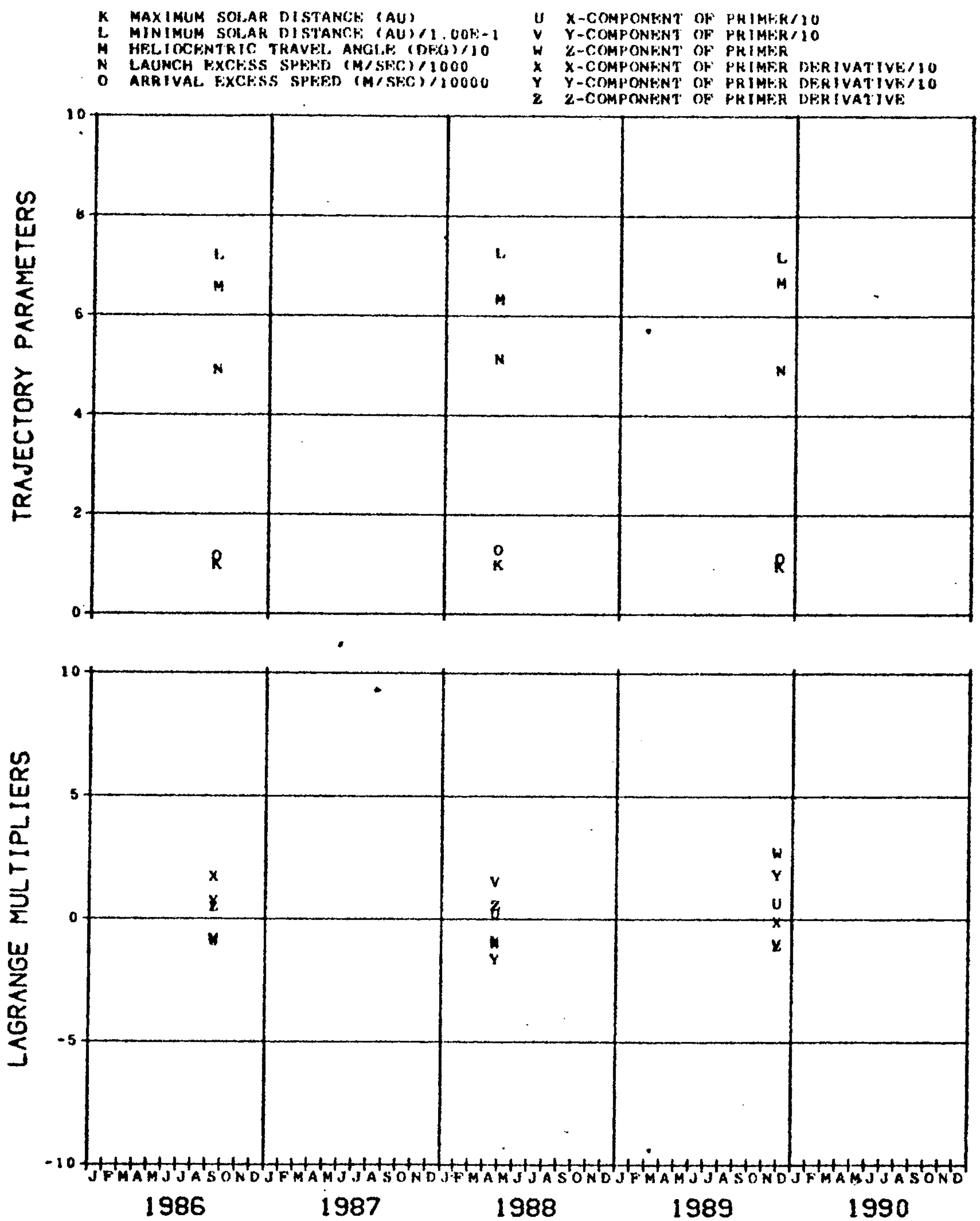

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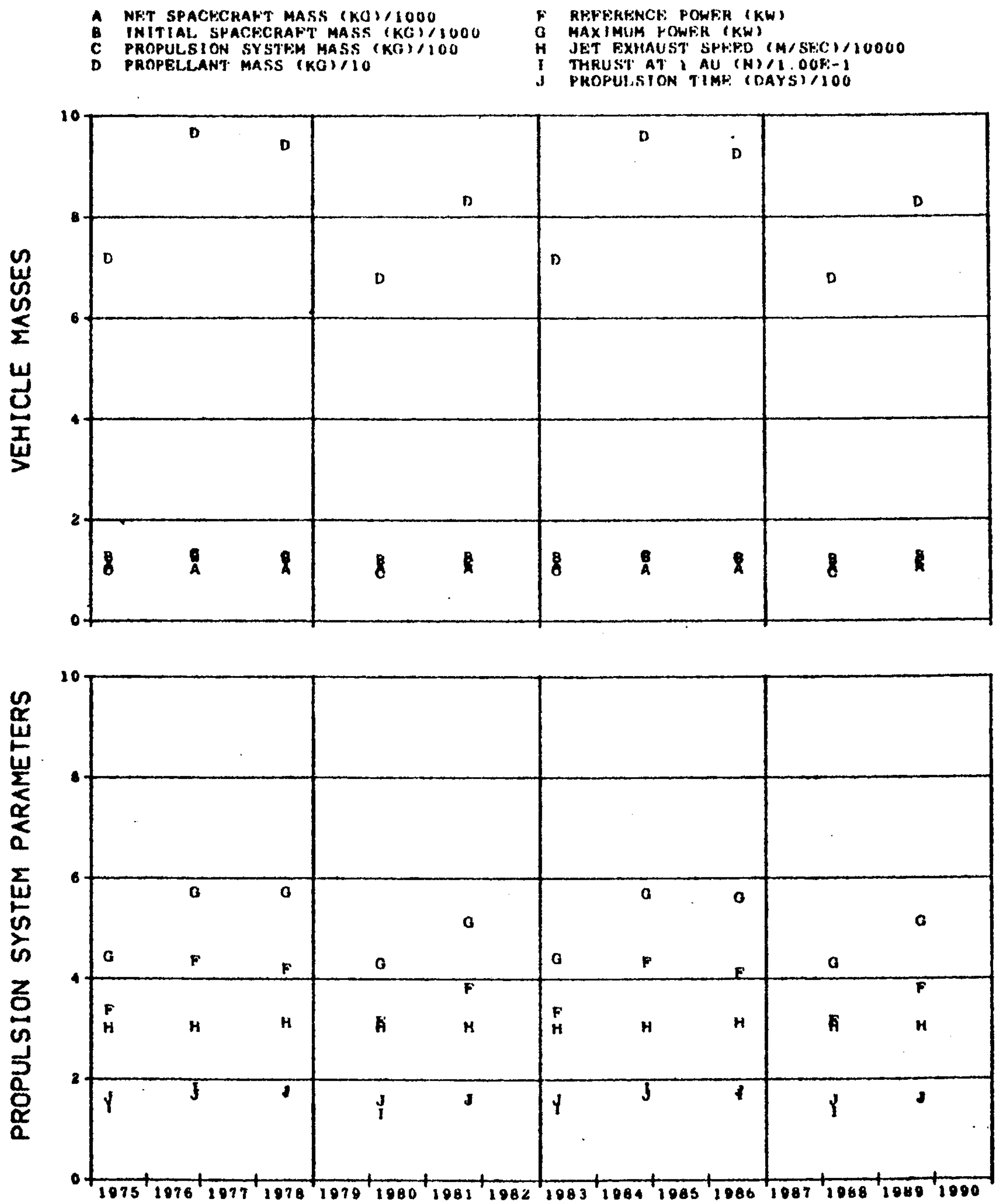
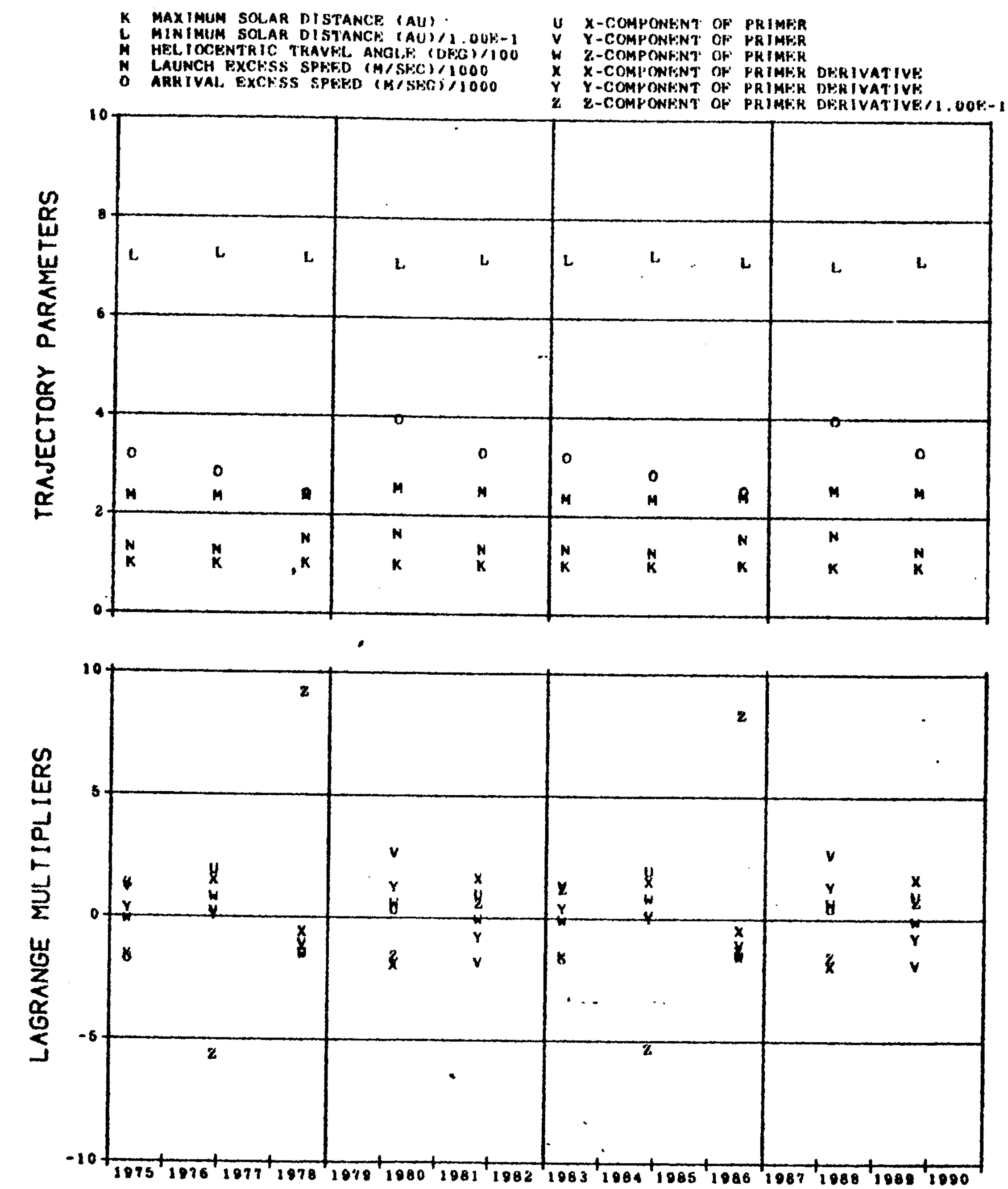


FIG. 2. VENUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 200 DAYS

XXXX 014



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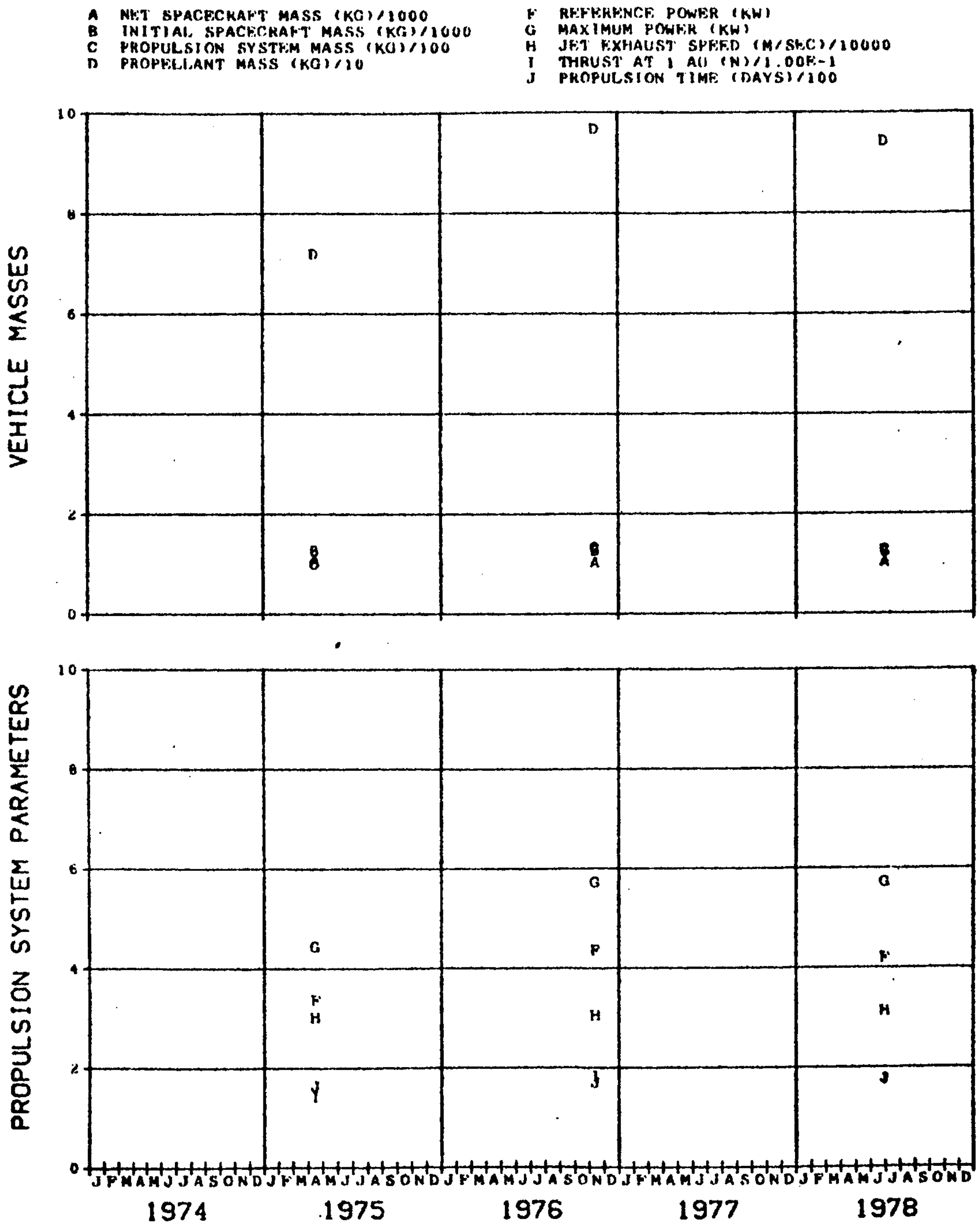


FIG. 2A. VENUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 200 DAYS

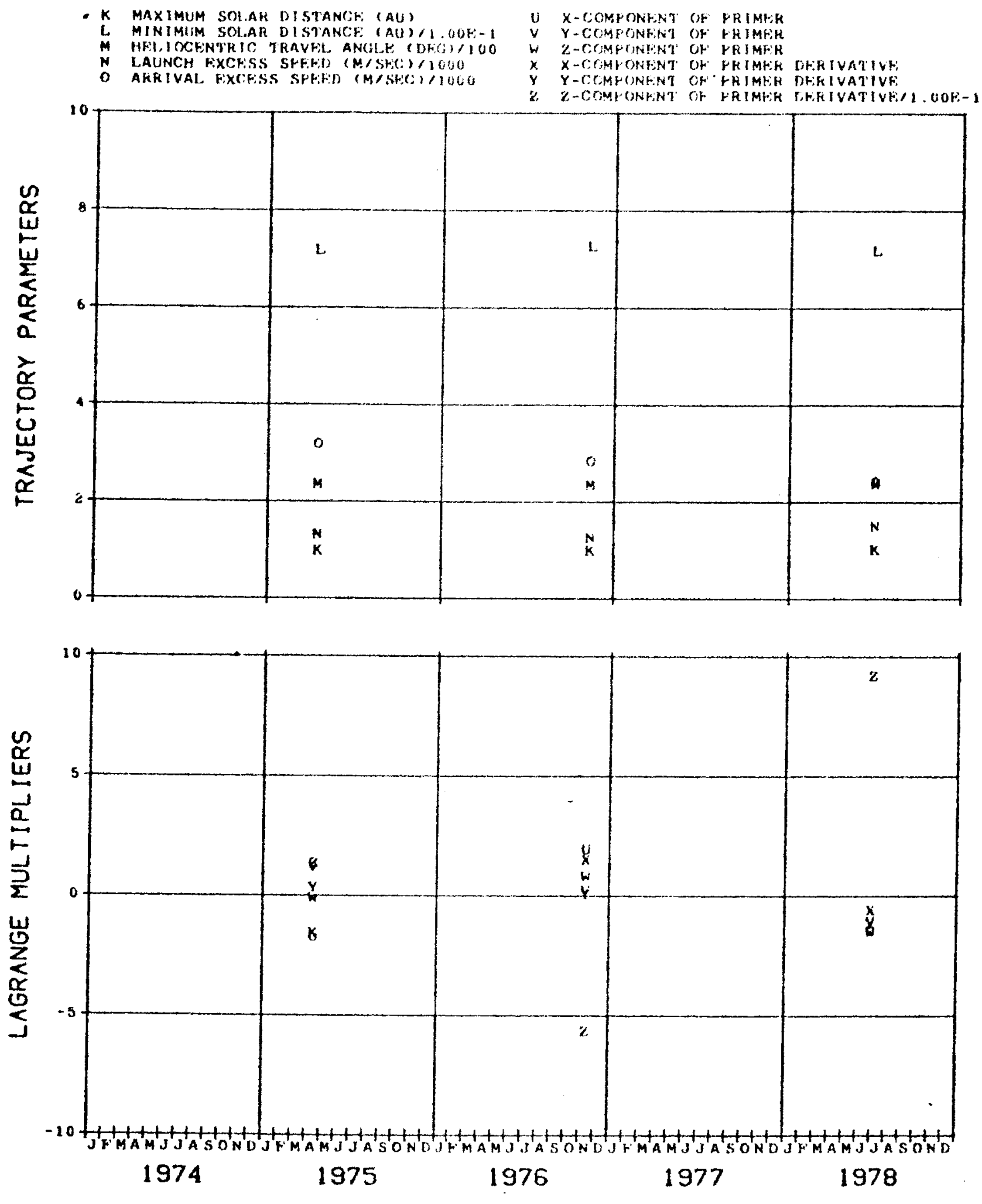
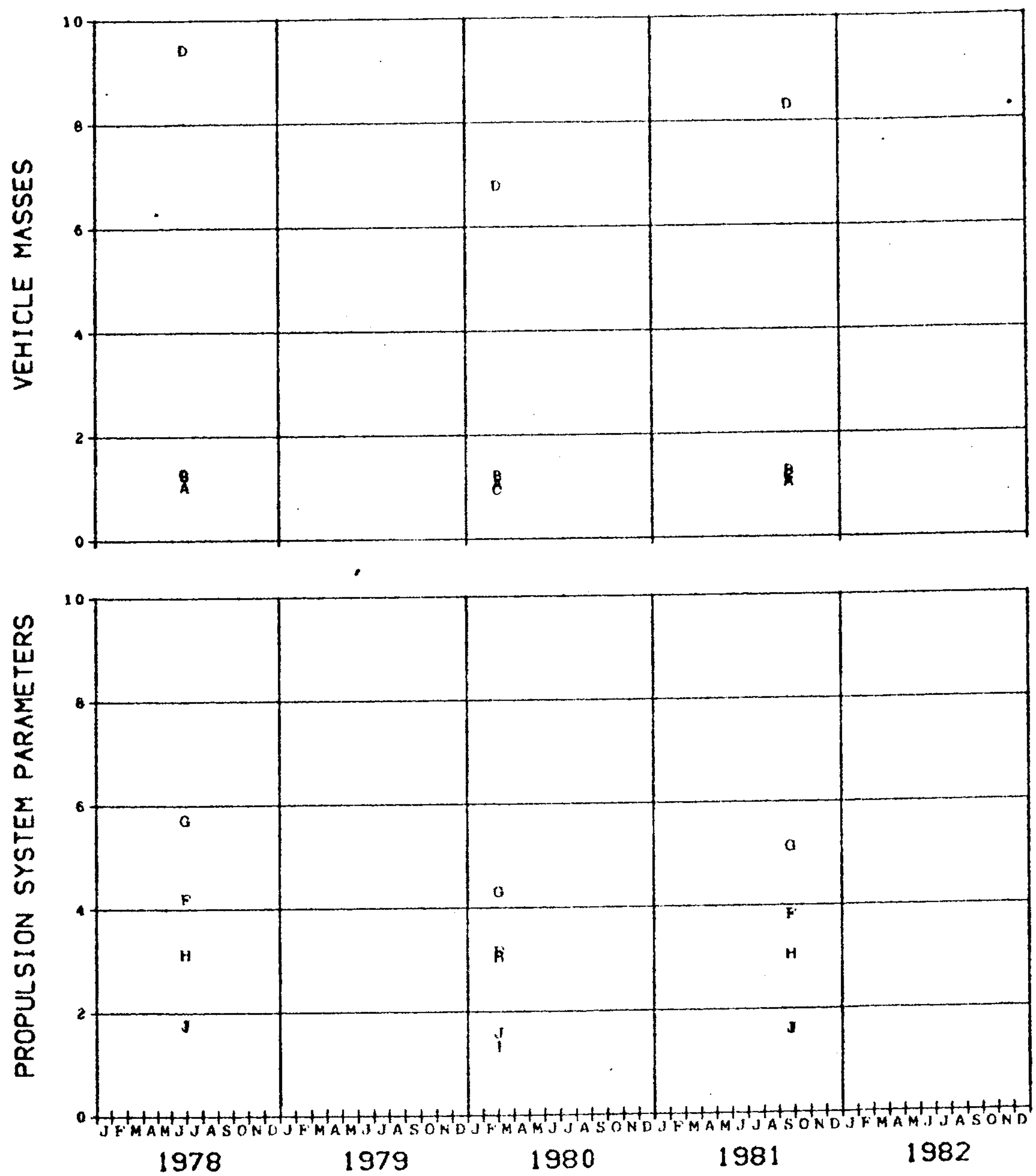


FIG. 2A. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/1000
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/10
F REFERENCE POWER (KW)
G MAXIMUM POWER (KW)
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100



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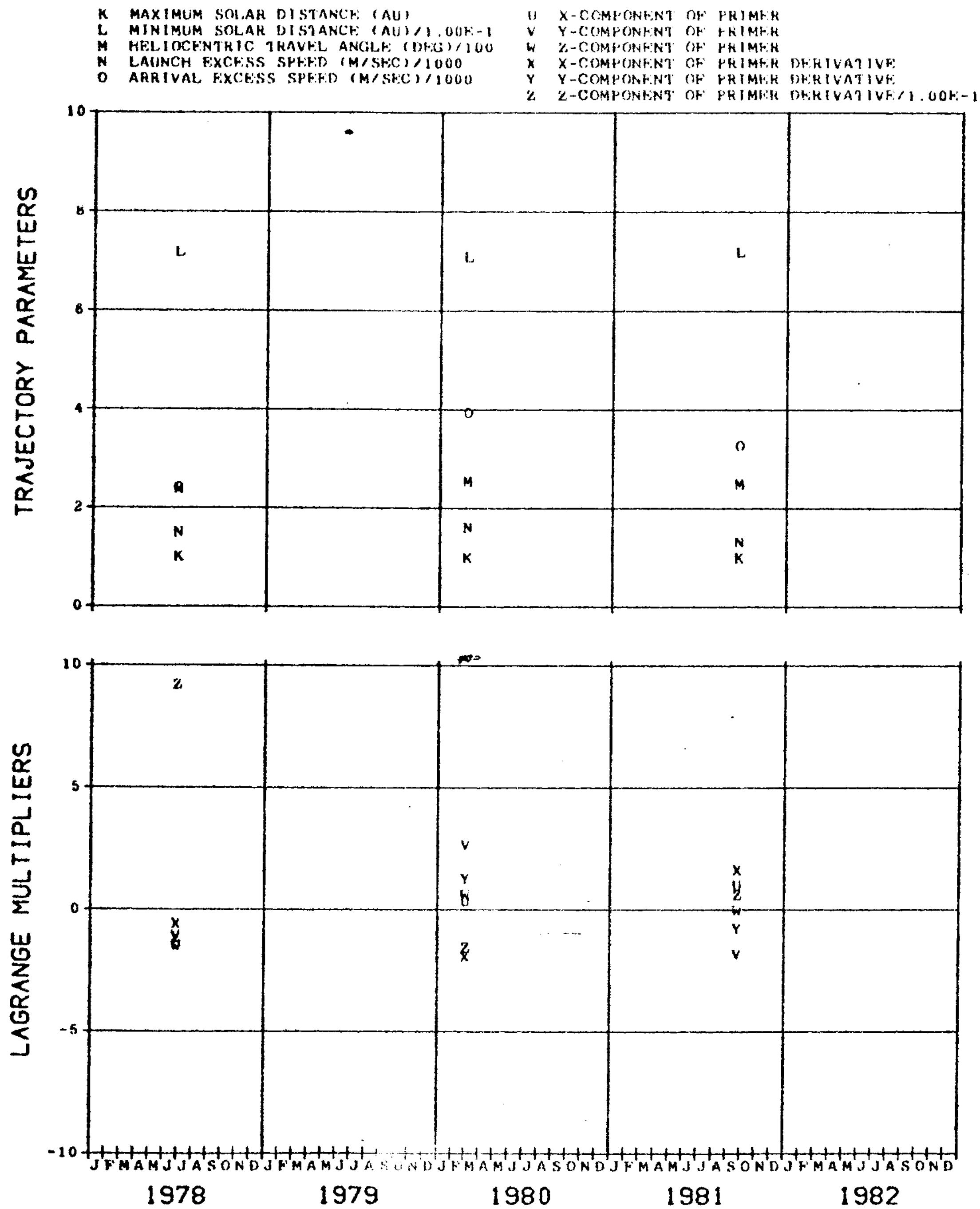

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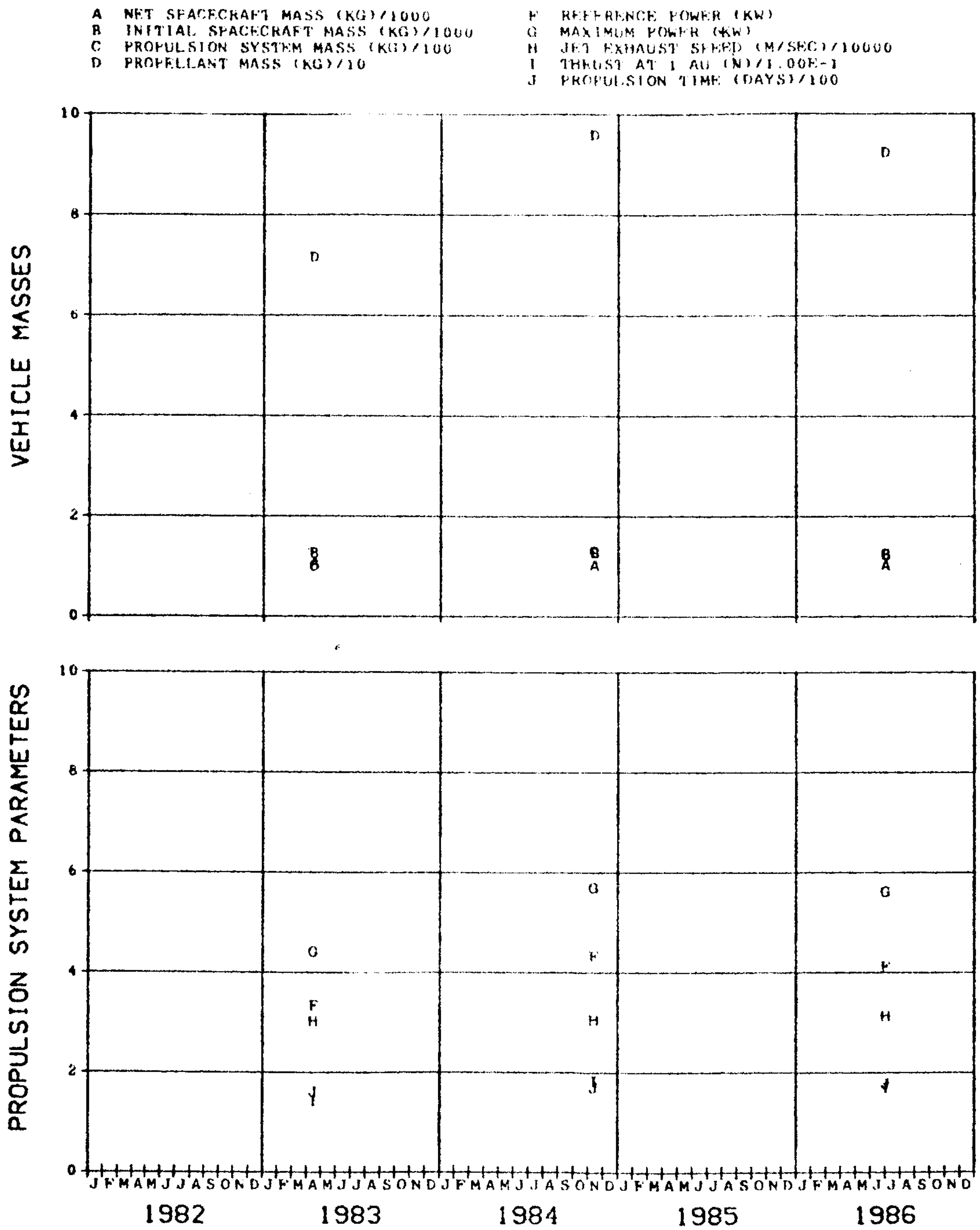

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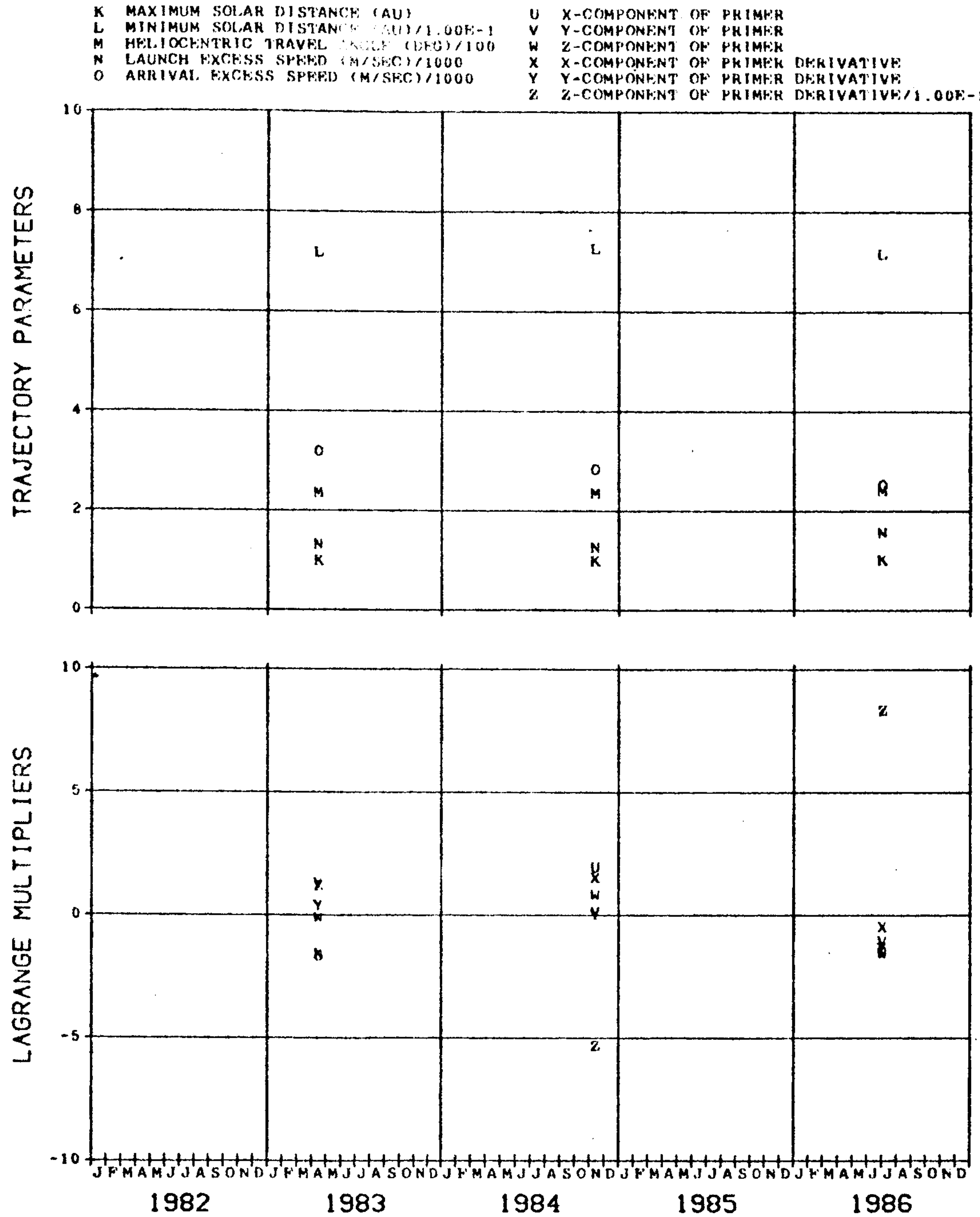

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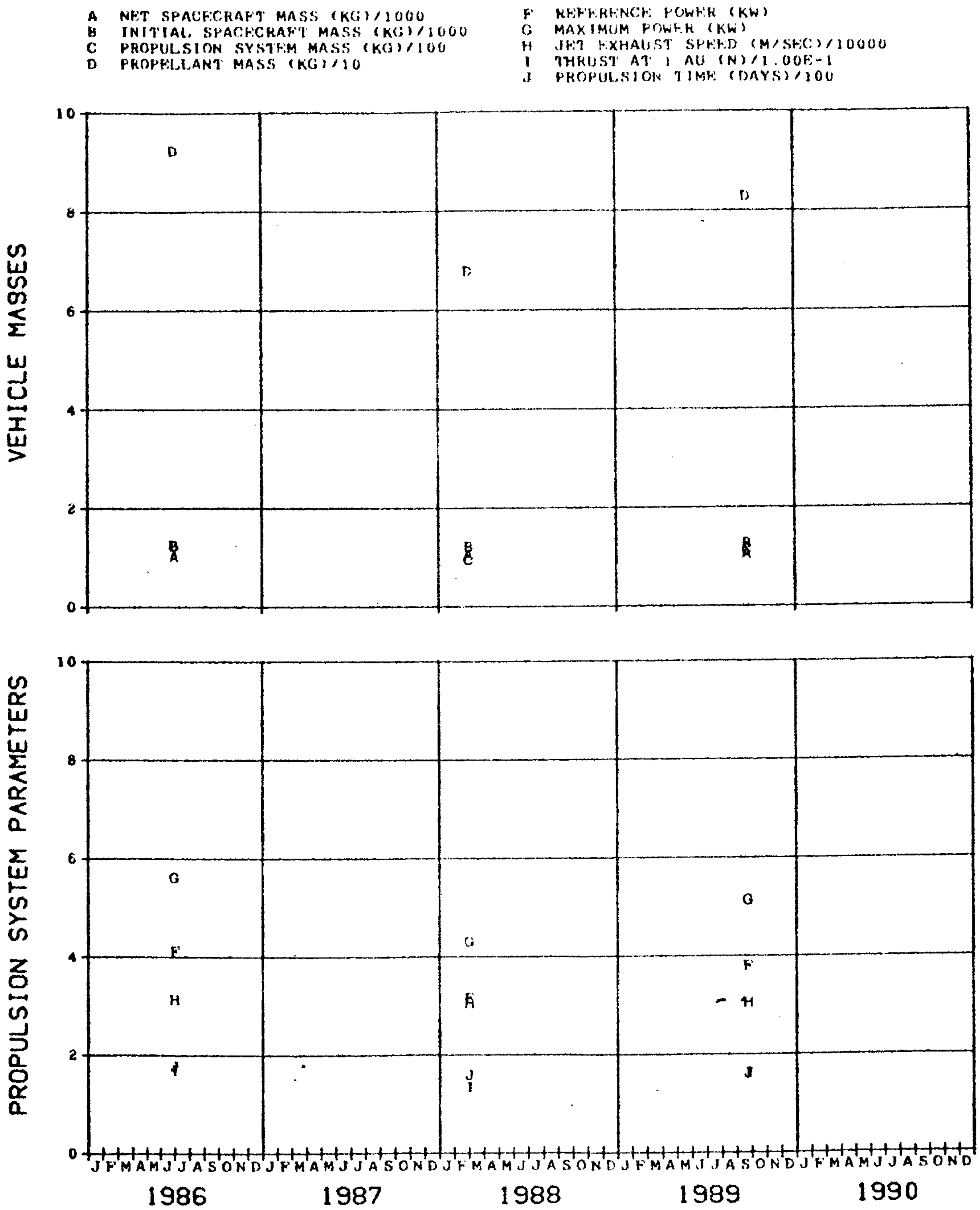

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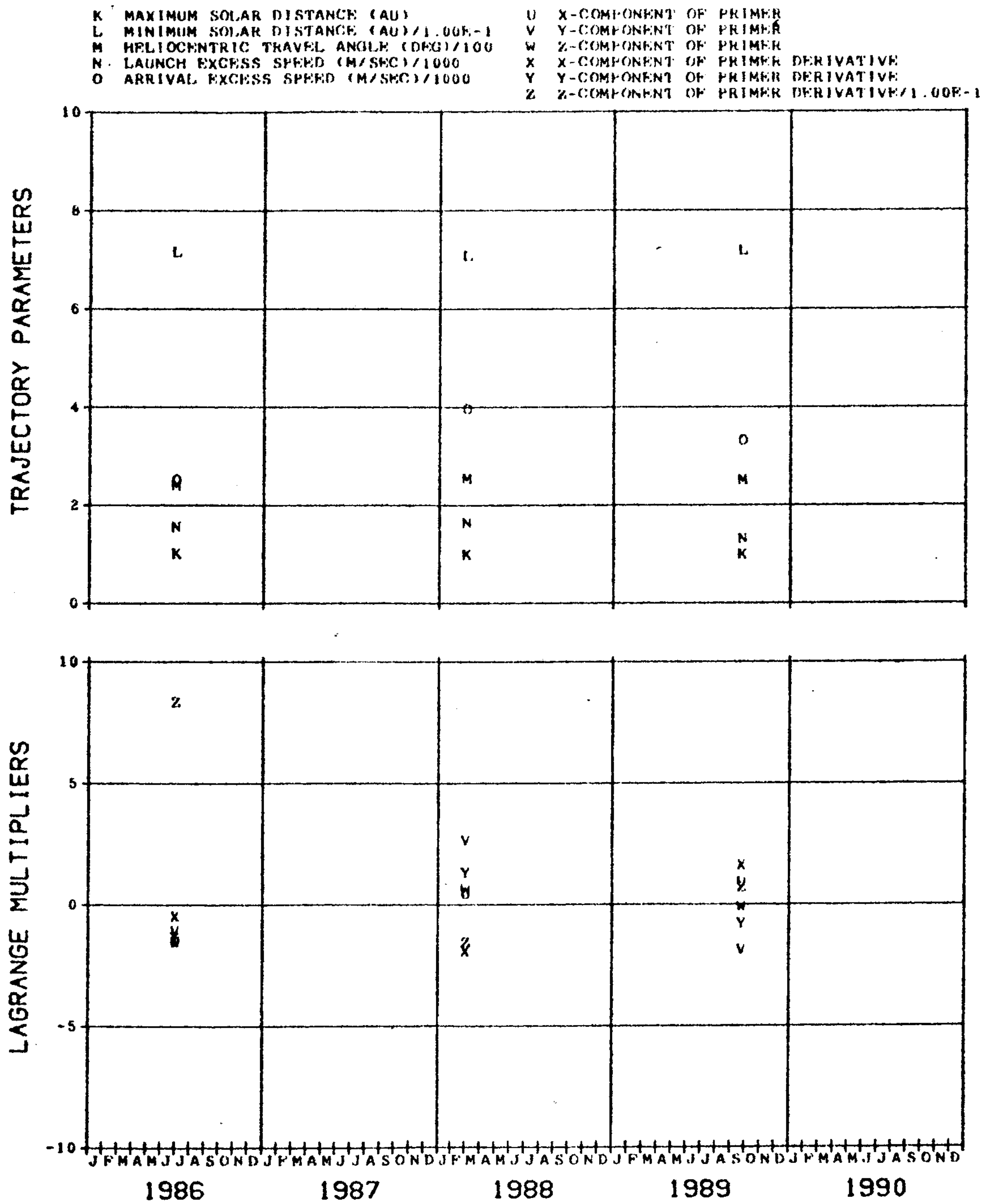

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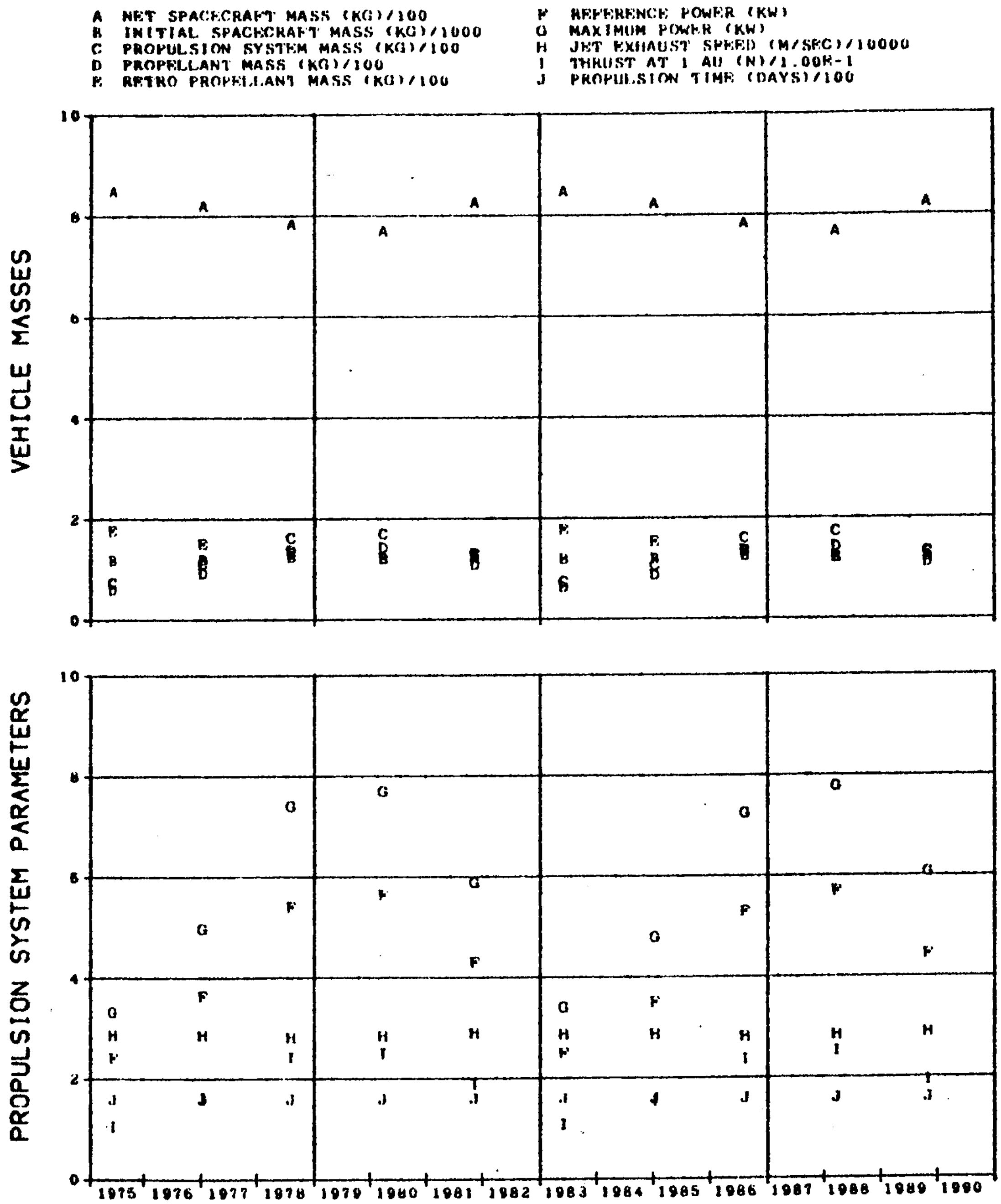
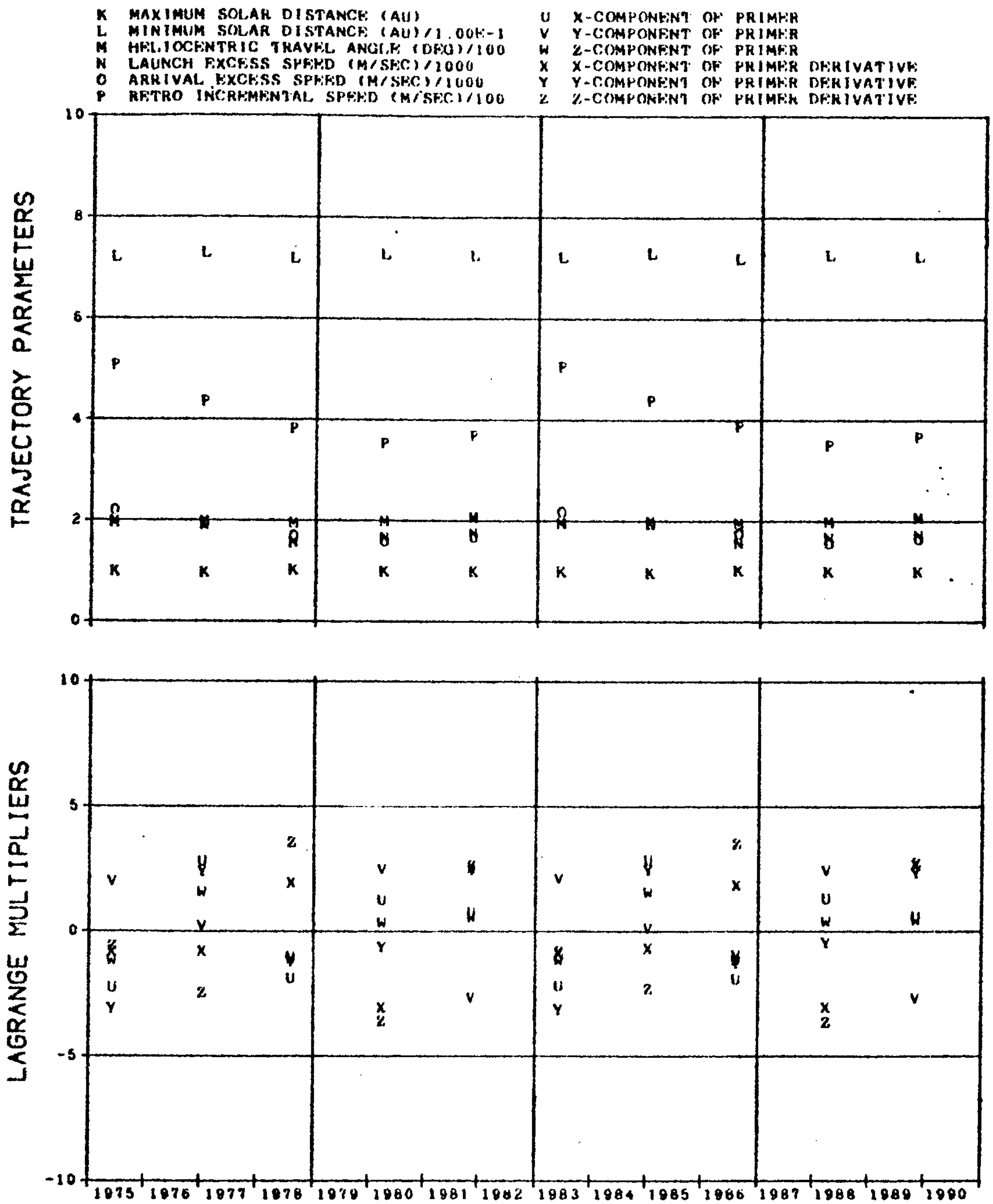


FIG. 3. VENUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 160 DAYS



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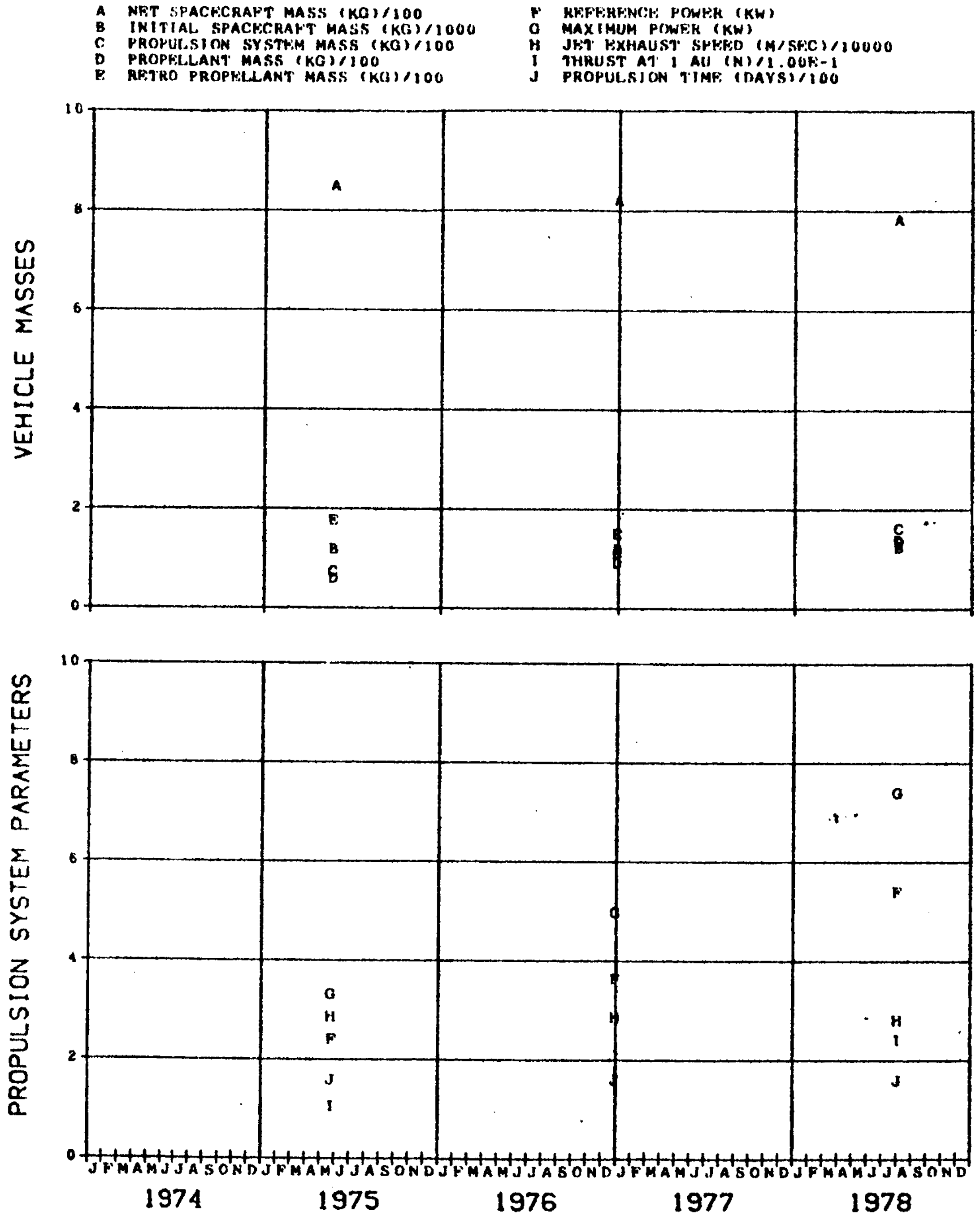

FIG. 3A. VENUS MODE A ORBITER OPPORTUNITIES
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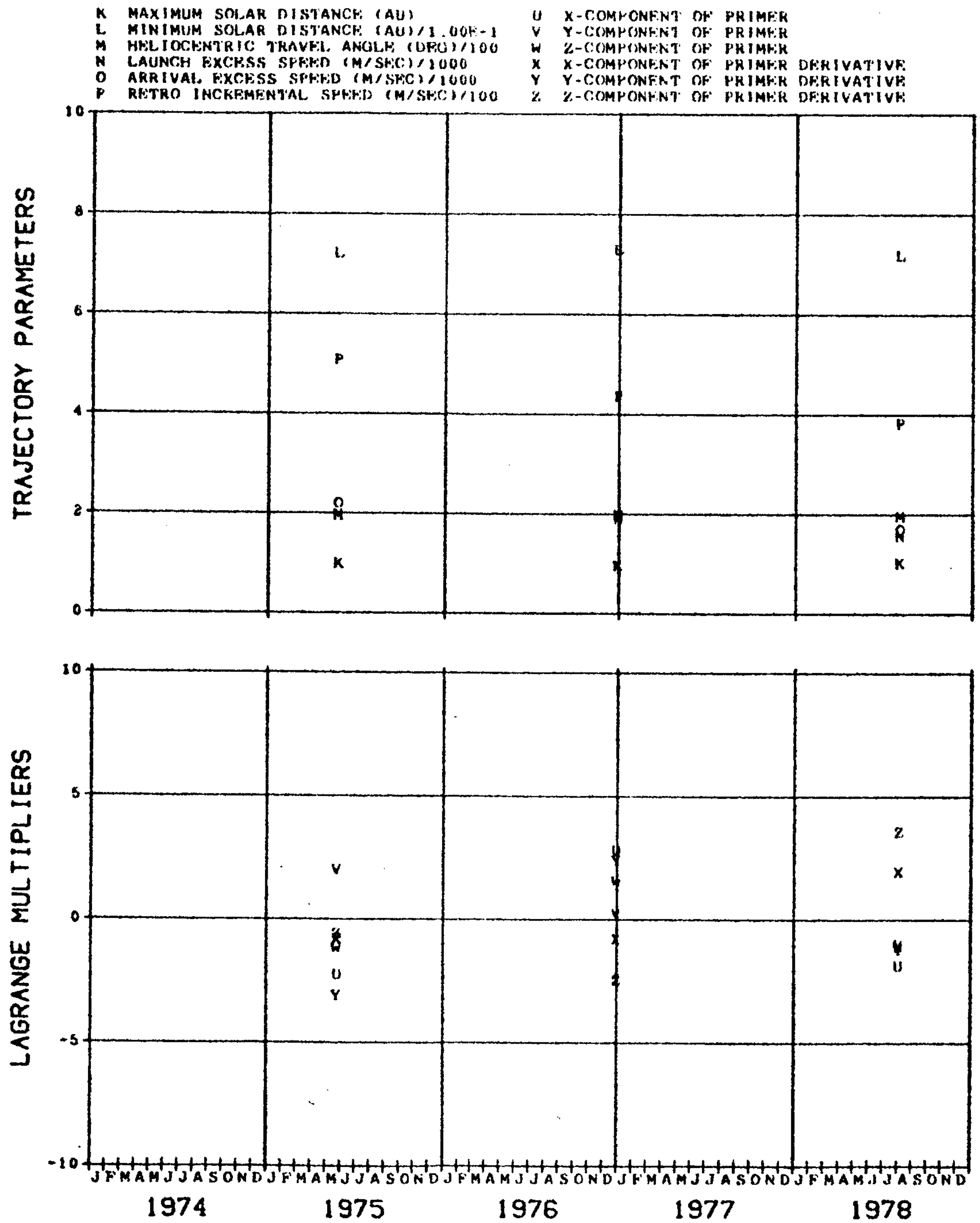

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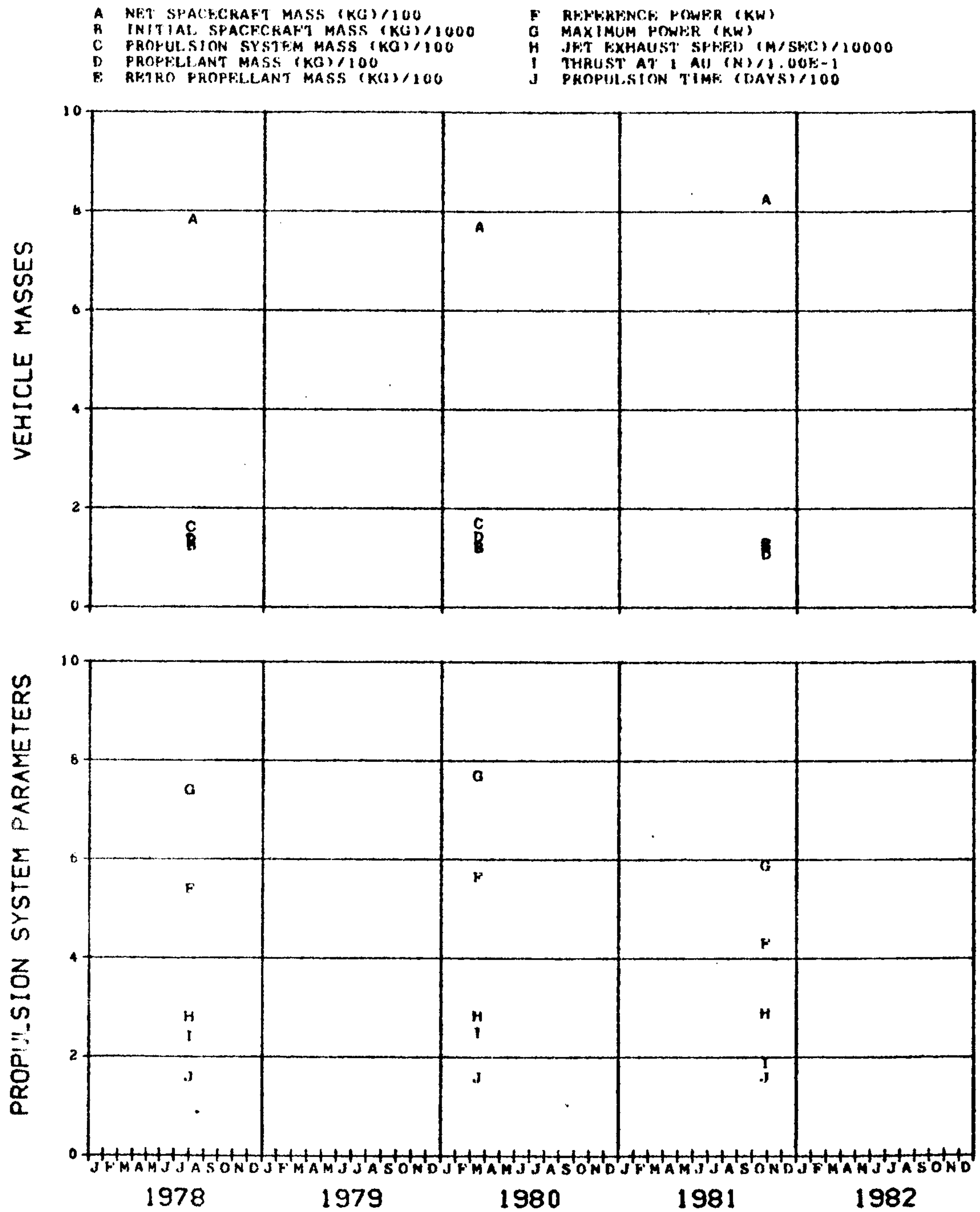

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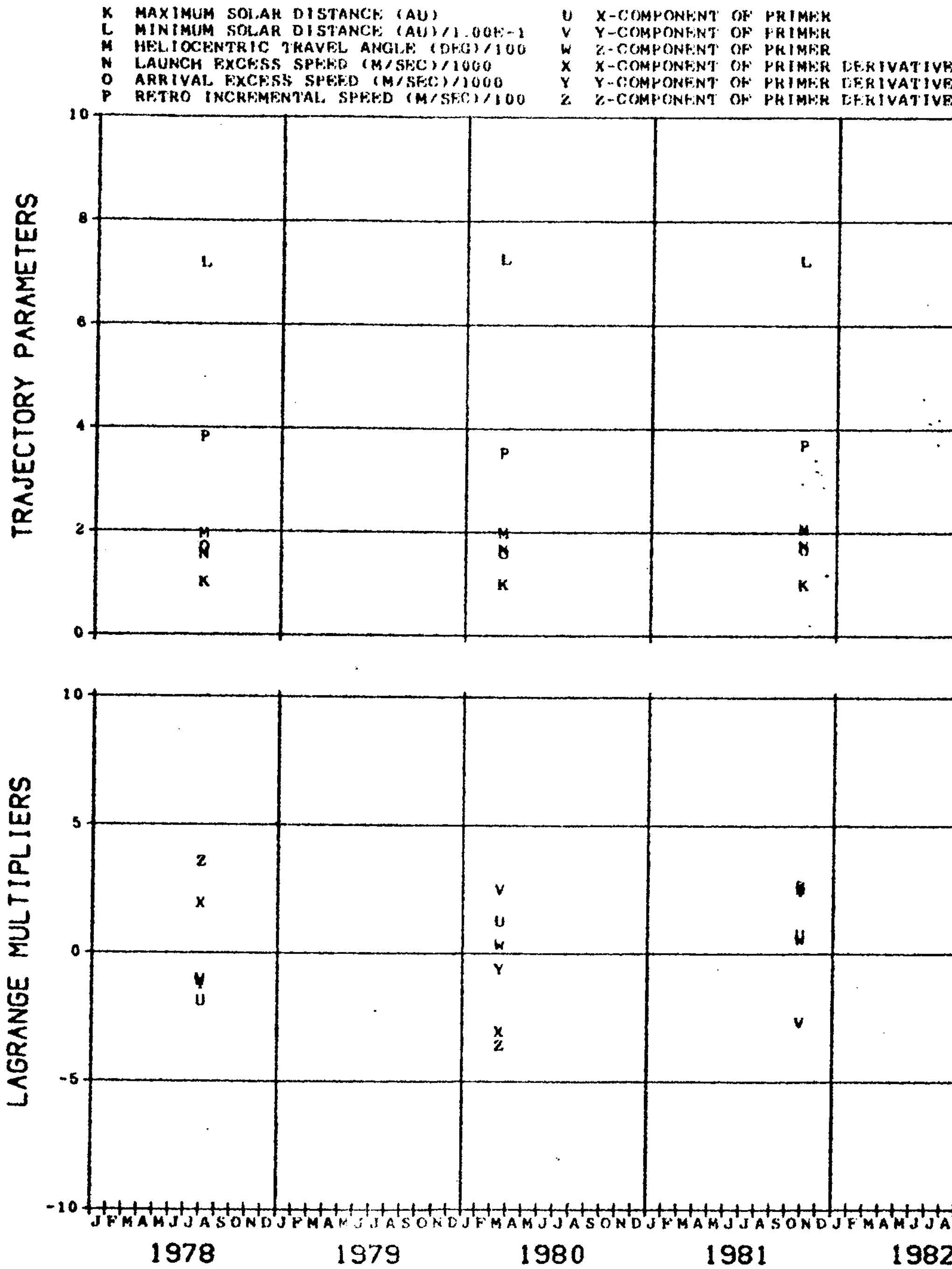

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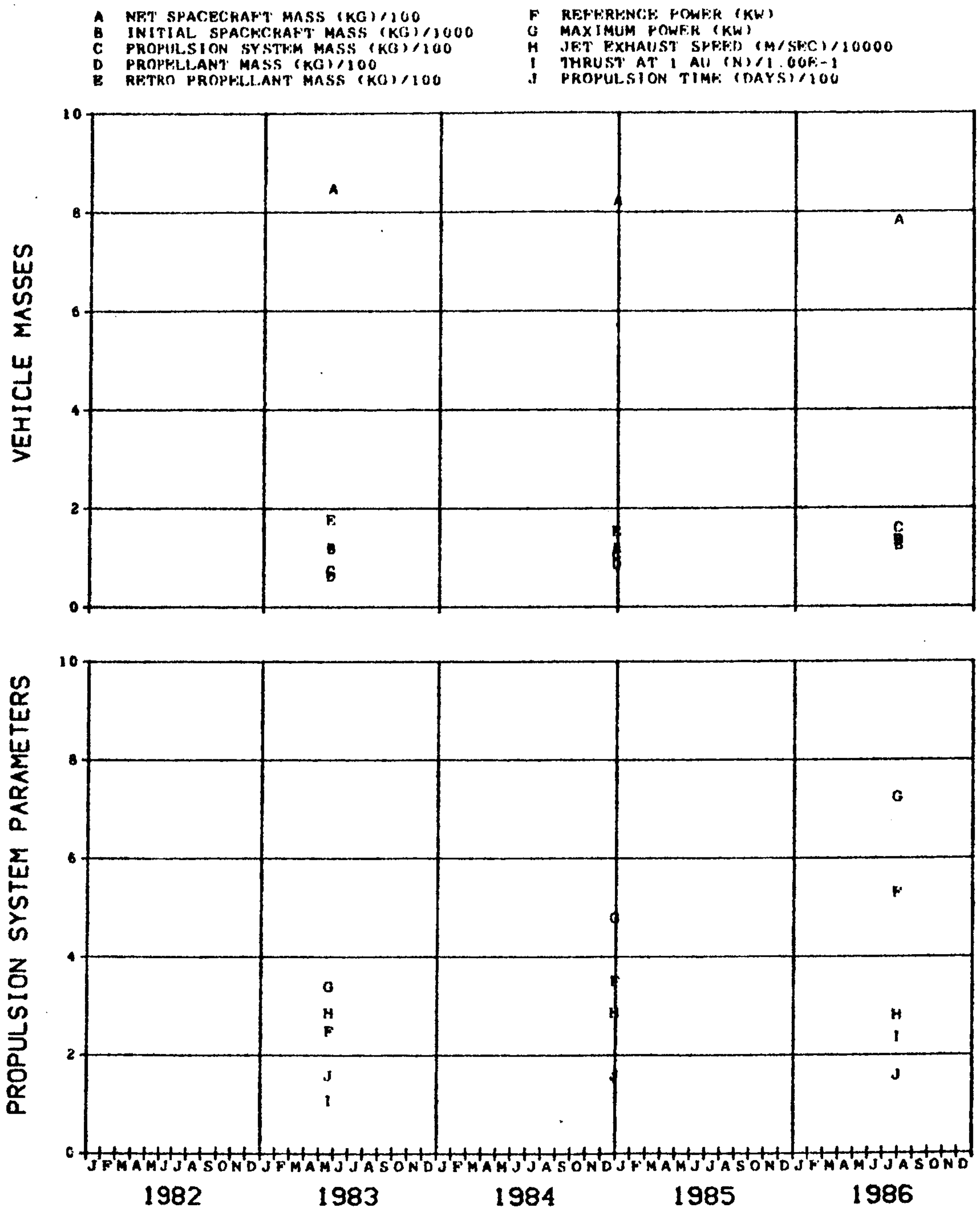

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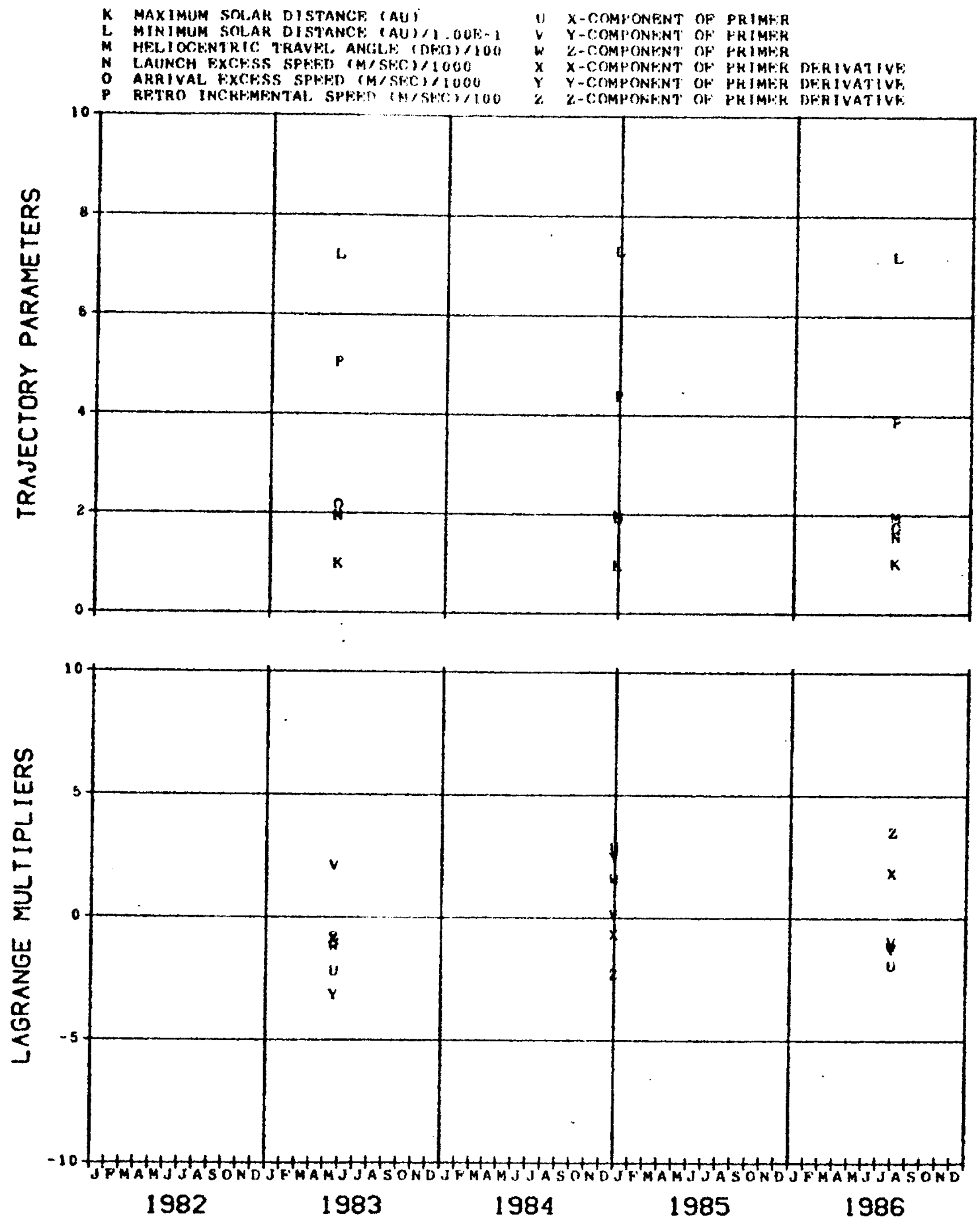

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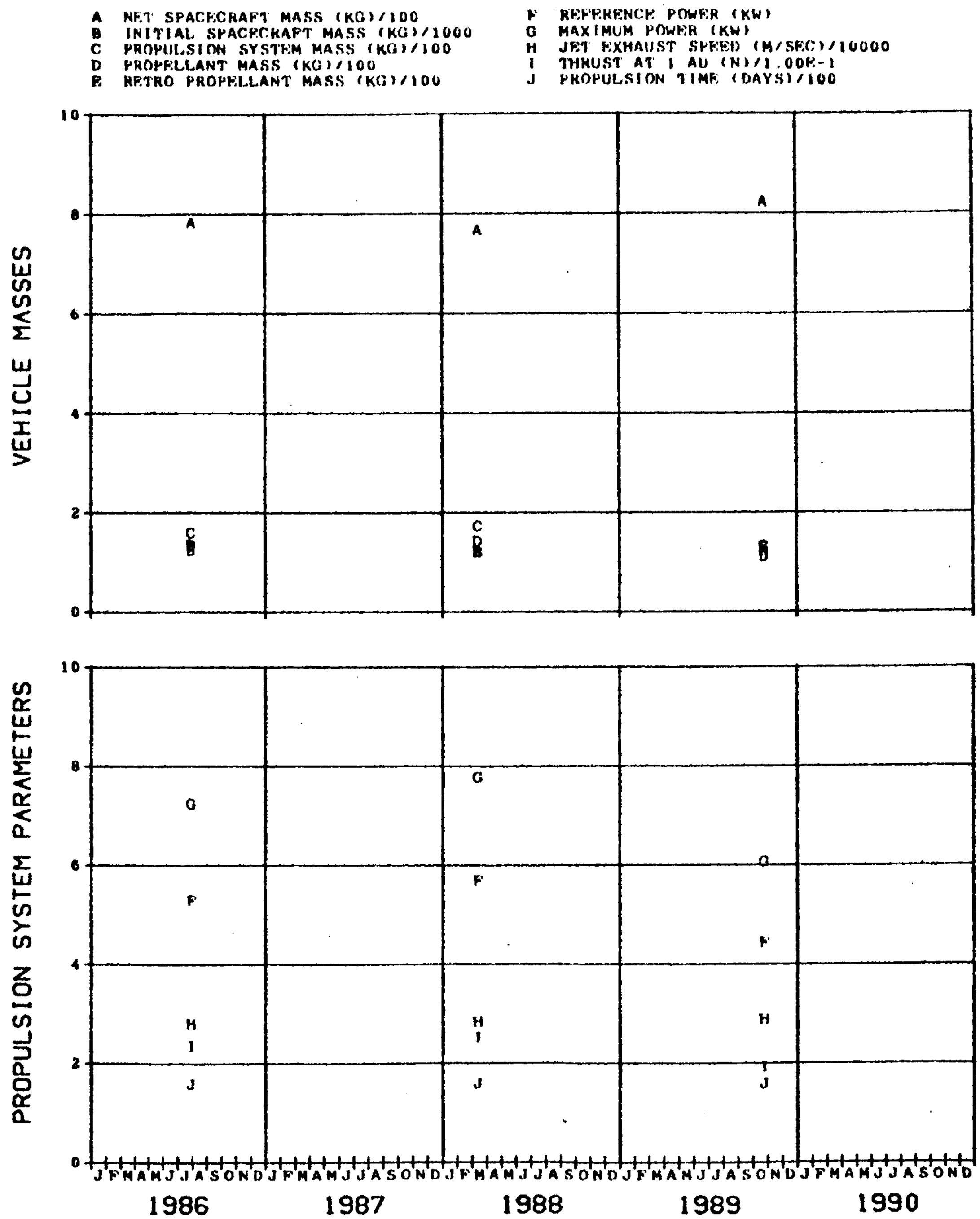

FIG. 3D. VENUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 160 DAYS

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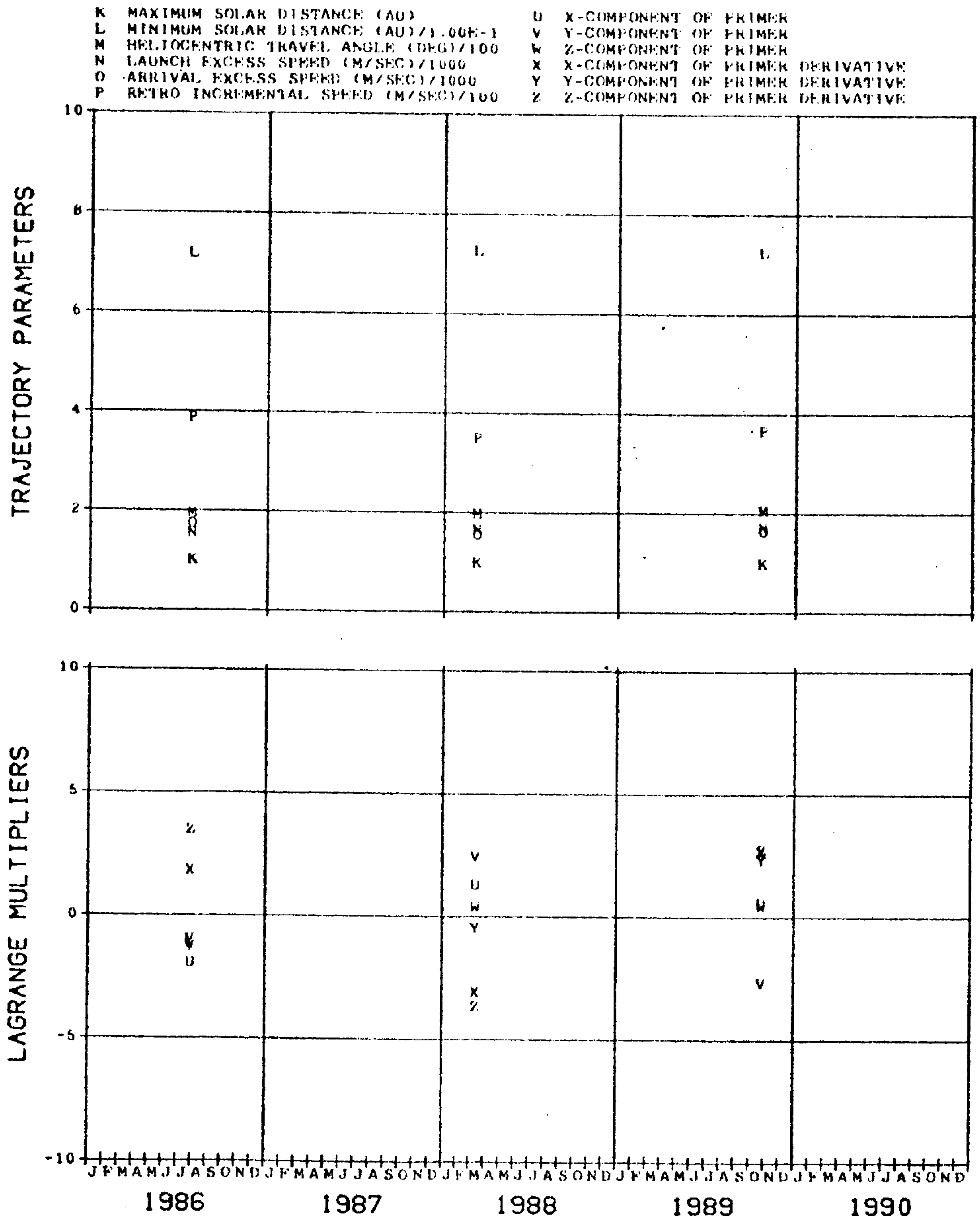

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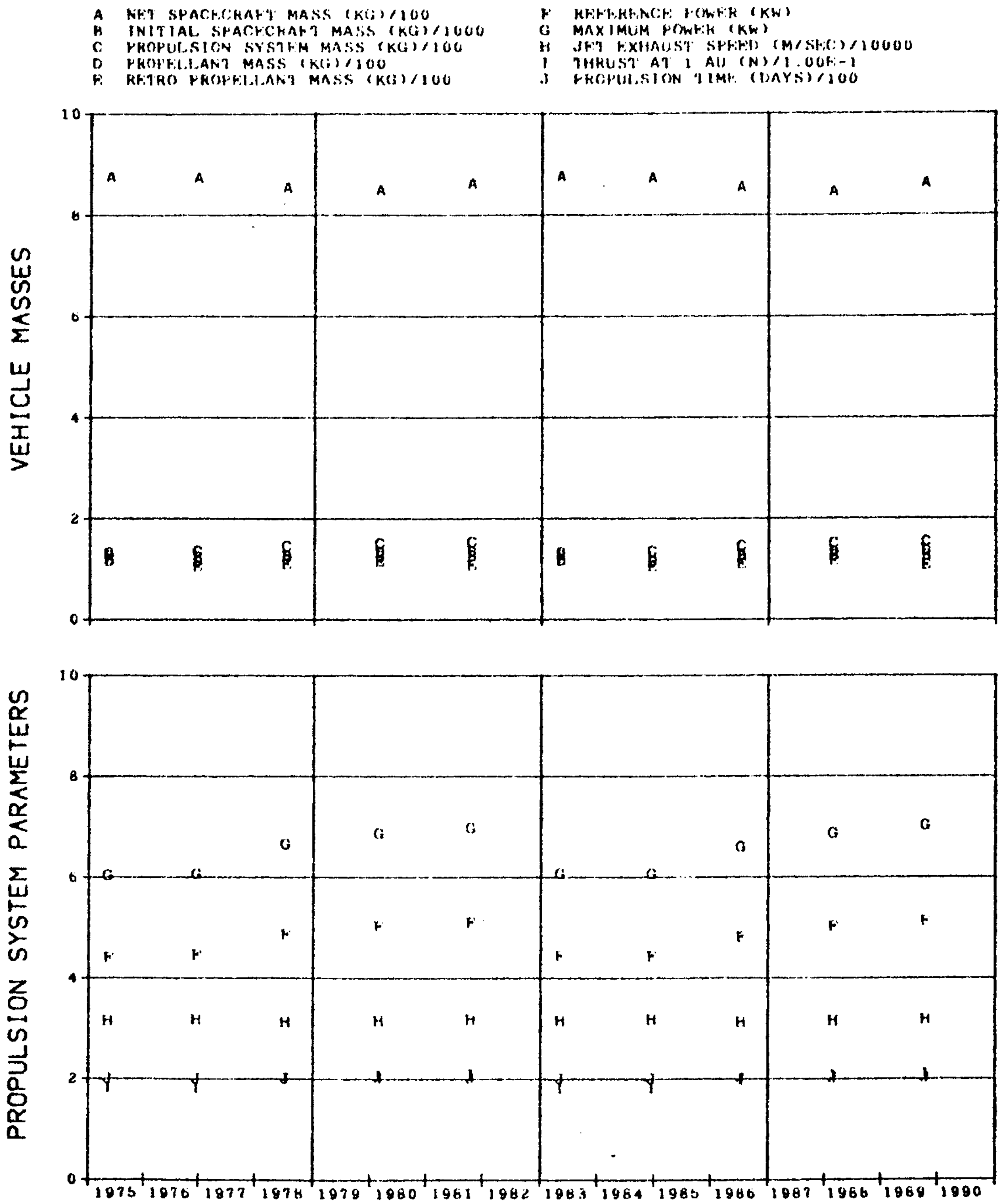

FIG. 4. VENUS MODE A ORBITER OPPORTUNITIES
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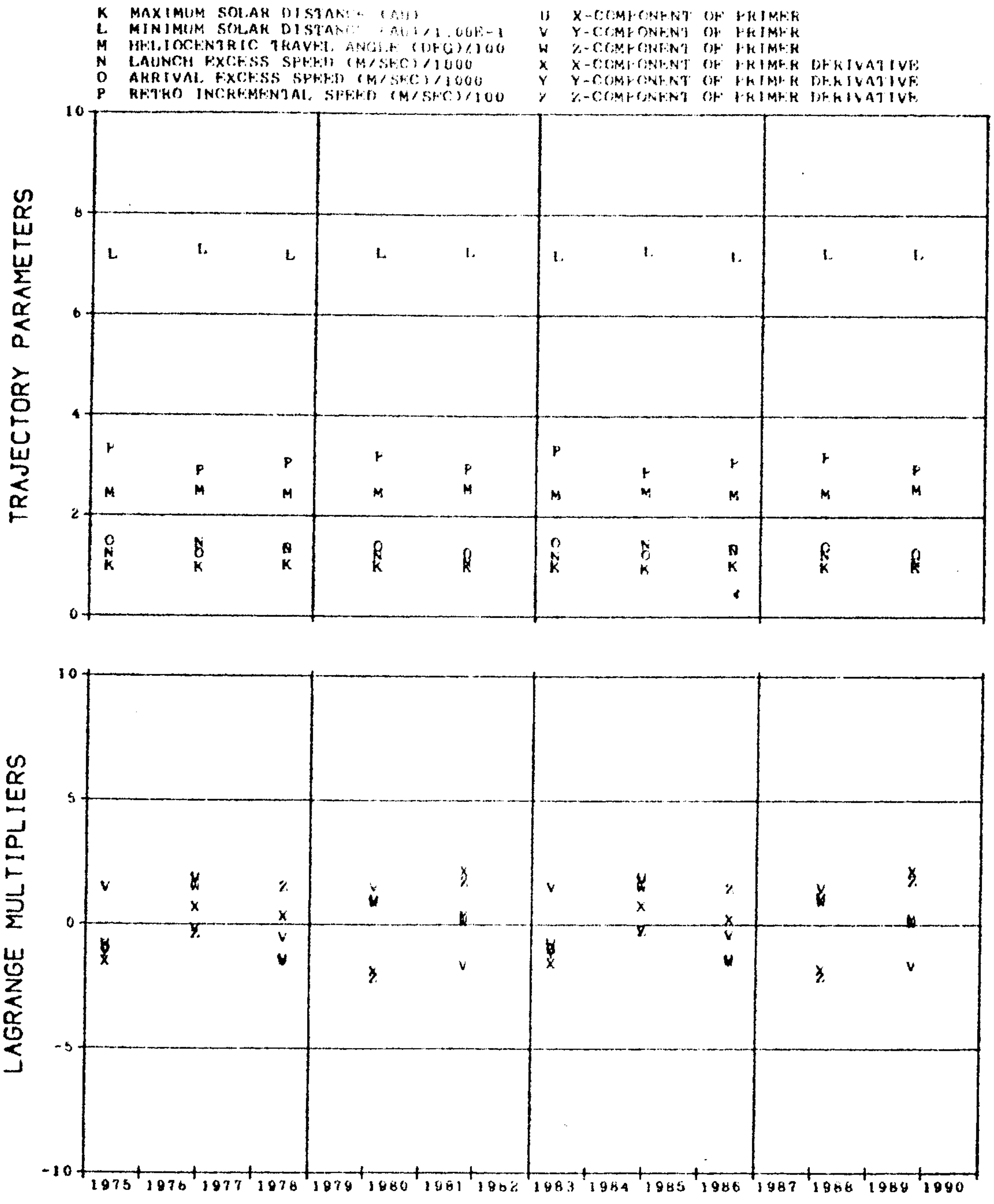

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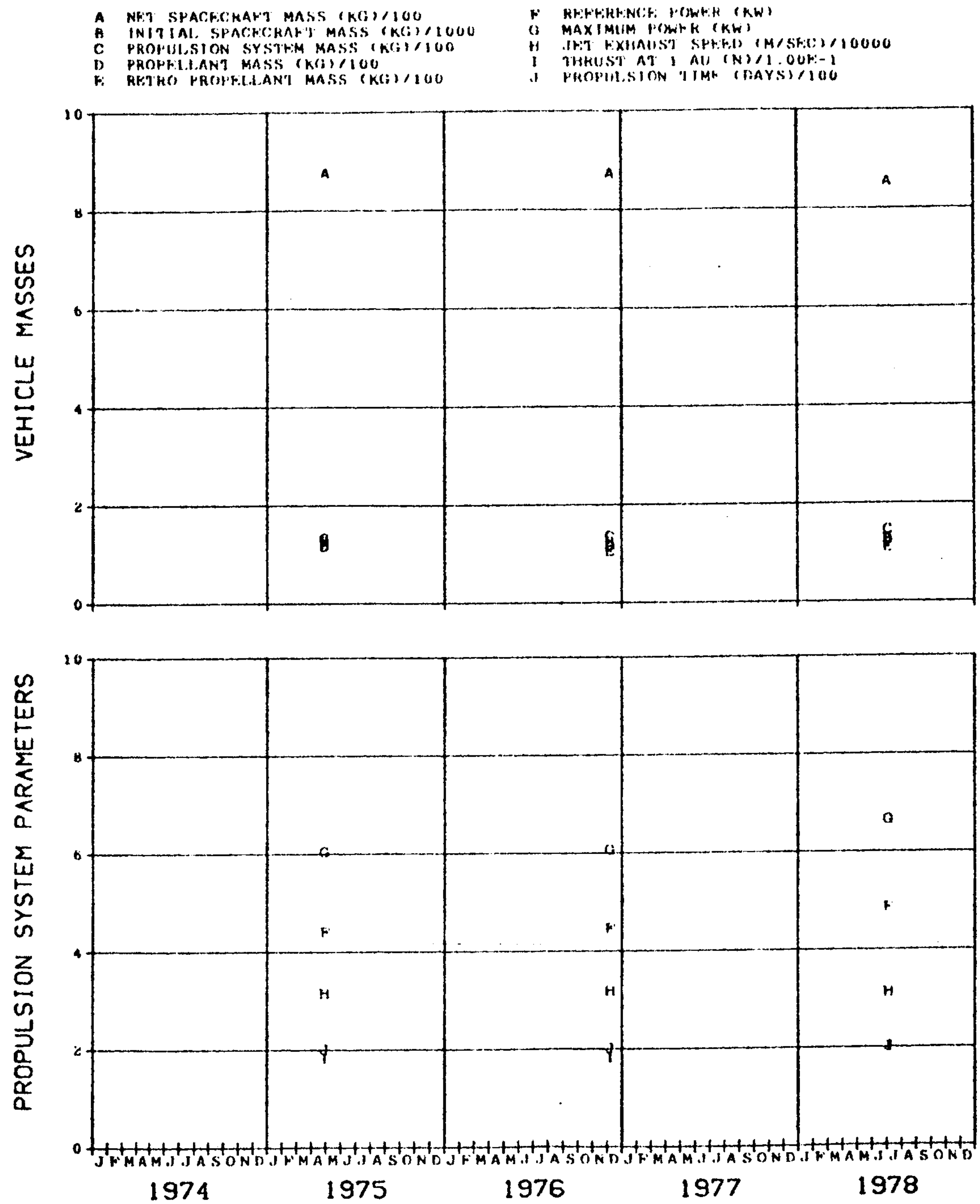

FIG. 4A. VENUS MODE A ORBITER OPPORTUNITIES
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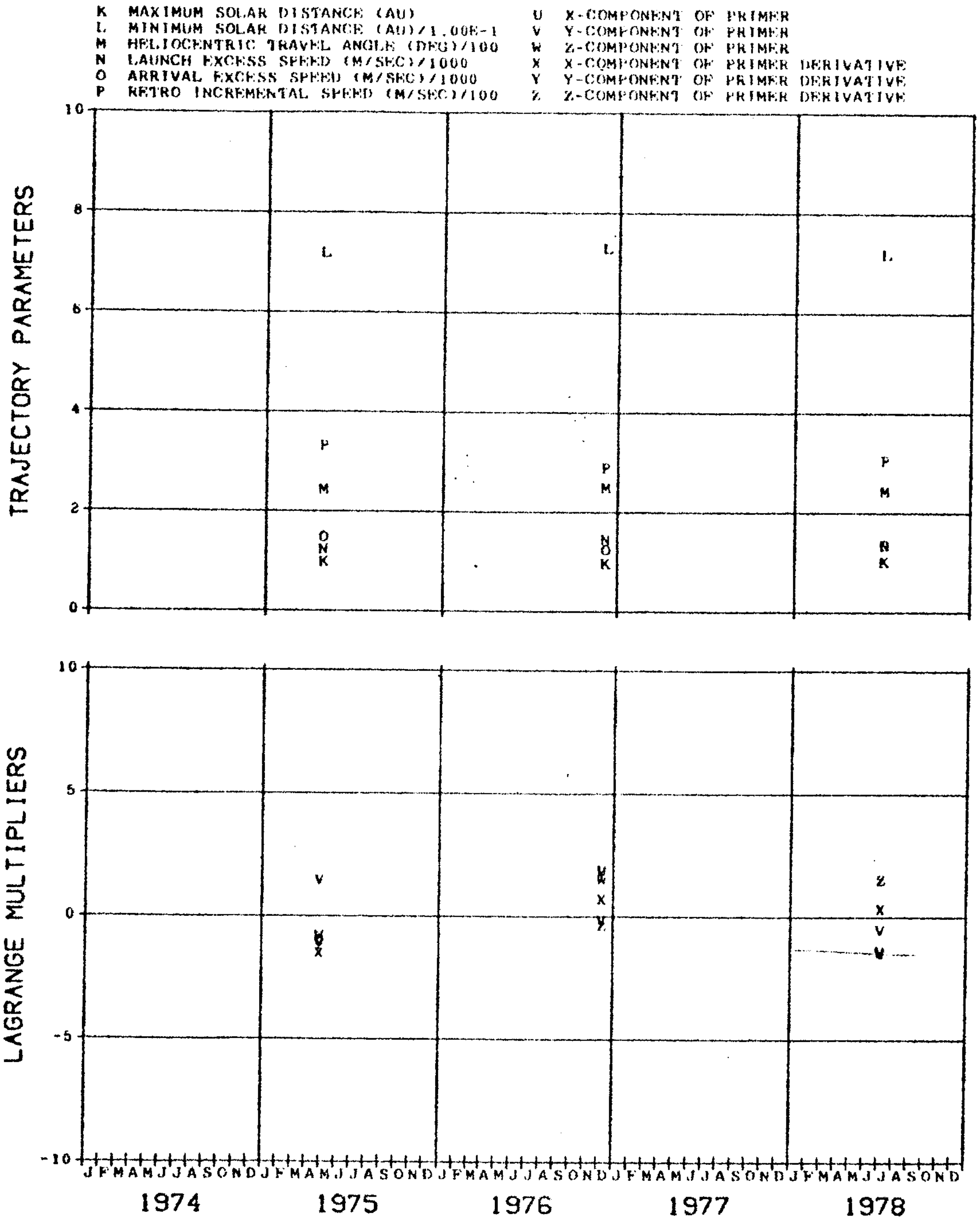

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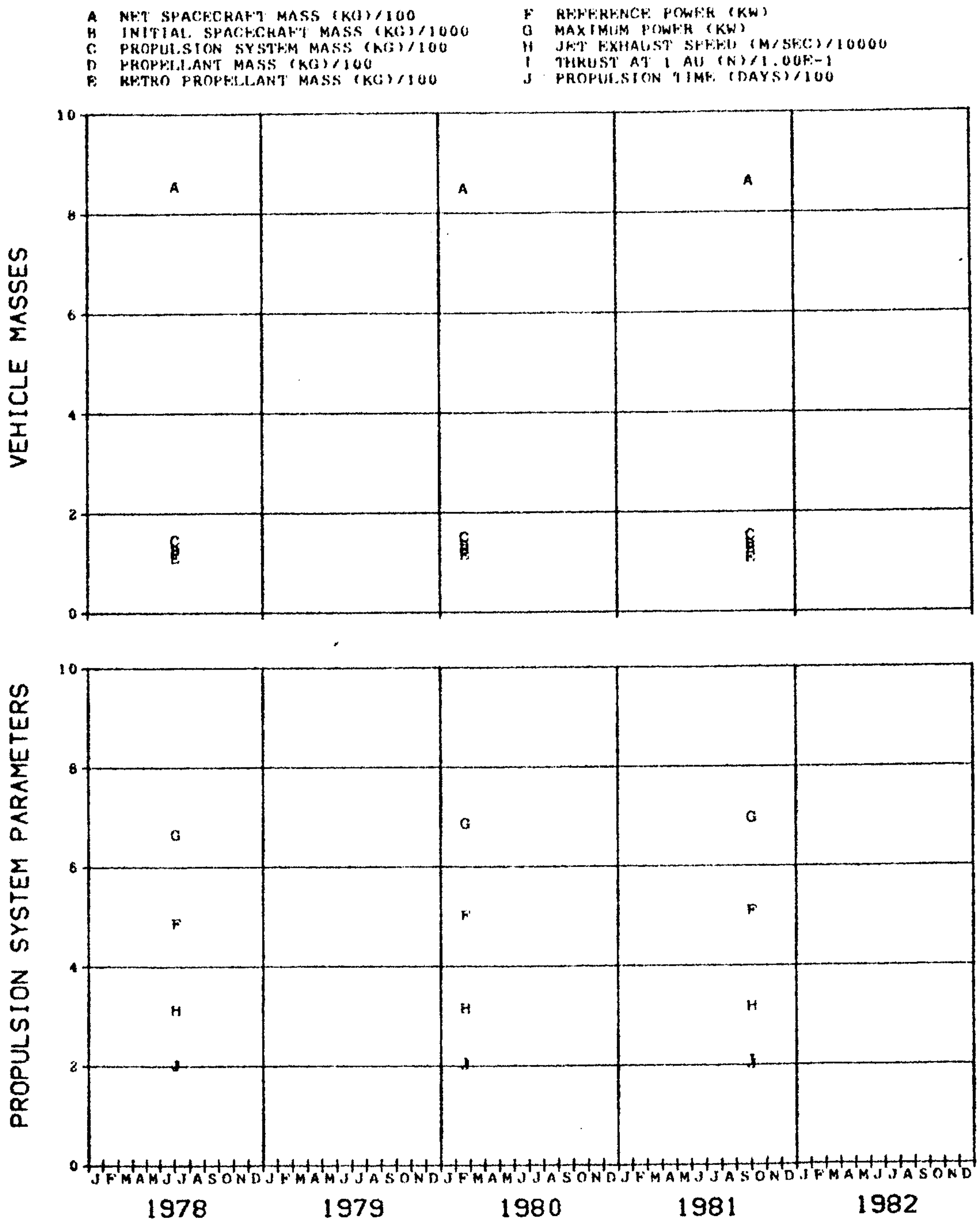

FIG. 4B. VENUS MODE A ORBITER OPPORTUNITIES
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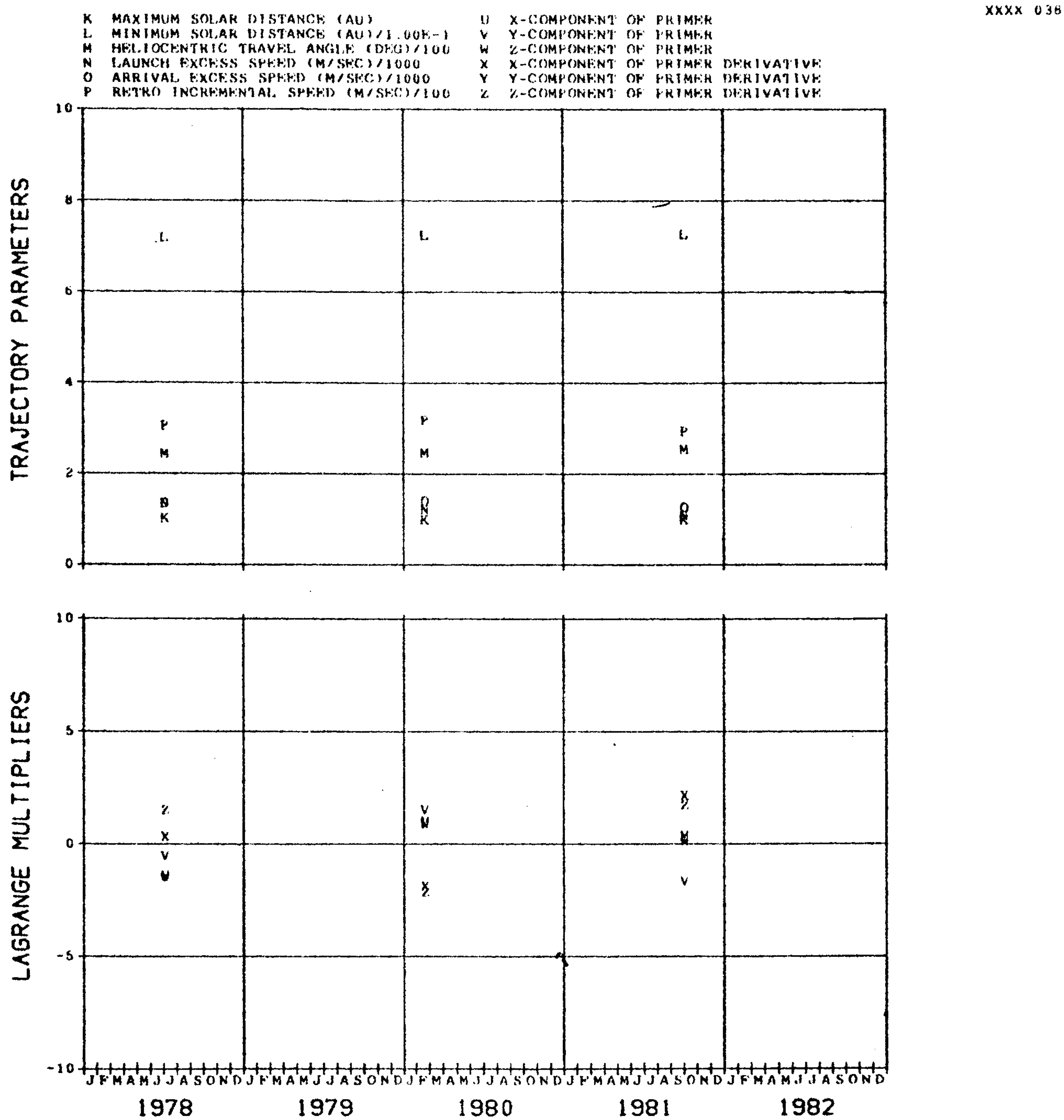

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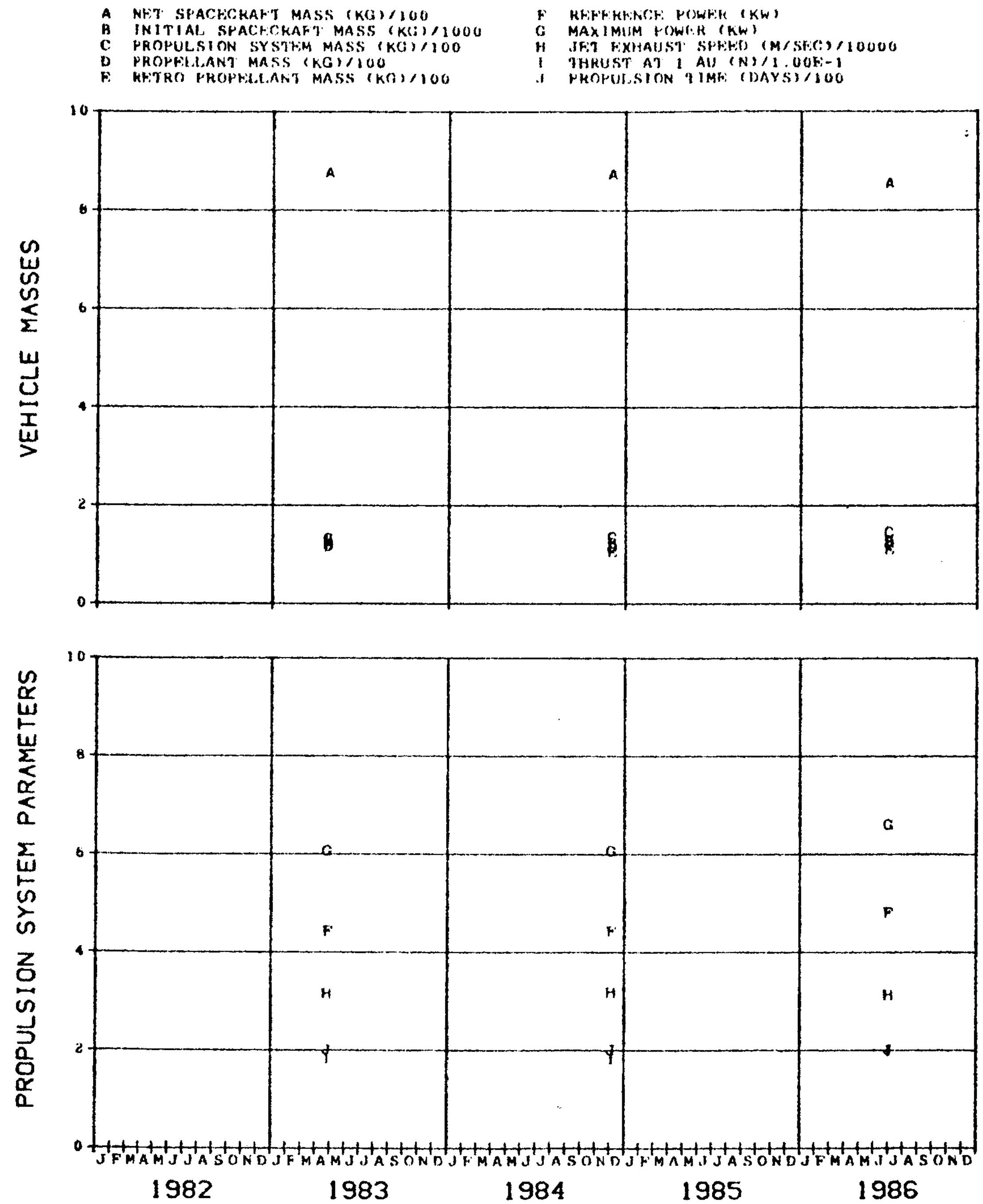

FIG. 4C. VENUS MODE A ORBITER OPPORTUNITIES
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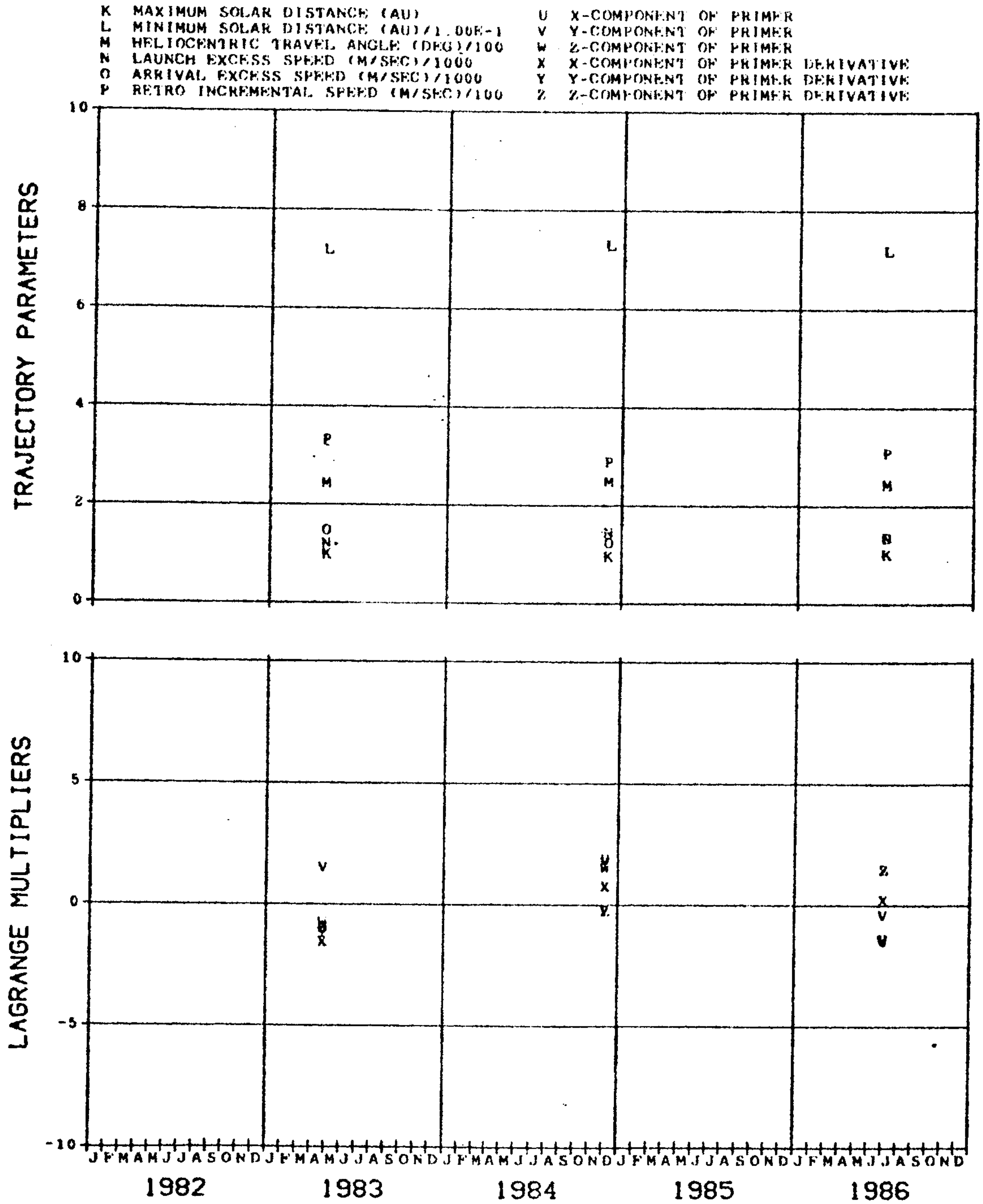

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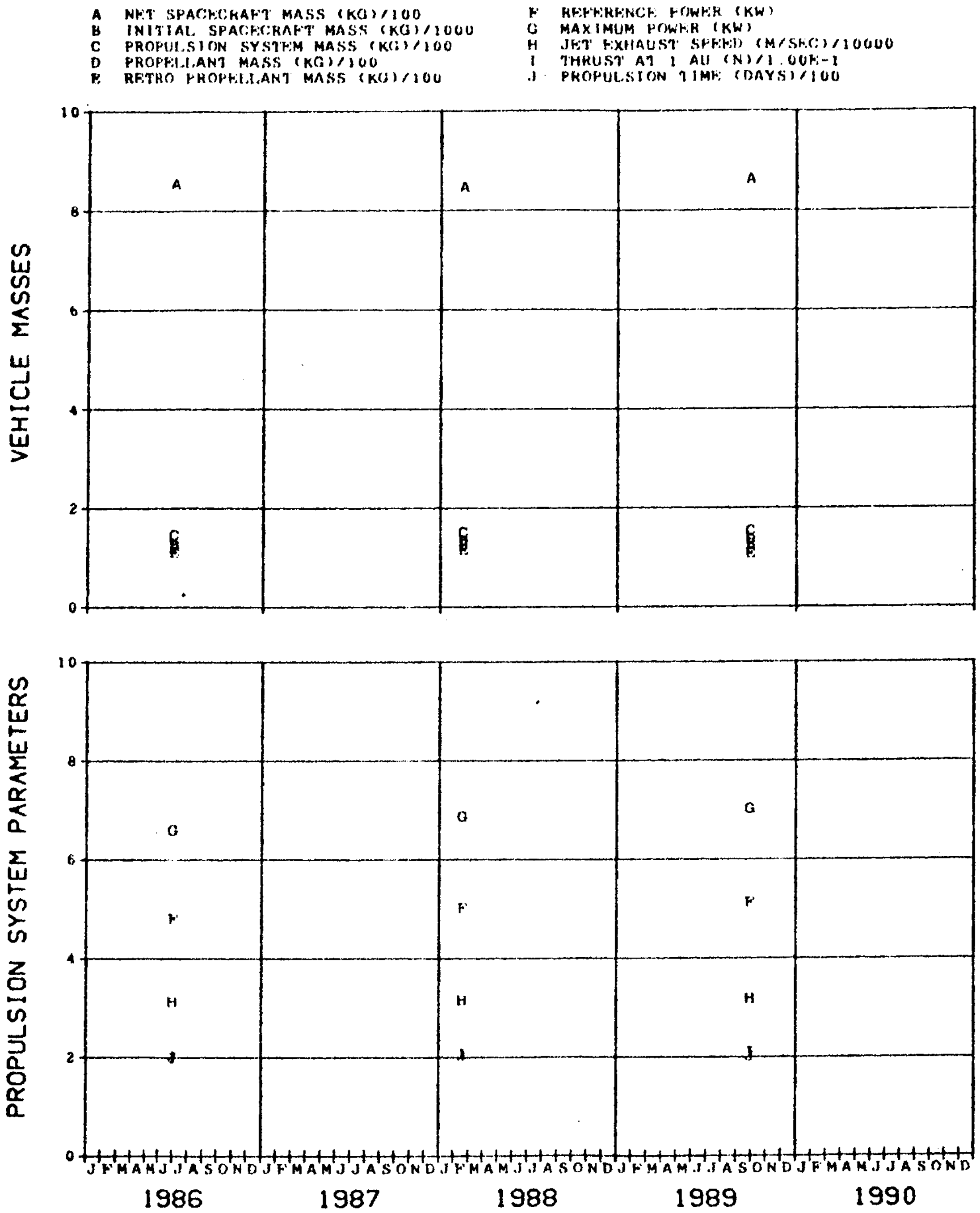

FIG. 4D. VENUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 200 DAYS

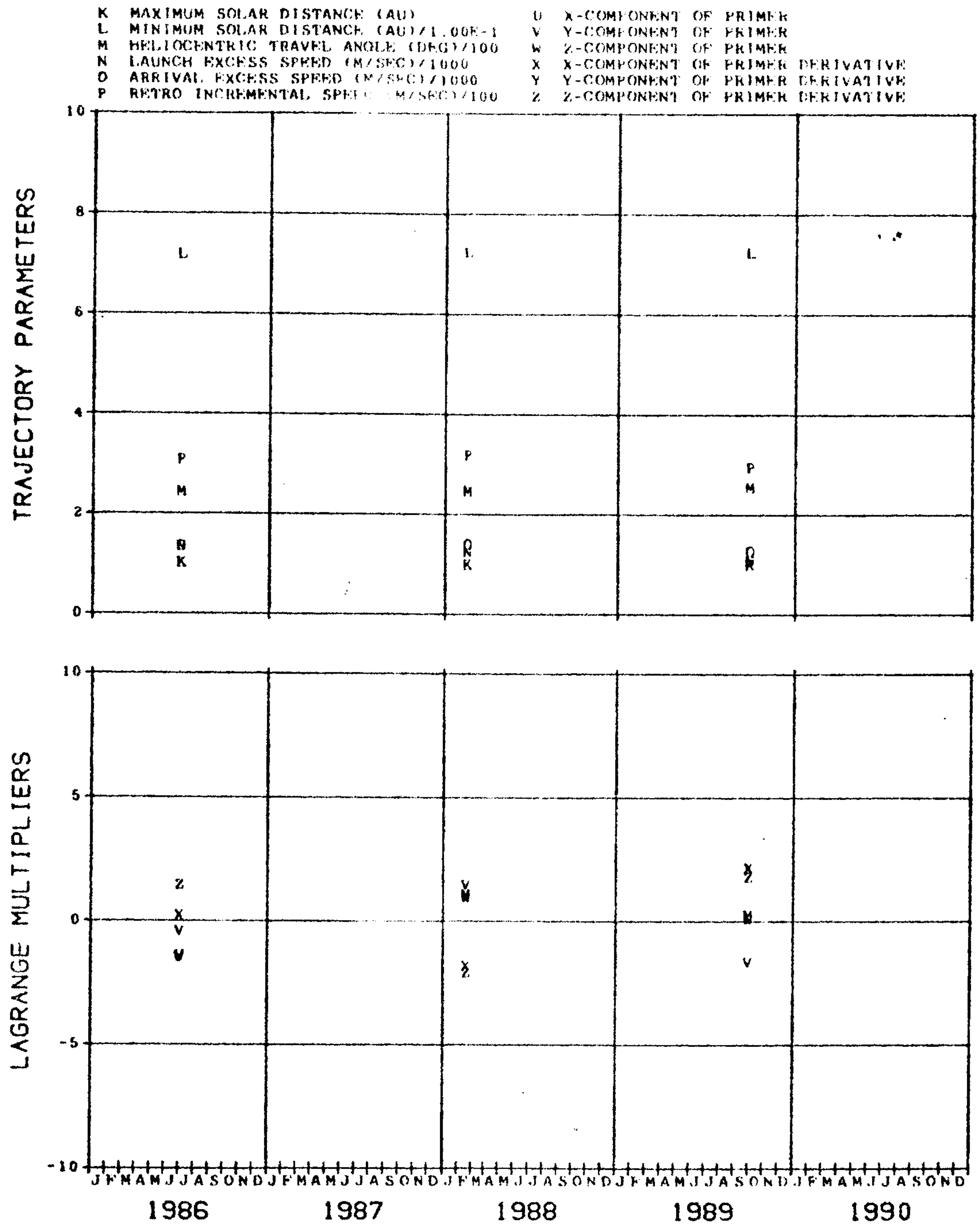

FIG. 4D. (CONCLUDED)

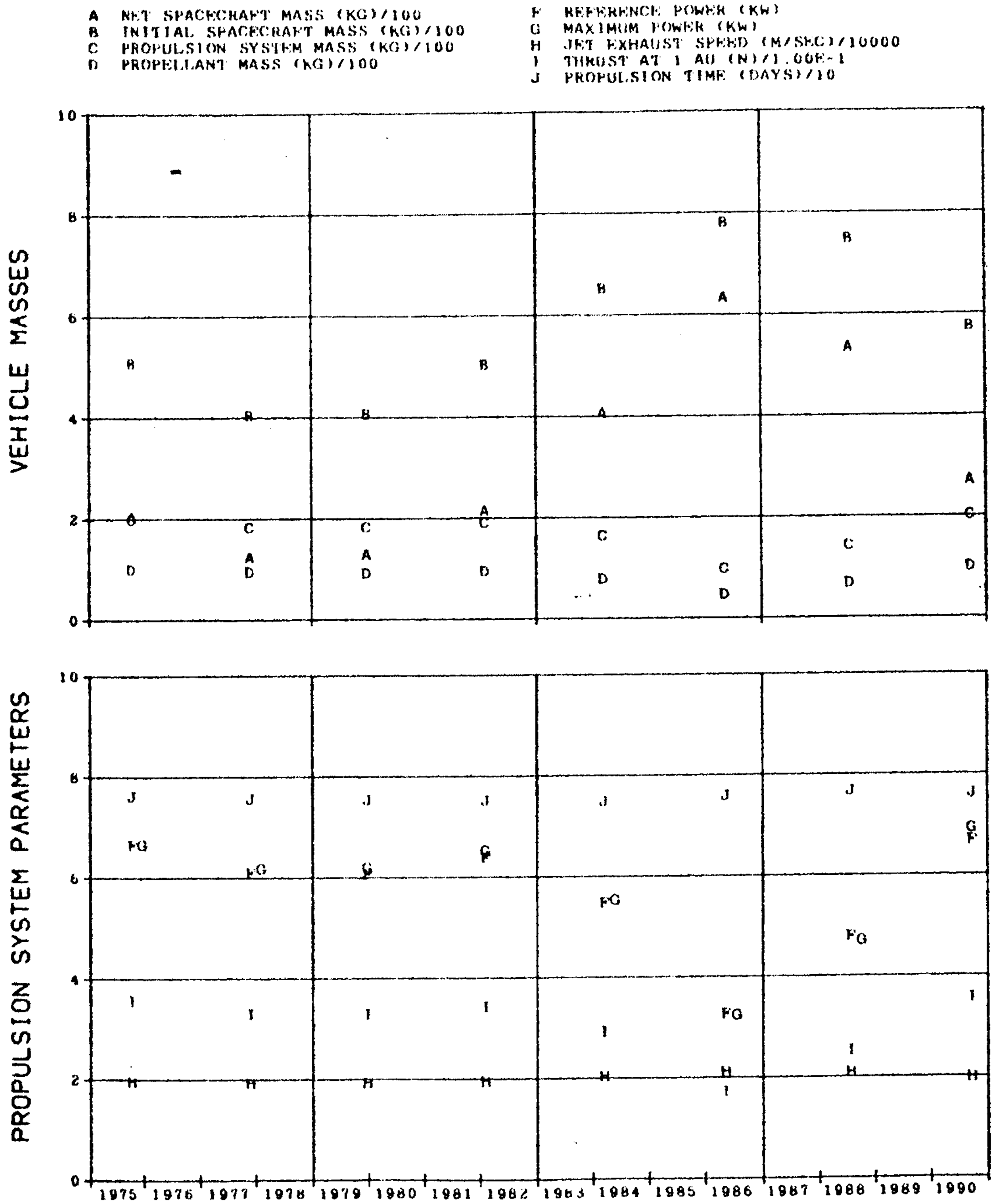

FIG. 5. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 100 DAYS

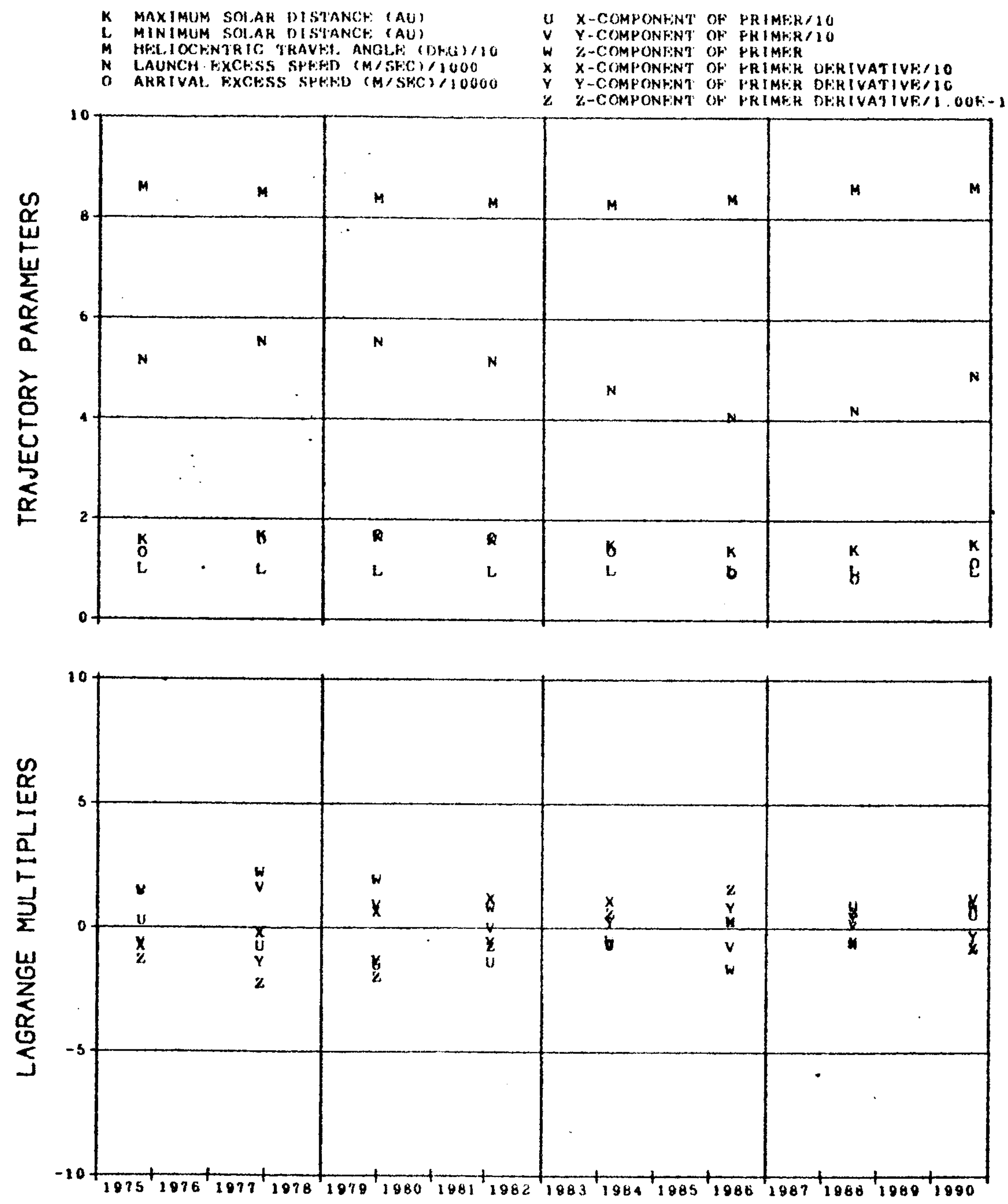

FIG. 5. (CONCLUDED)

XXXX 045

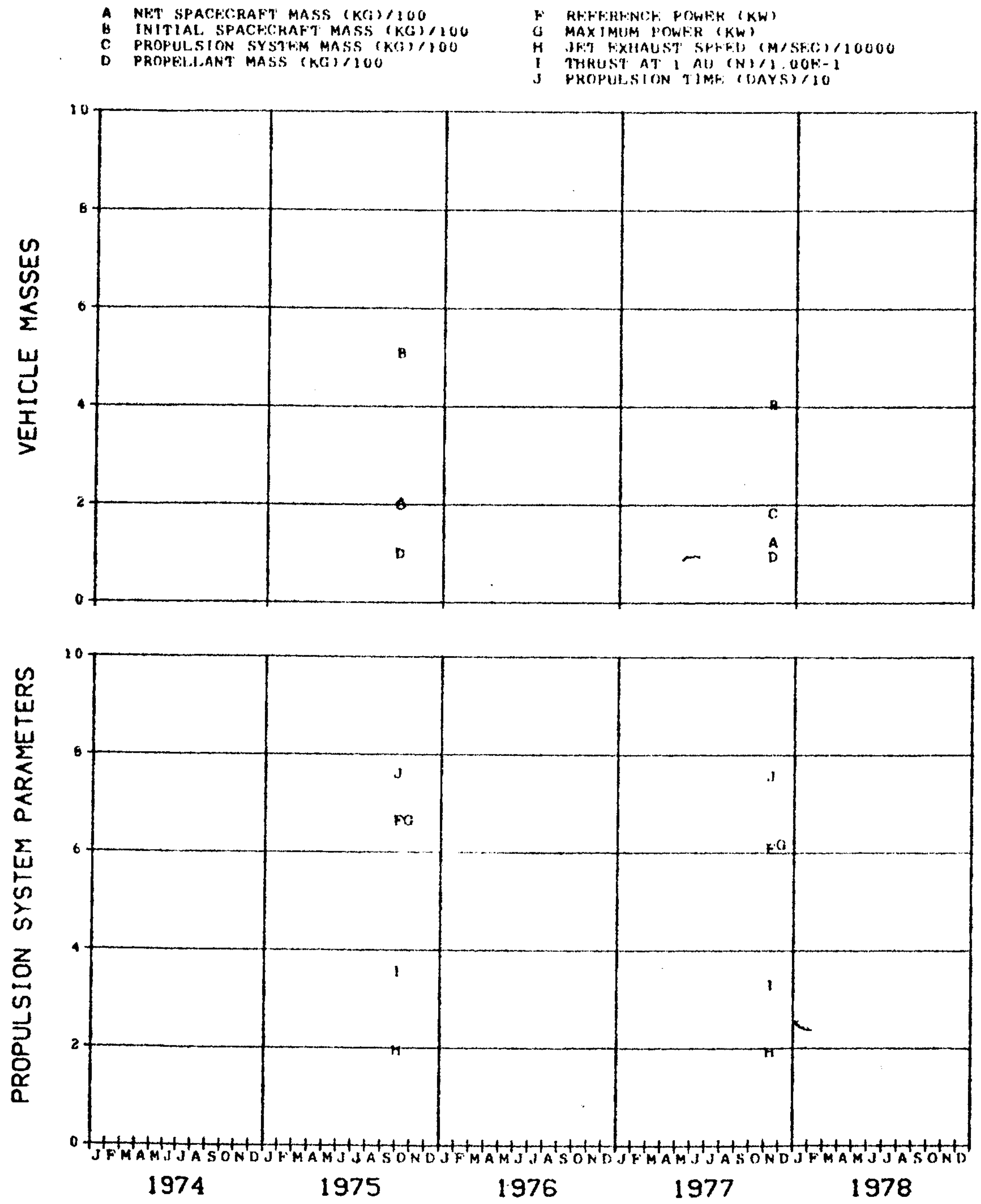

FIG. 5A. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 100 DAYS

XXXX 046

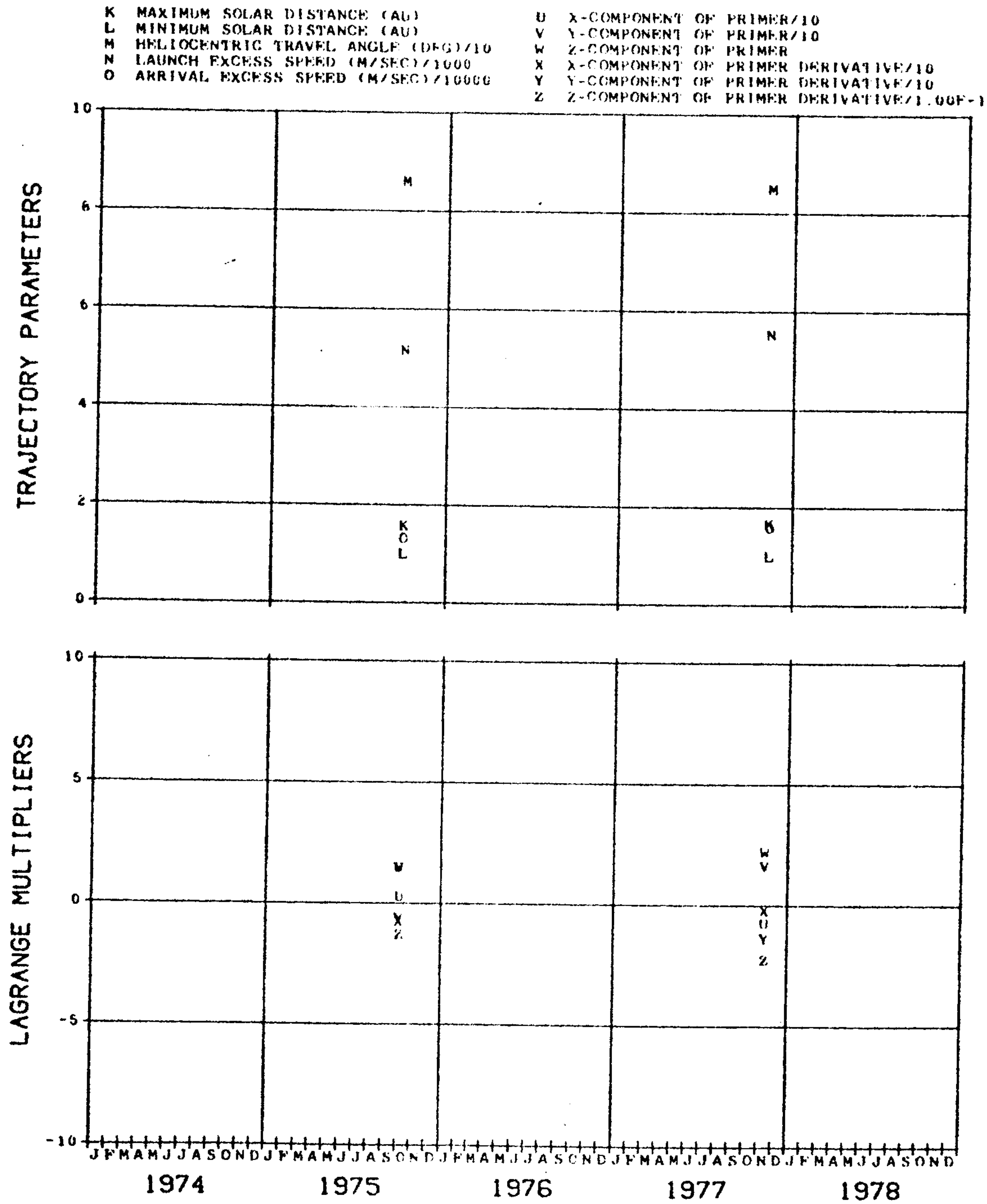

FIG. 5A. (CONCLUDED)

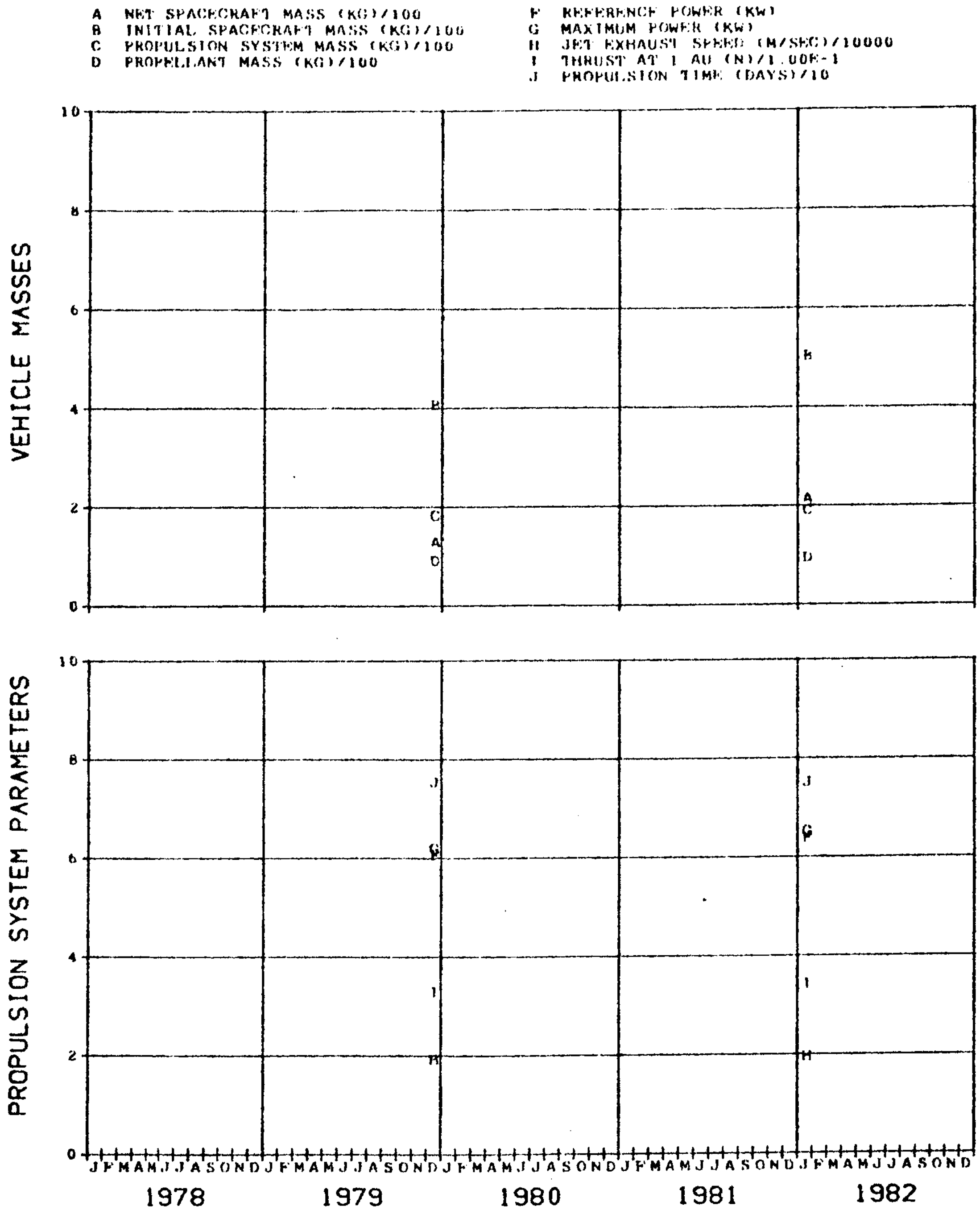

FIG. 5B. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 100 DAYS

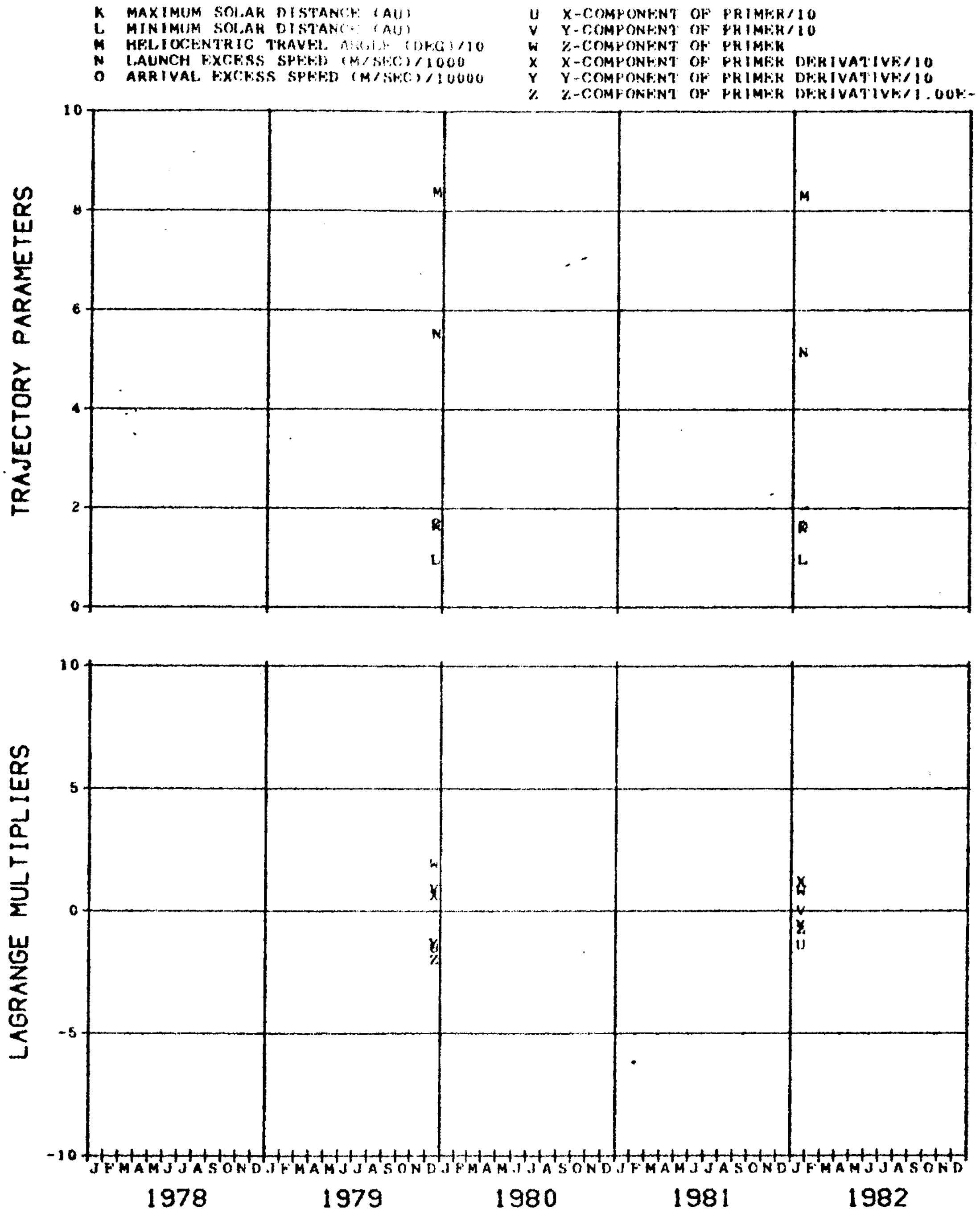

FIG. 5B. (CONCLUDED)

XXXX 049

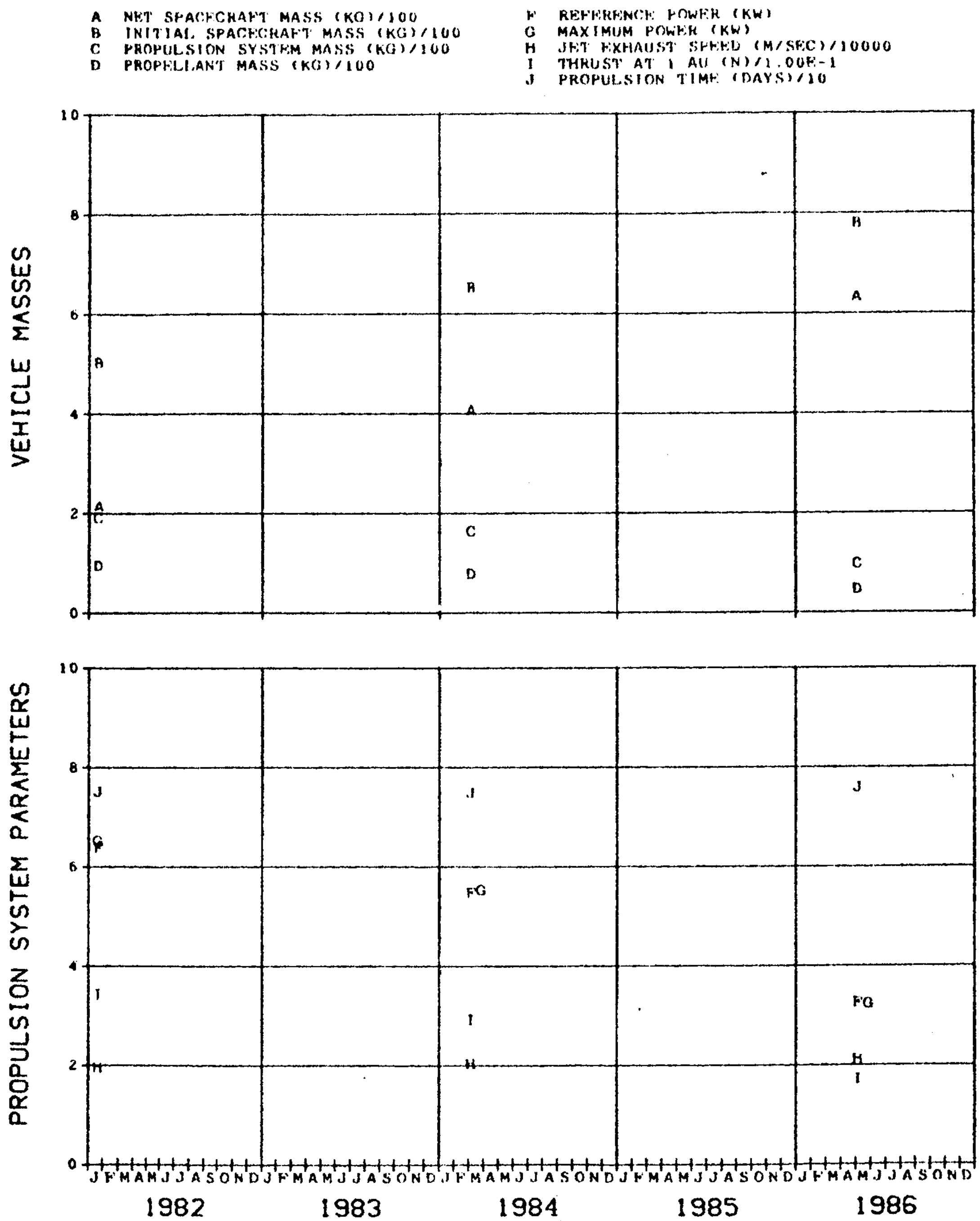

FIG. 5C. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 100 DAYS

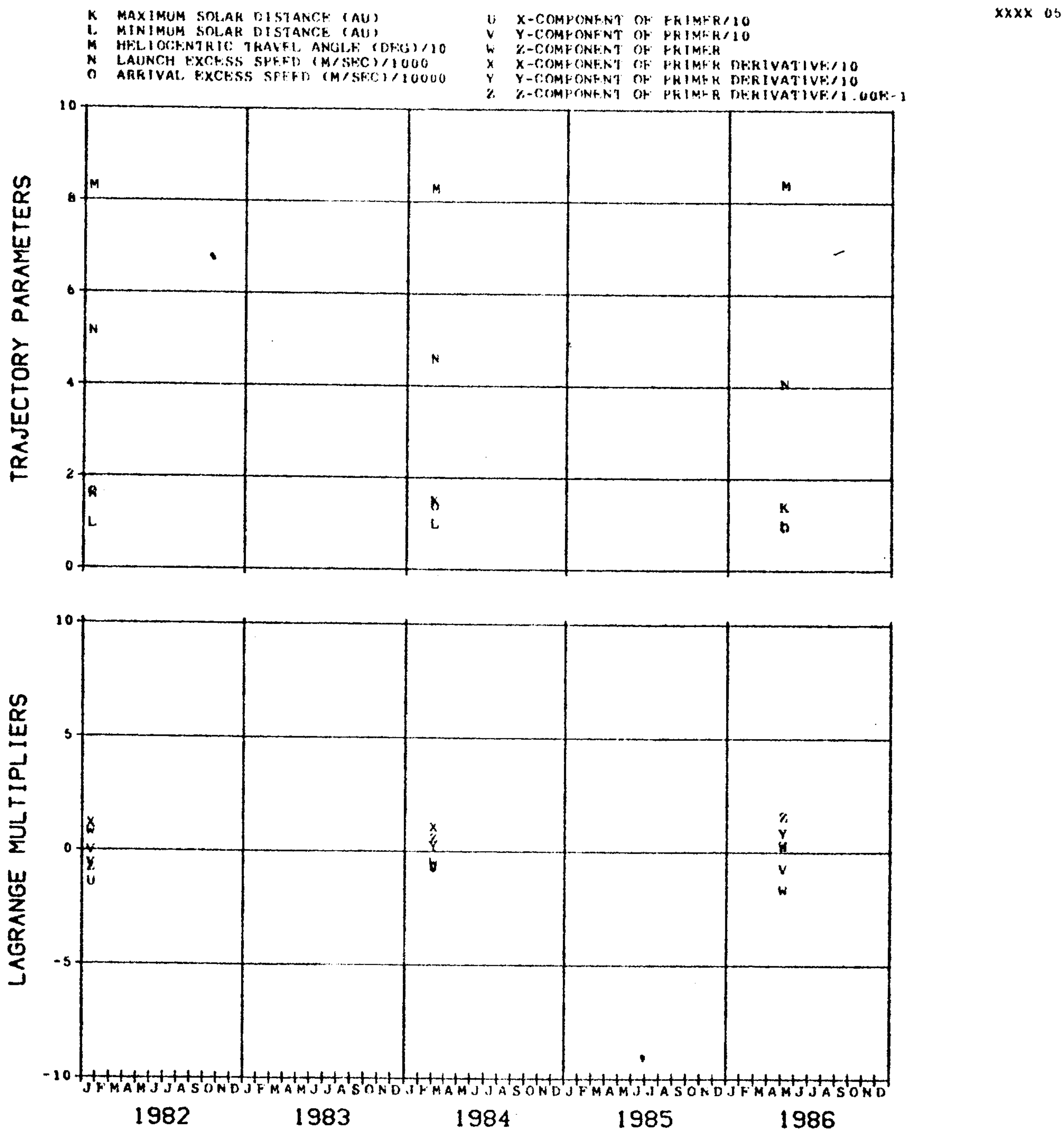

FIG. 5C. (CONCLUDED)

XXXX 051

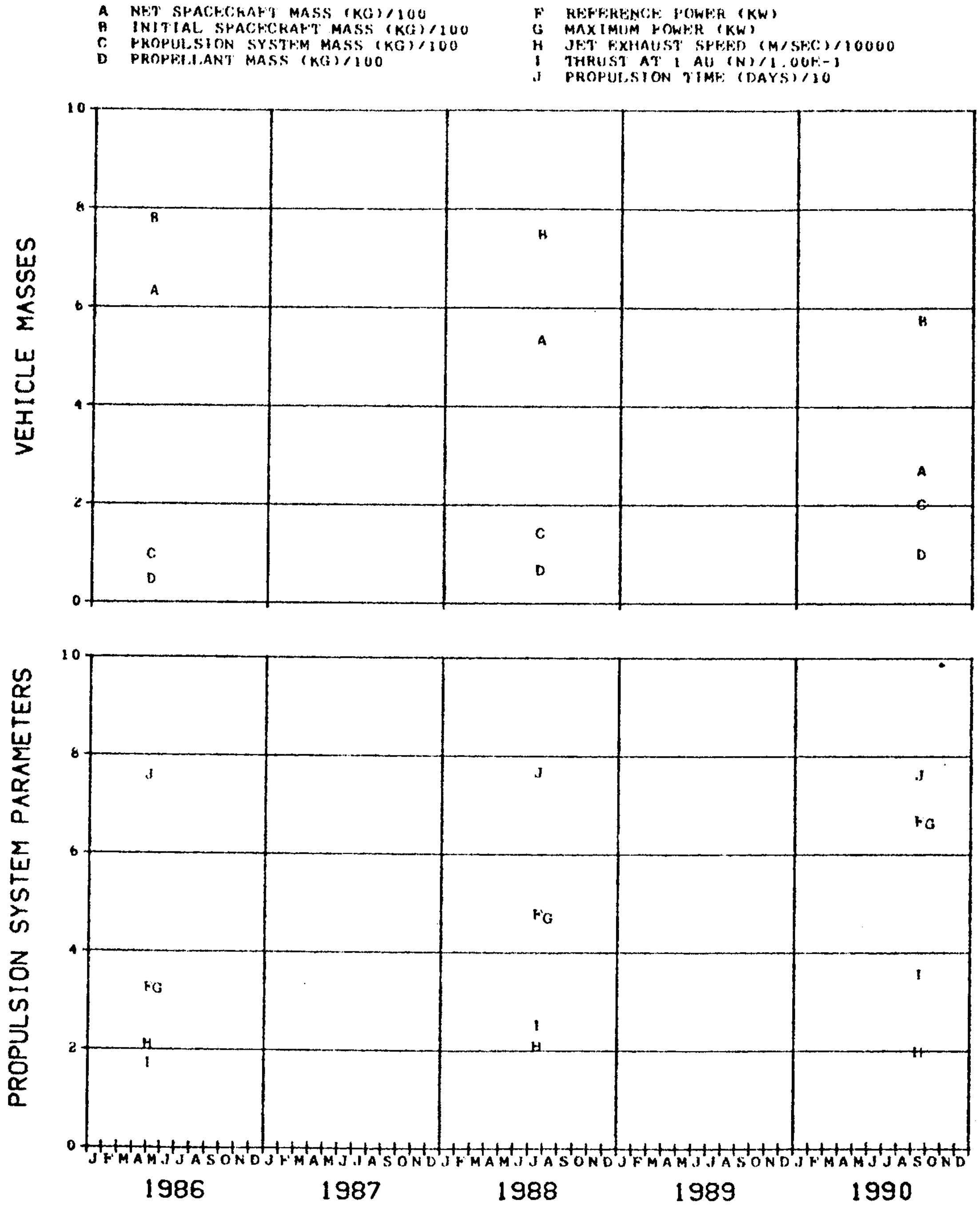

FIG. 5D. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 100 DAYS

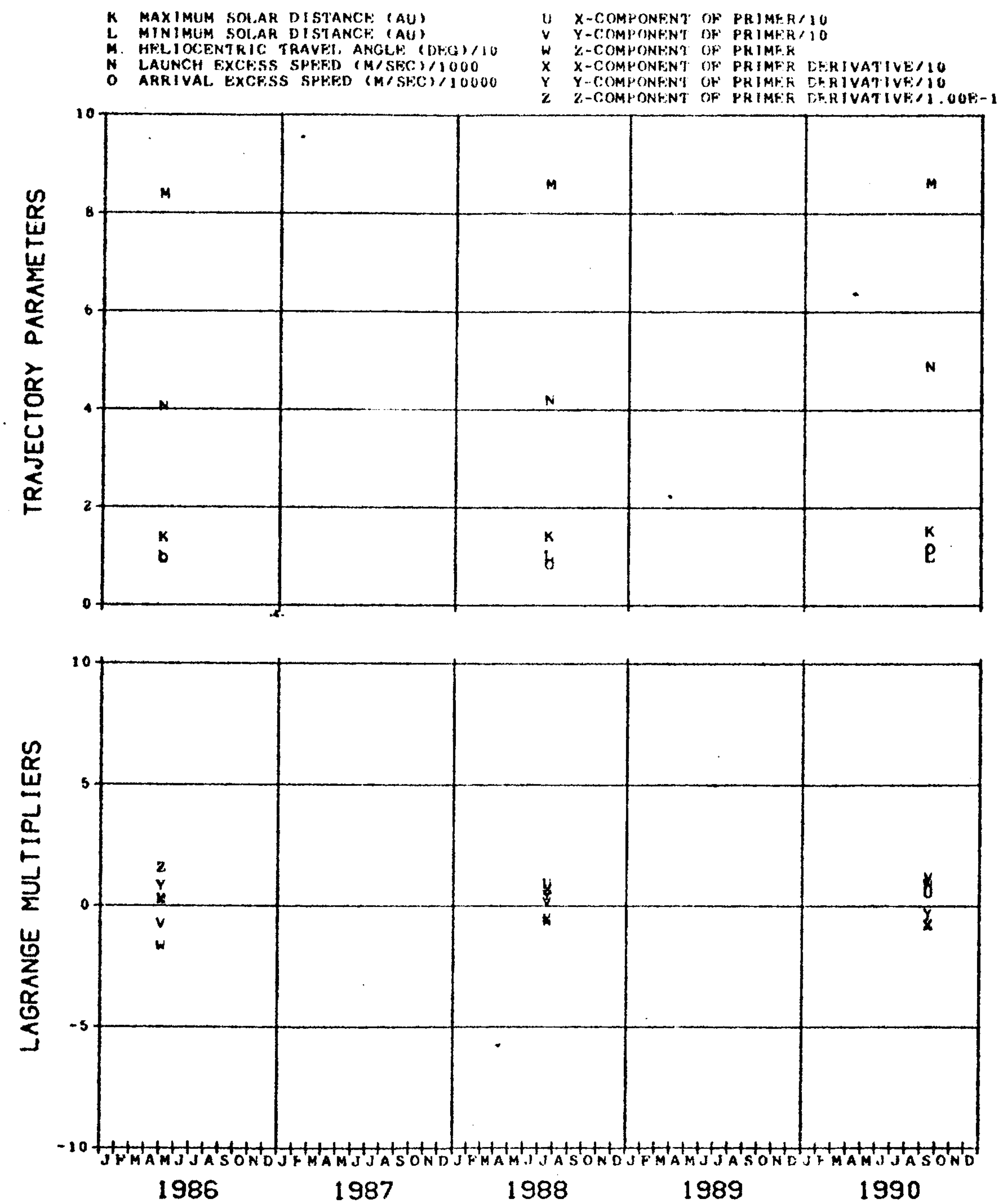

FIG. 5D. -(CONCLUDED)

XXXX- 053

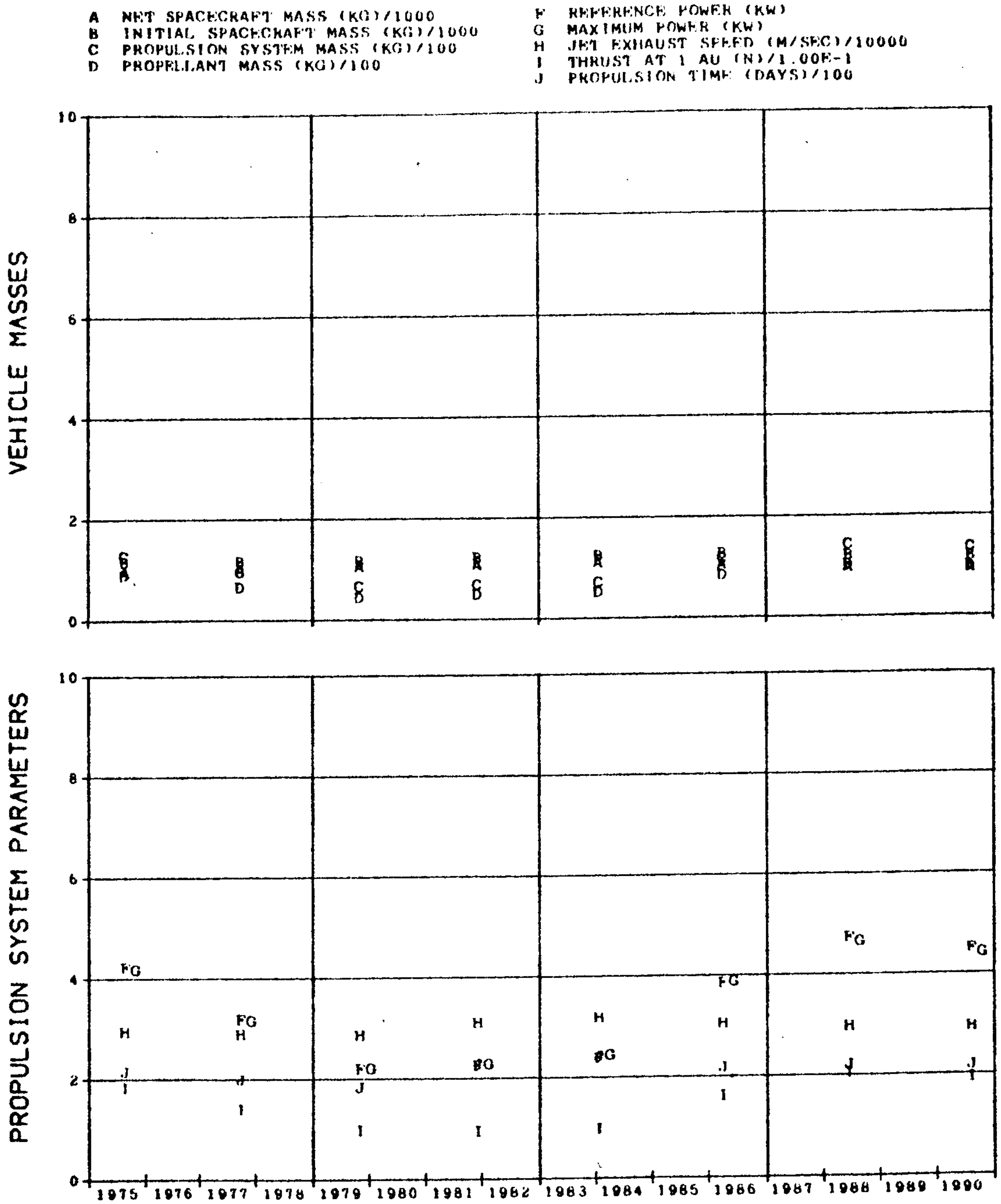

FIG. 6. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 300 DAYS

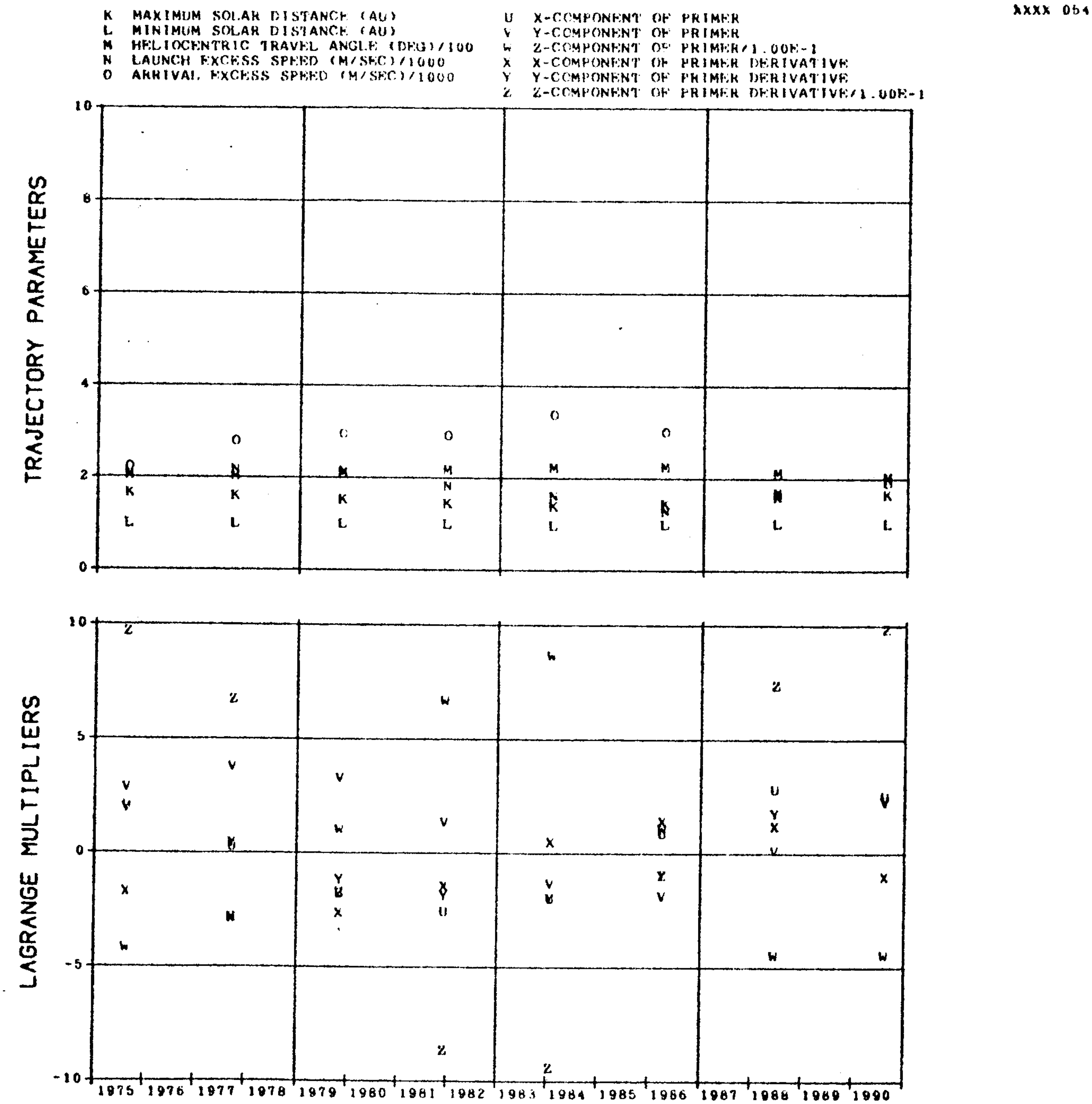

FIG. 6. (CONCLUDED)

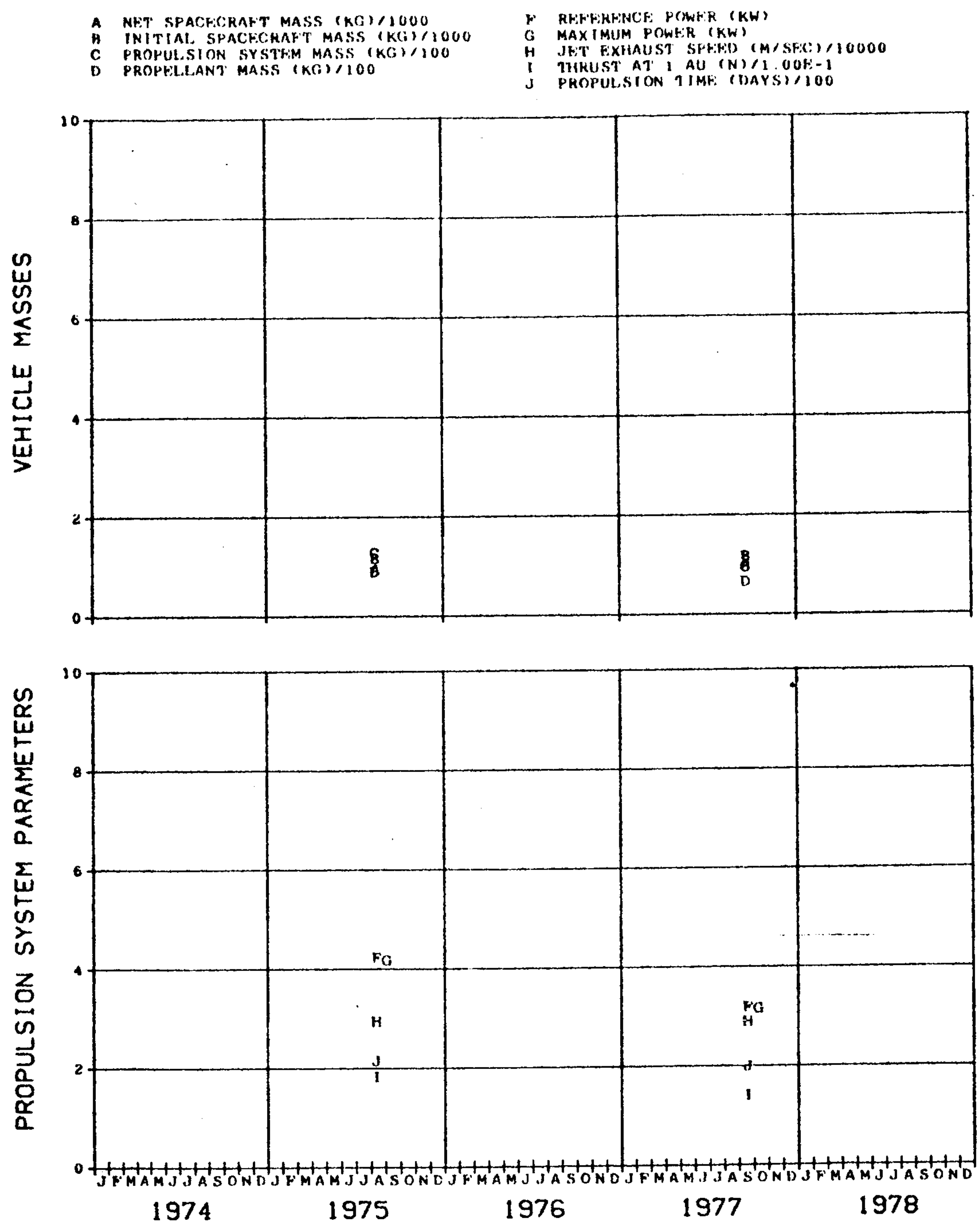

FIG. 6A. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 300 DAYS

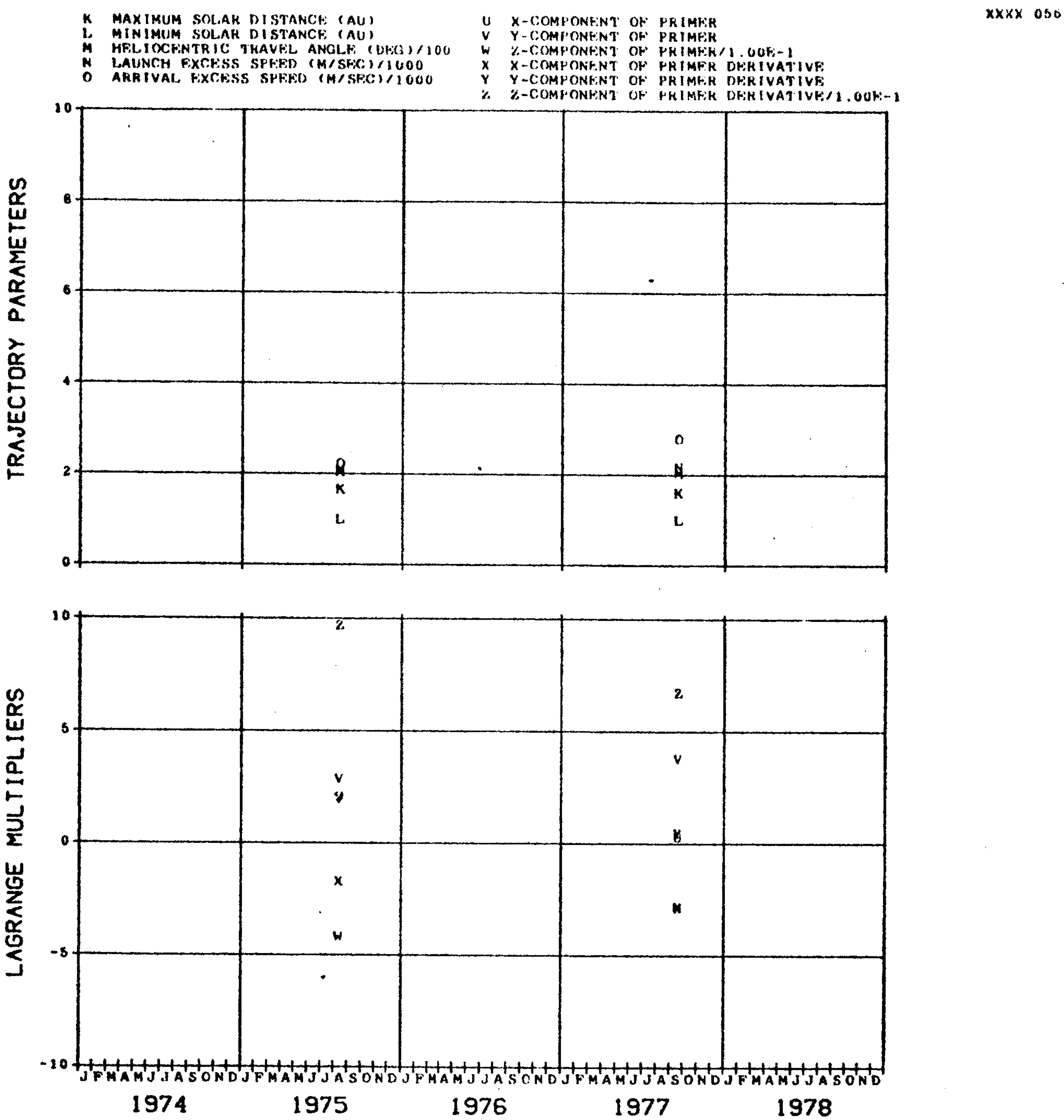

FIG. 6A. (CONCLUDED)

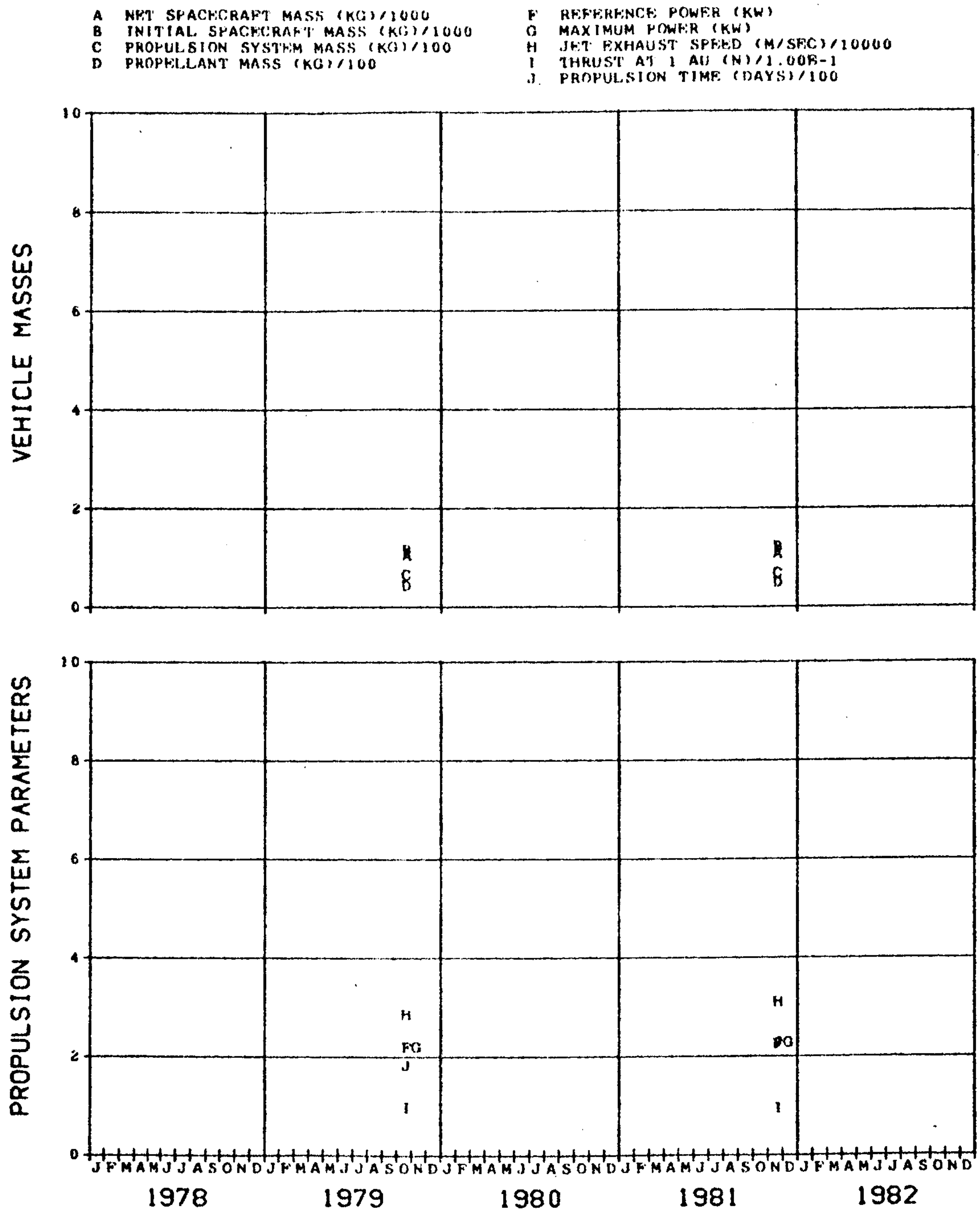

FIG. 6B. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 300 DAYS

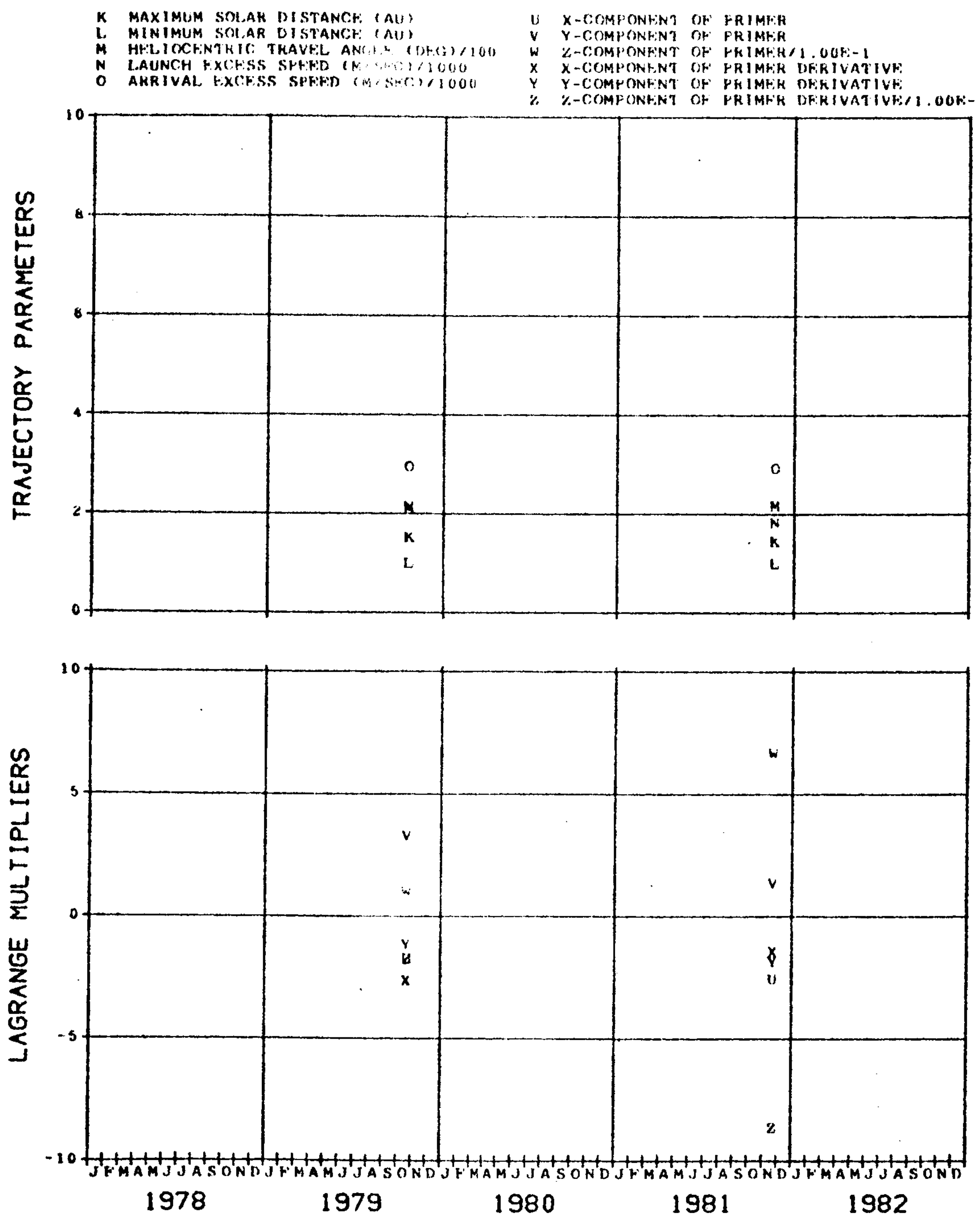

FIG. 6B. (CONCLUDED)

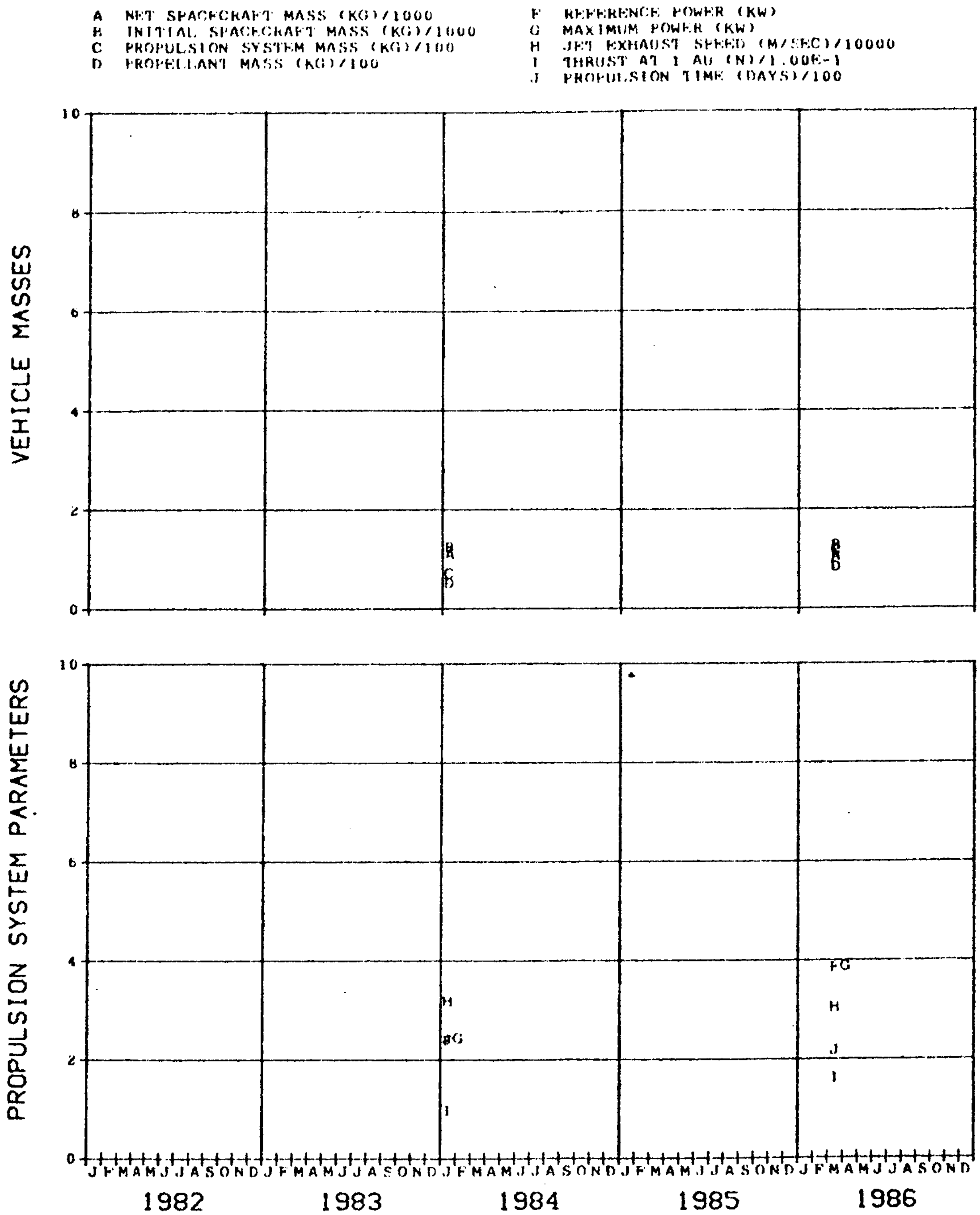

FIG. 6C. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 300 DAYS

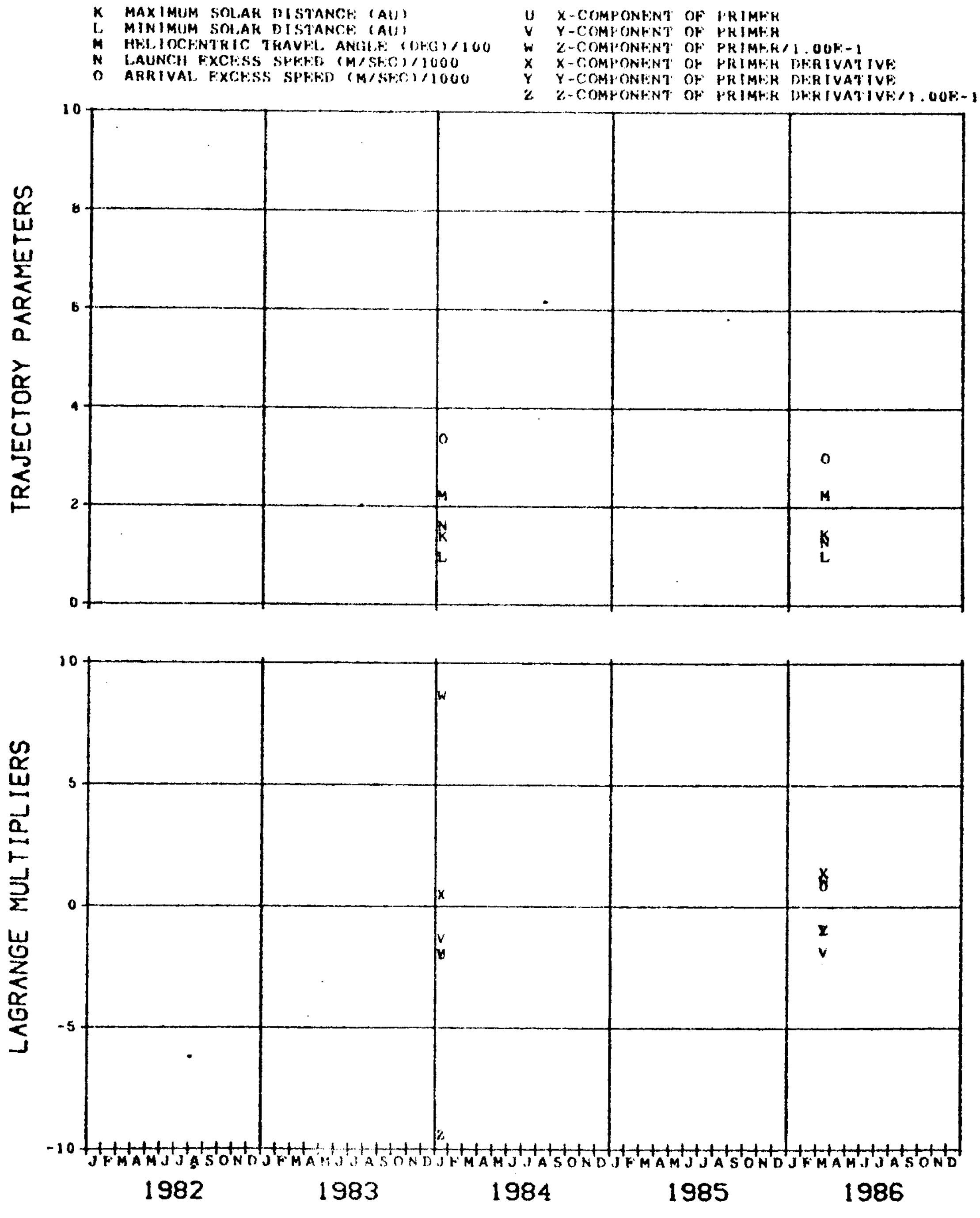

FIG. 6C. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/1000
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)
G MAXIMUM POWER (KW)
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

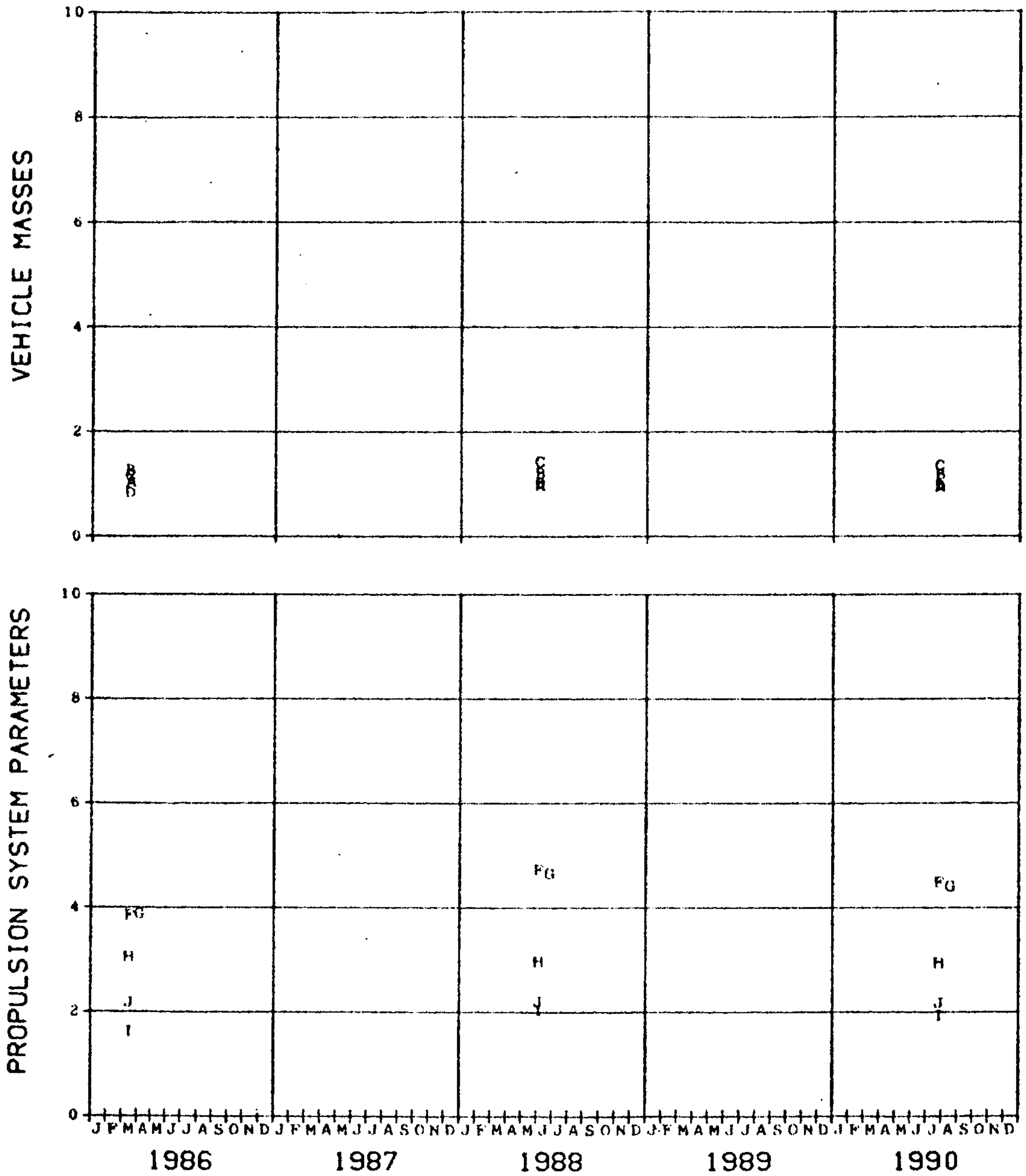

FIG. 6D. MARS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 300 DAYS

K MAXIMUM SOLAR DISTANCE (AU)
L MINIMUM SOLAR DISTANCE (AU)
M HELIOCENTRIC TRAVEL ANGLE (DEG)/100
N LAUNCH EXCESS SPEED (M/SEC)/1000
O ARRIVAL EXCESS SPEED (M/SEC)/1000

U X-COMPONENT OF PRIMER
V Y-COMPONENT OF PRIMER
W Z-COMPONENT OF PRIMER/1.00E-1
X X-COMPONENT OF PRIMER DERIVATIVE
Y Y-COMPONENT OF PRIMER DERIVATIVE
Z Z-COMPONENT OF PRIMER DERIVATIVE/1.00E-1

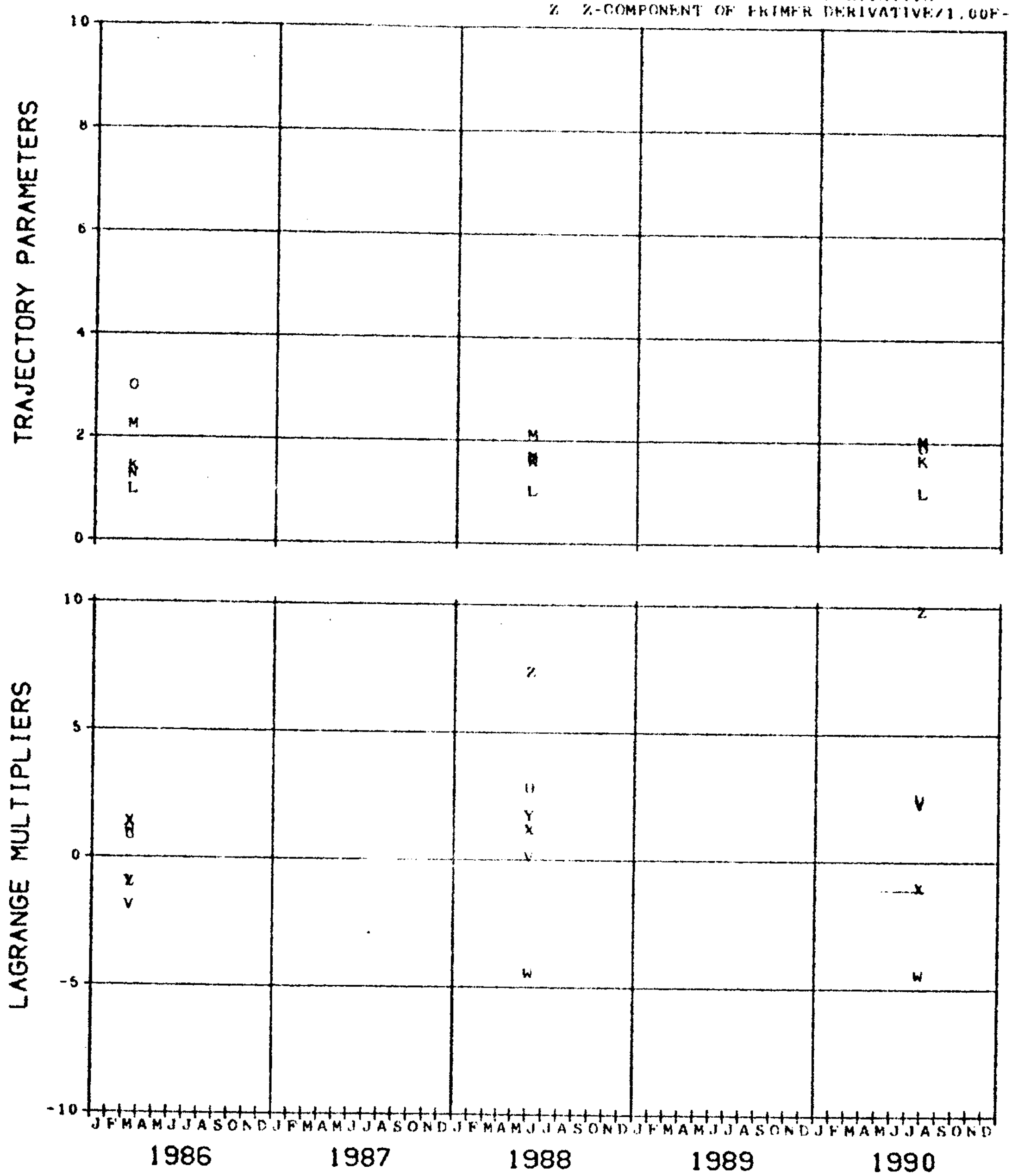

FIG. 6D. (CONCLUDED)

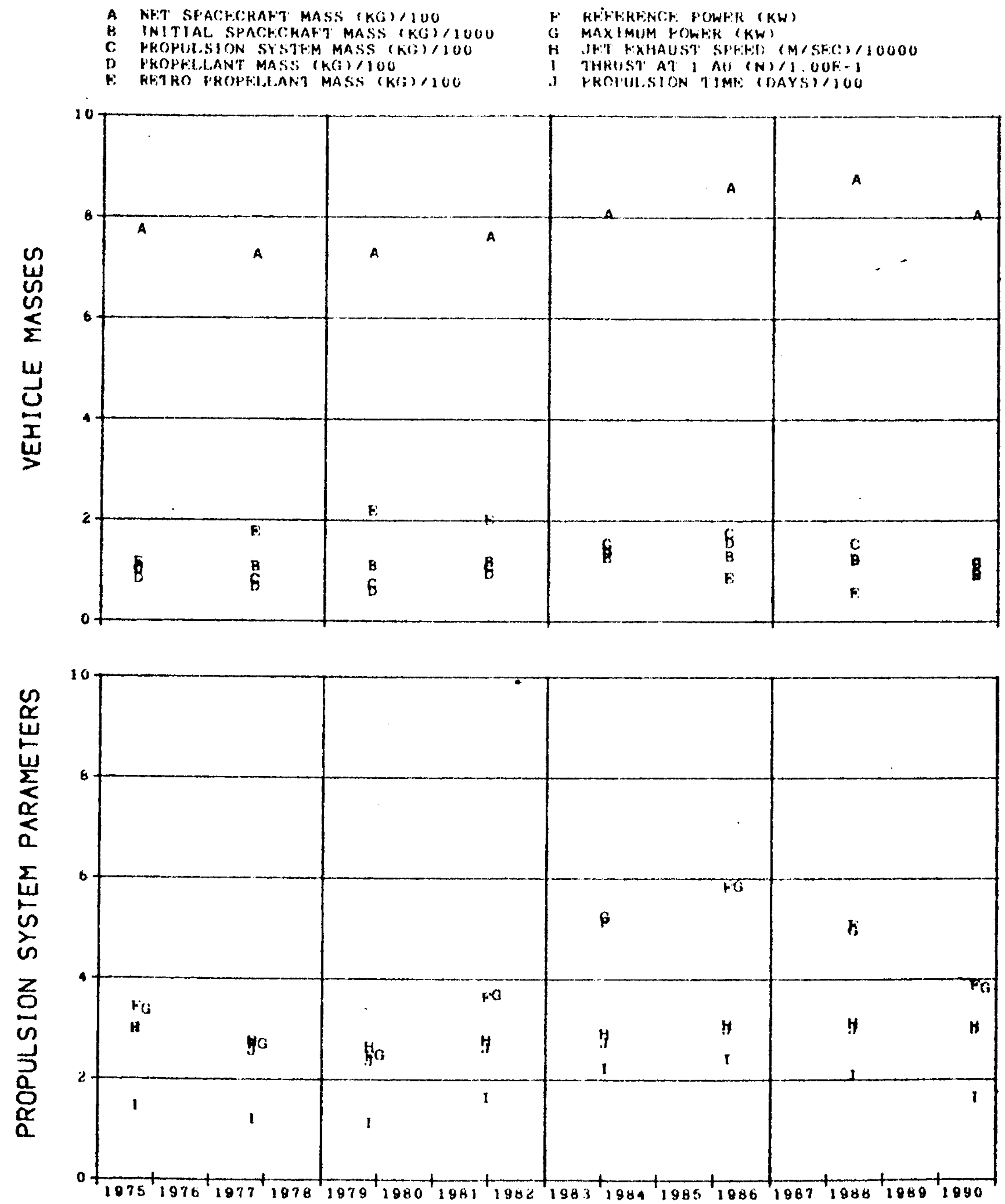

FIG. 7. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 300 DAYS

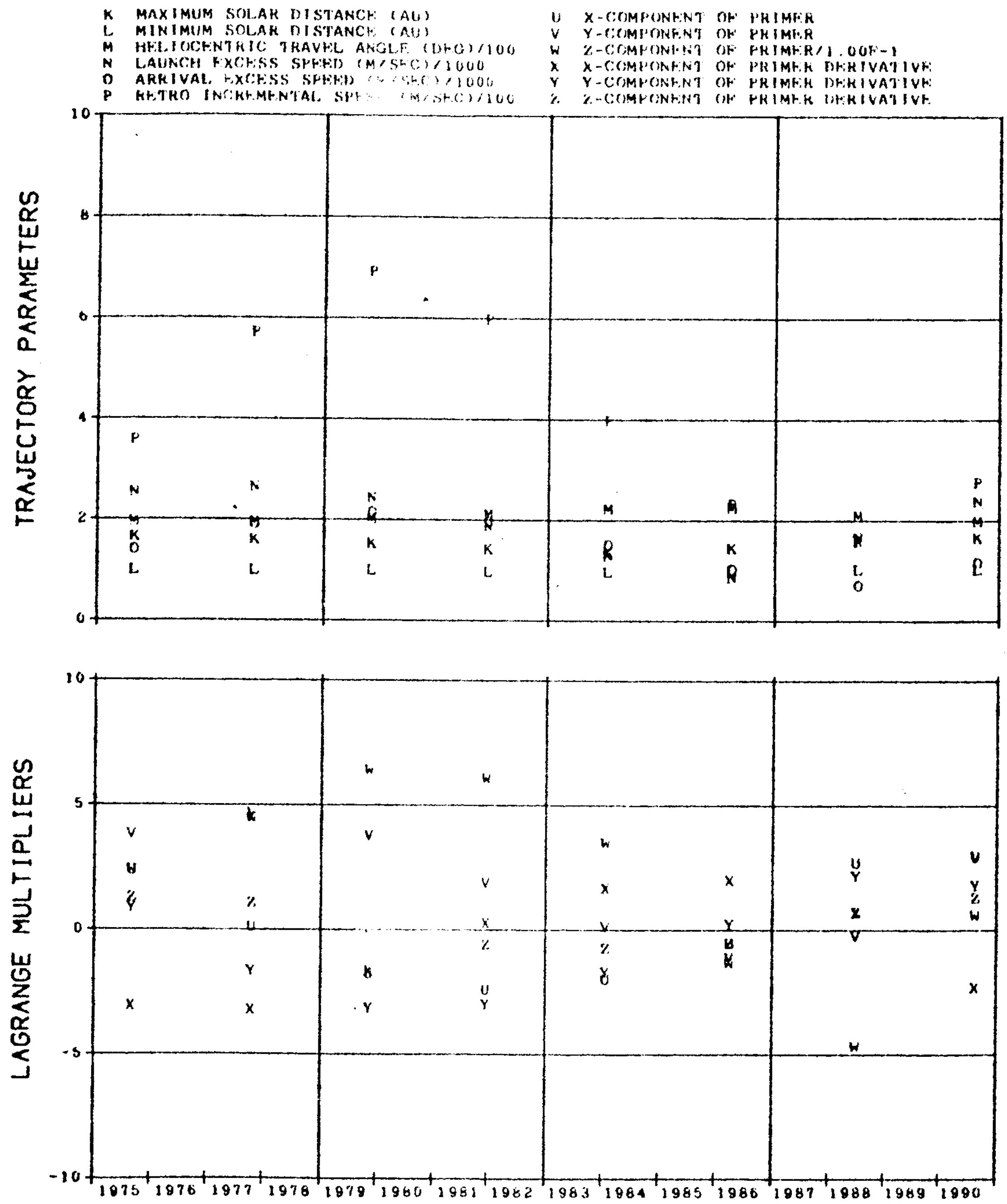

FIG. 7. (CONCLUDED)

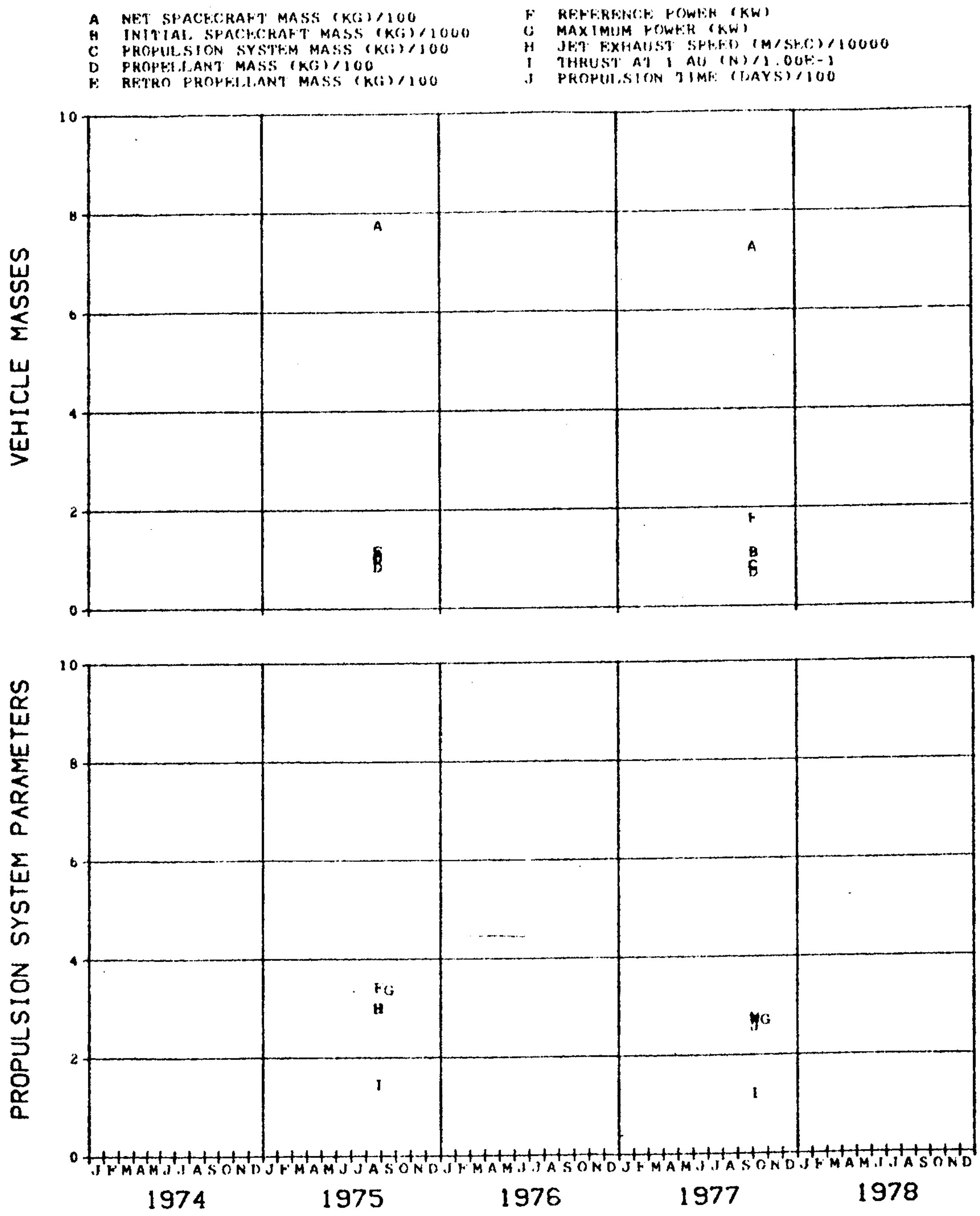

FIG. 7A. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 300 DAYS

XXXX 066

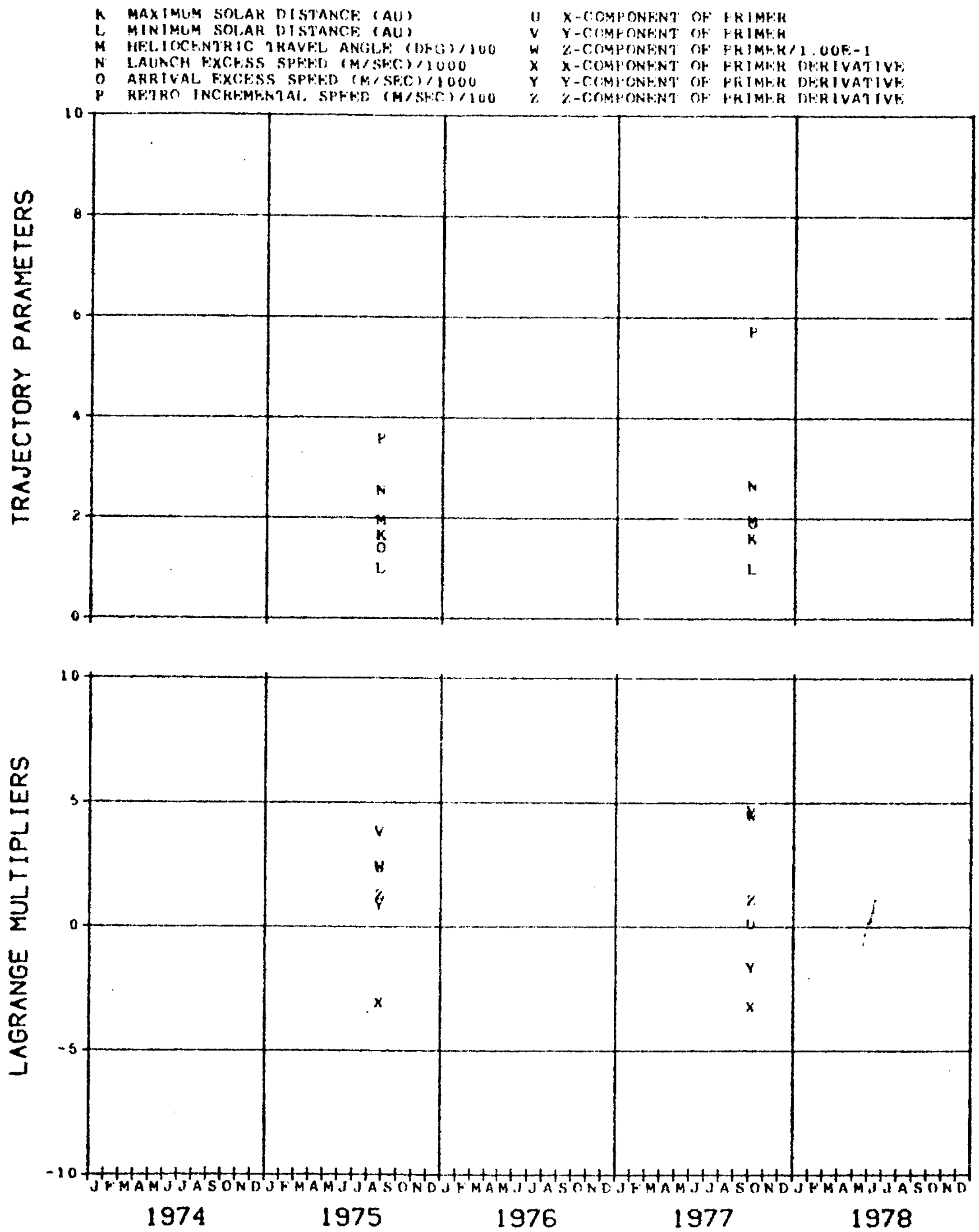

FIG. 7A. (CONCLUDED)

XXXX 067

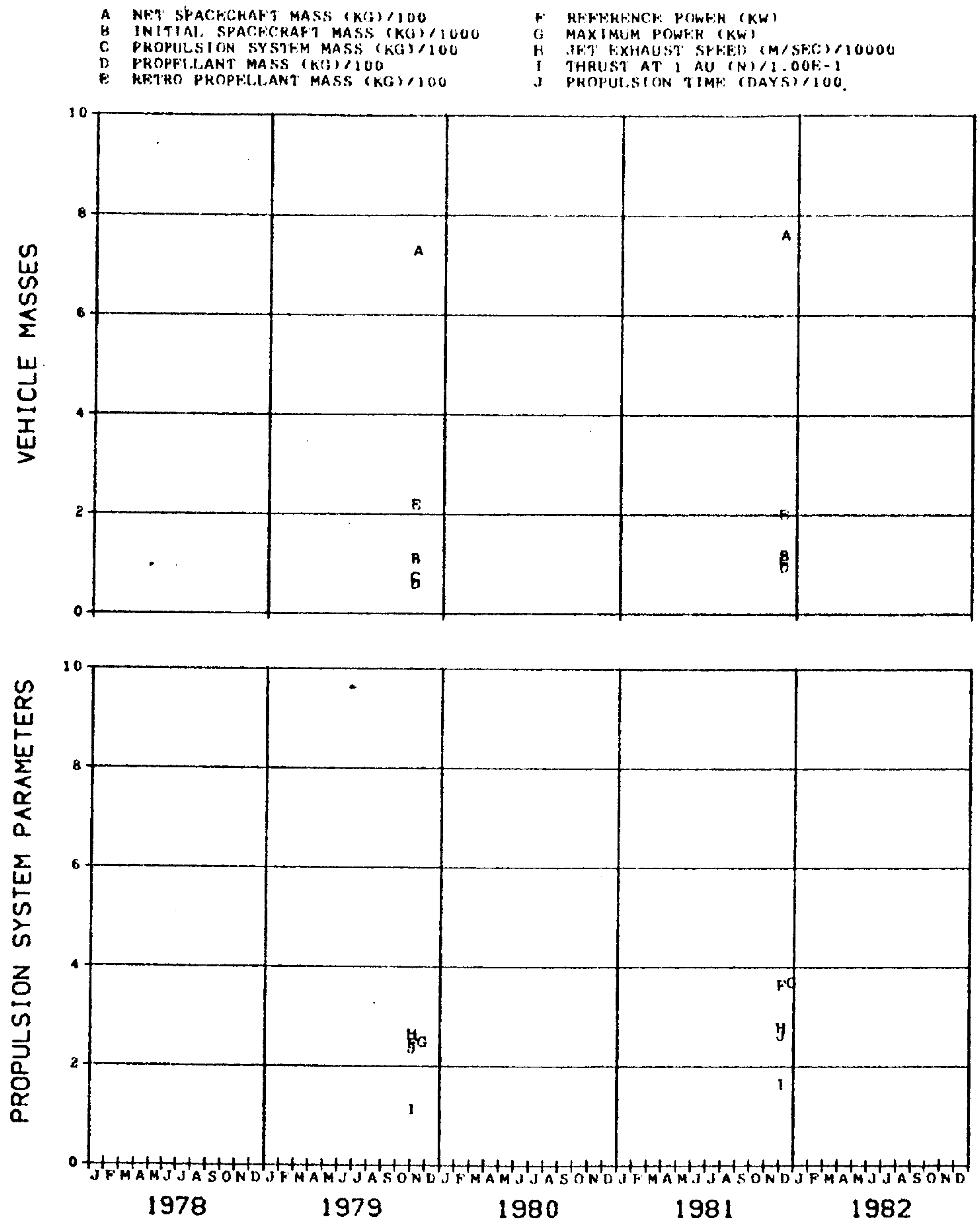

FIG. 7B. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 300 DAYS

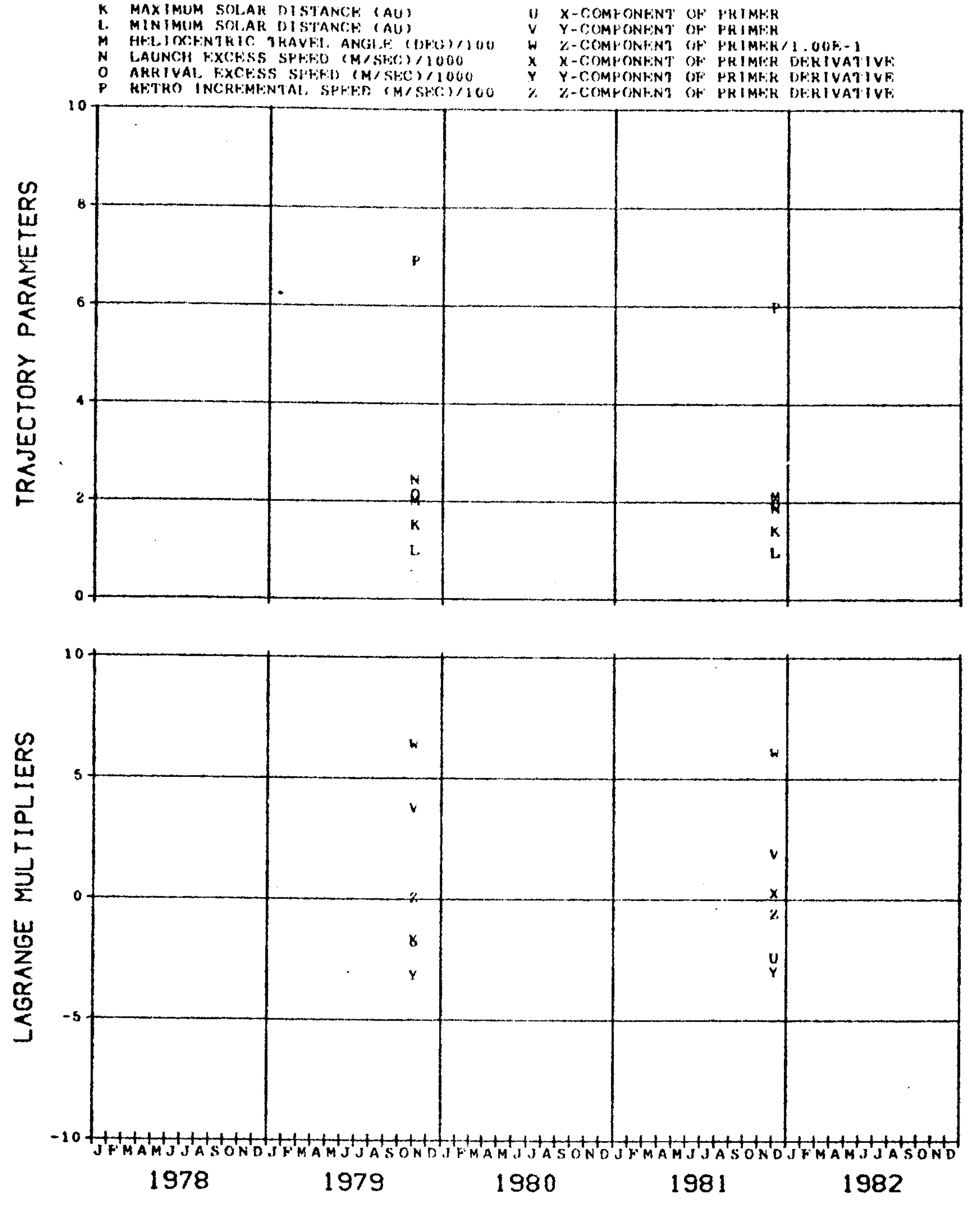

FIG. 7B. (CONCLUDED)

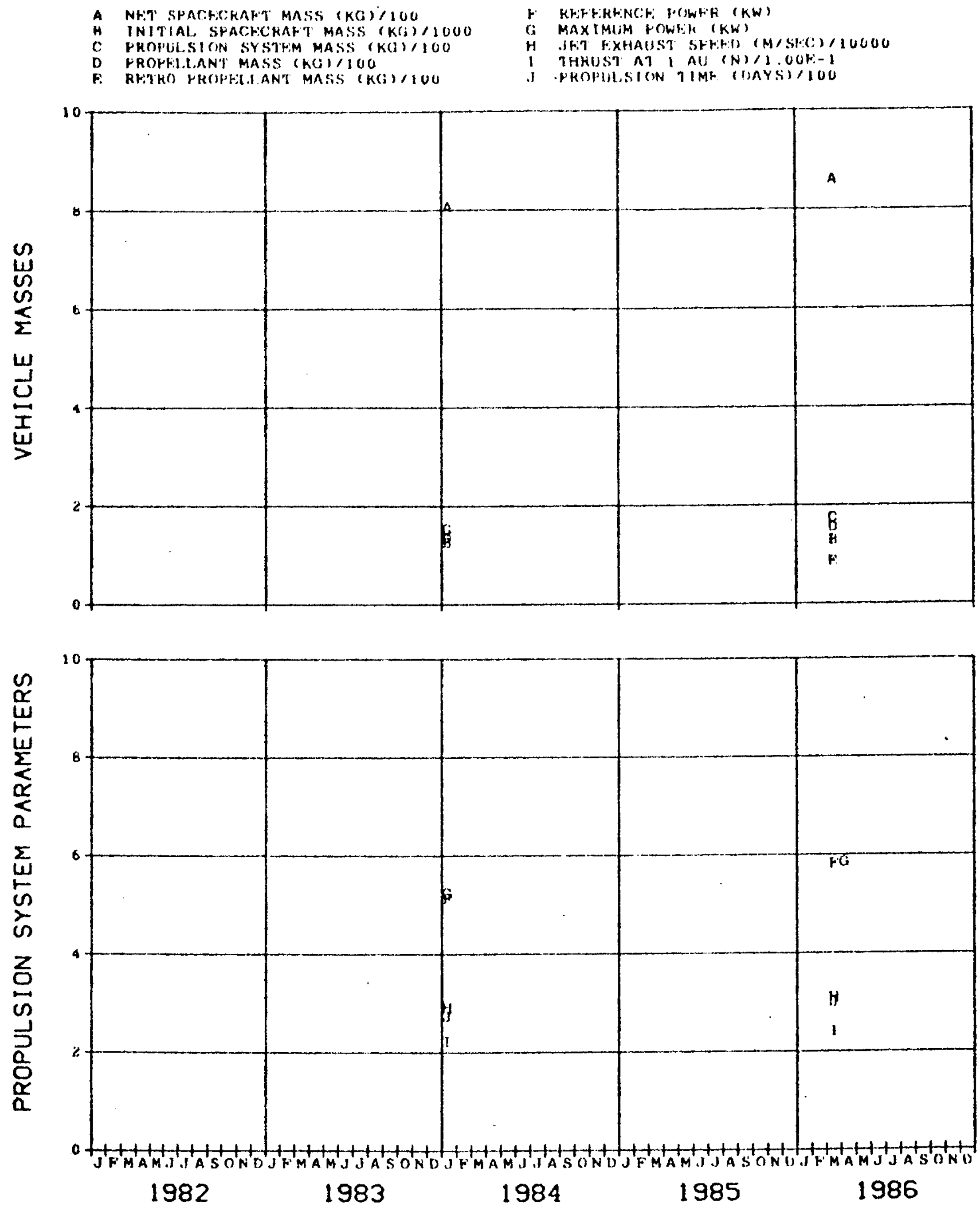

FIG. 7C. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 300 DAYS

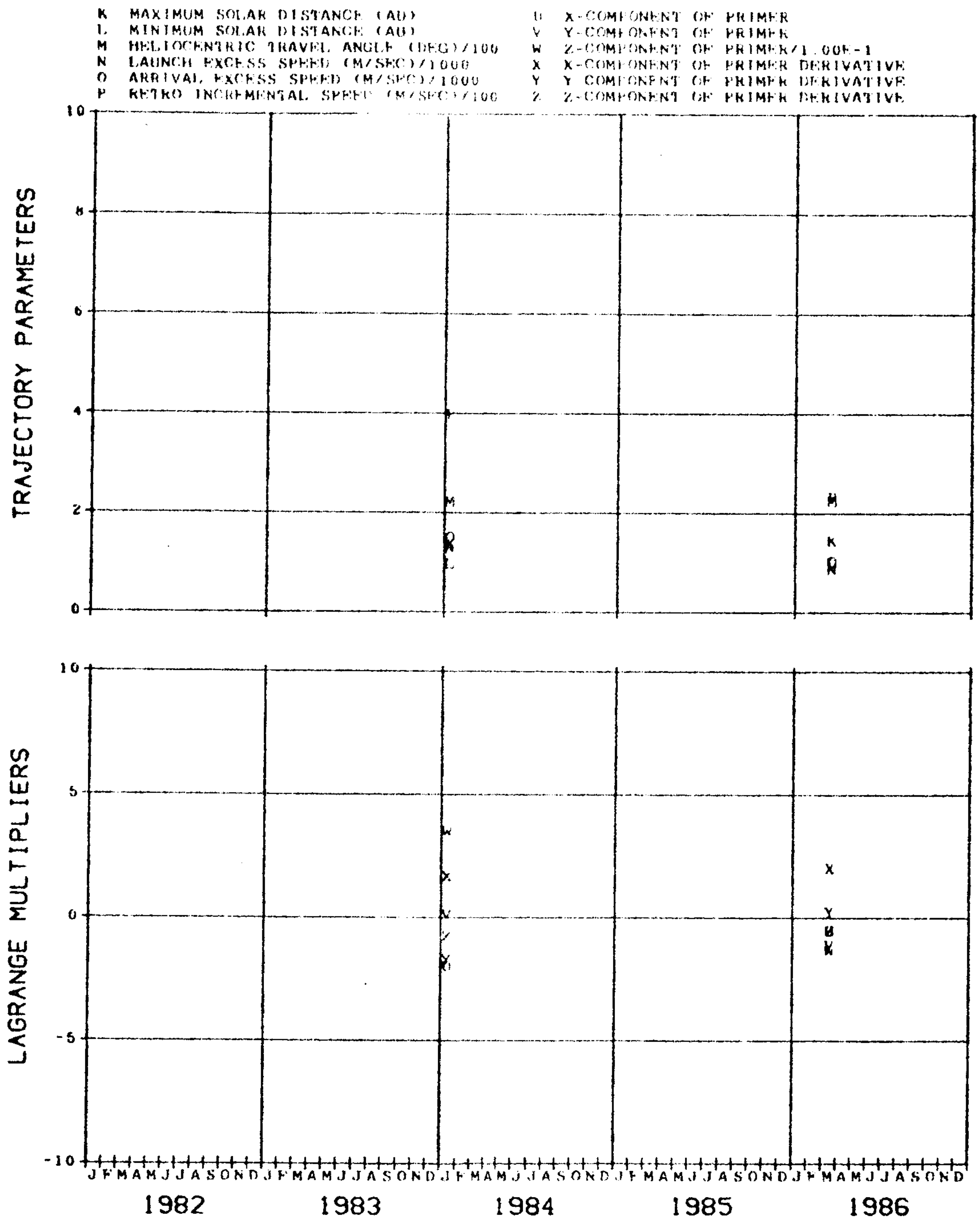

FIG. 7C. (CONCLUDED)

XXXX 071

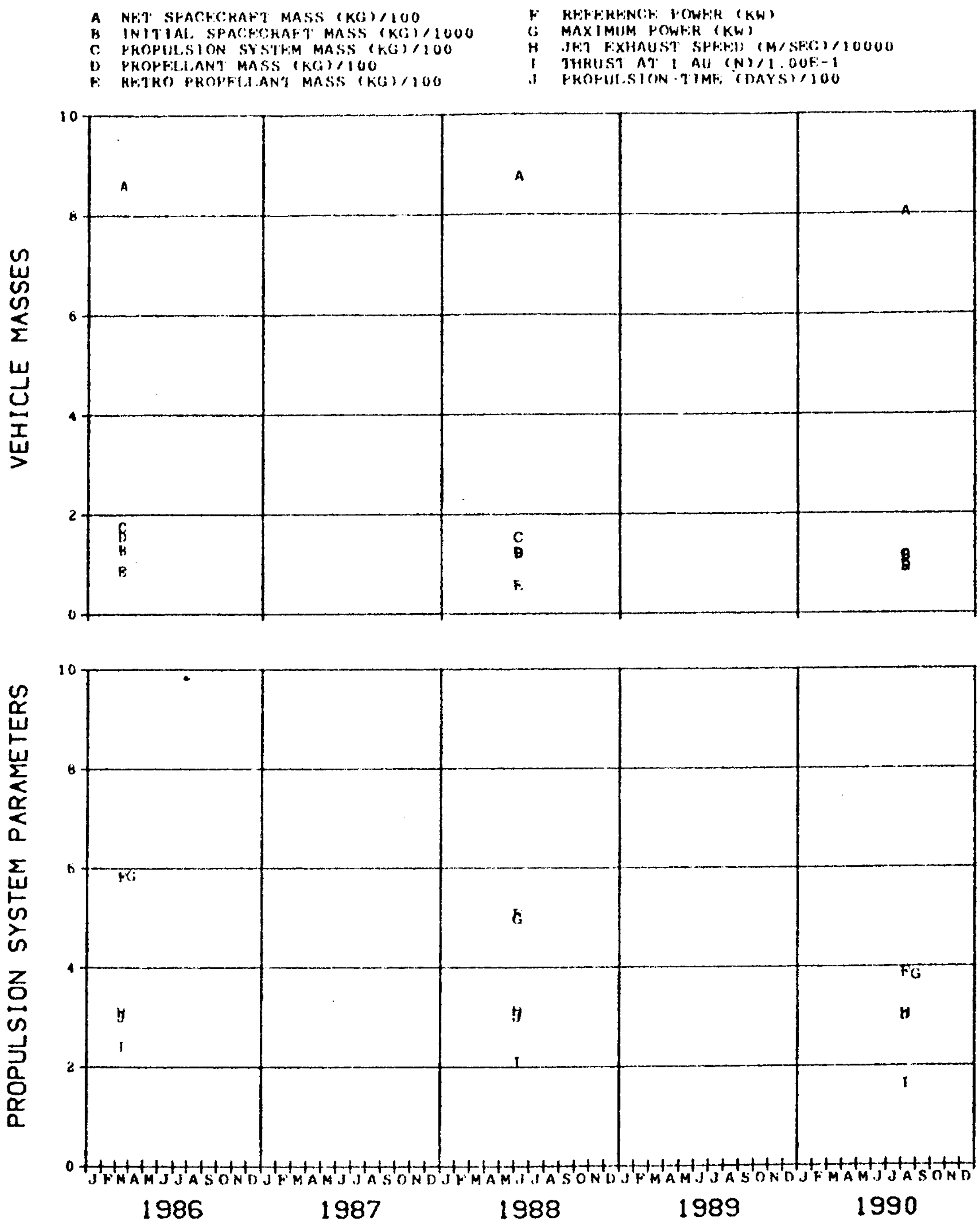

FIG. 7D. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 300 DAYS

XXXX 072

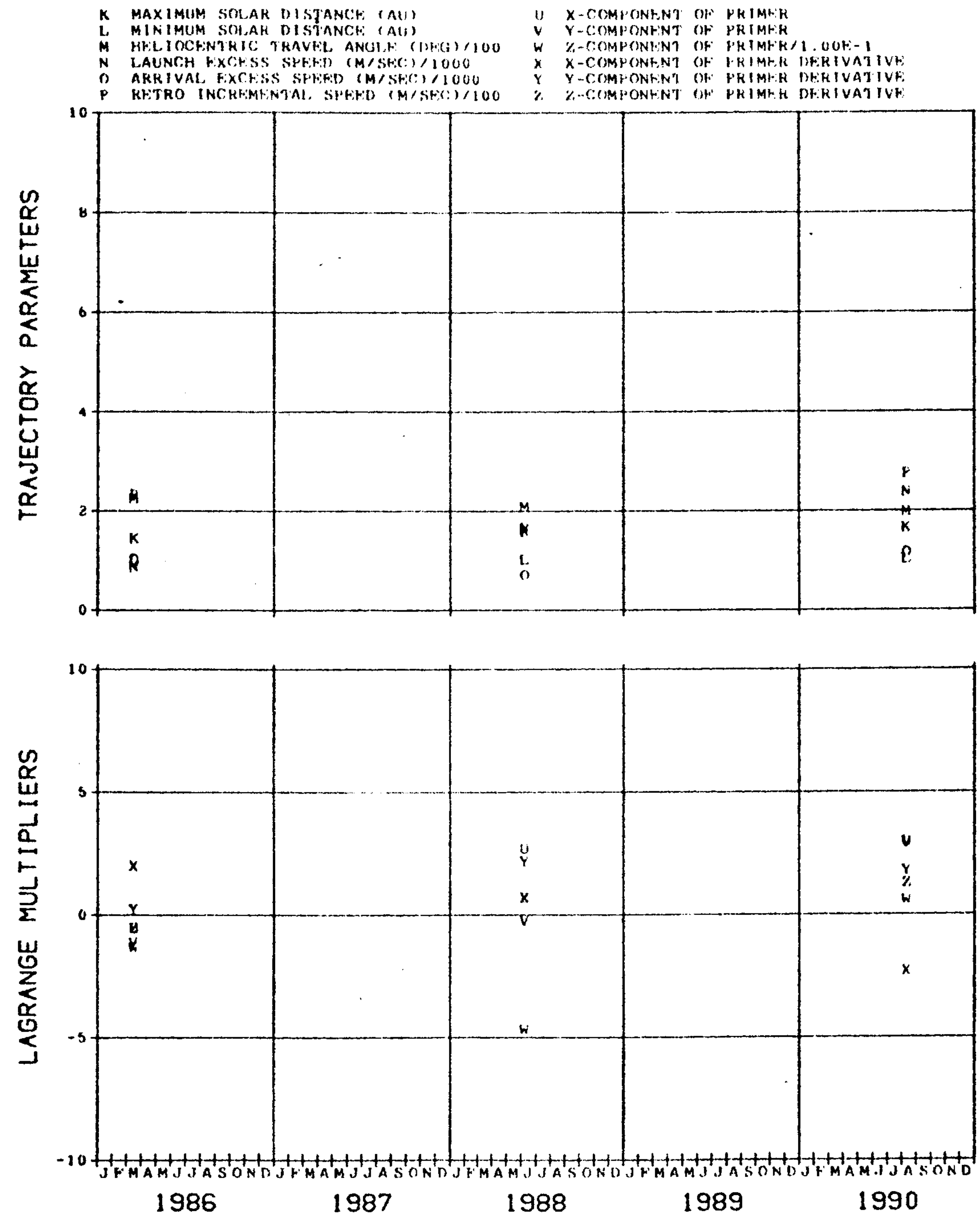

FIG. 7D. (CONCLUDED)

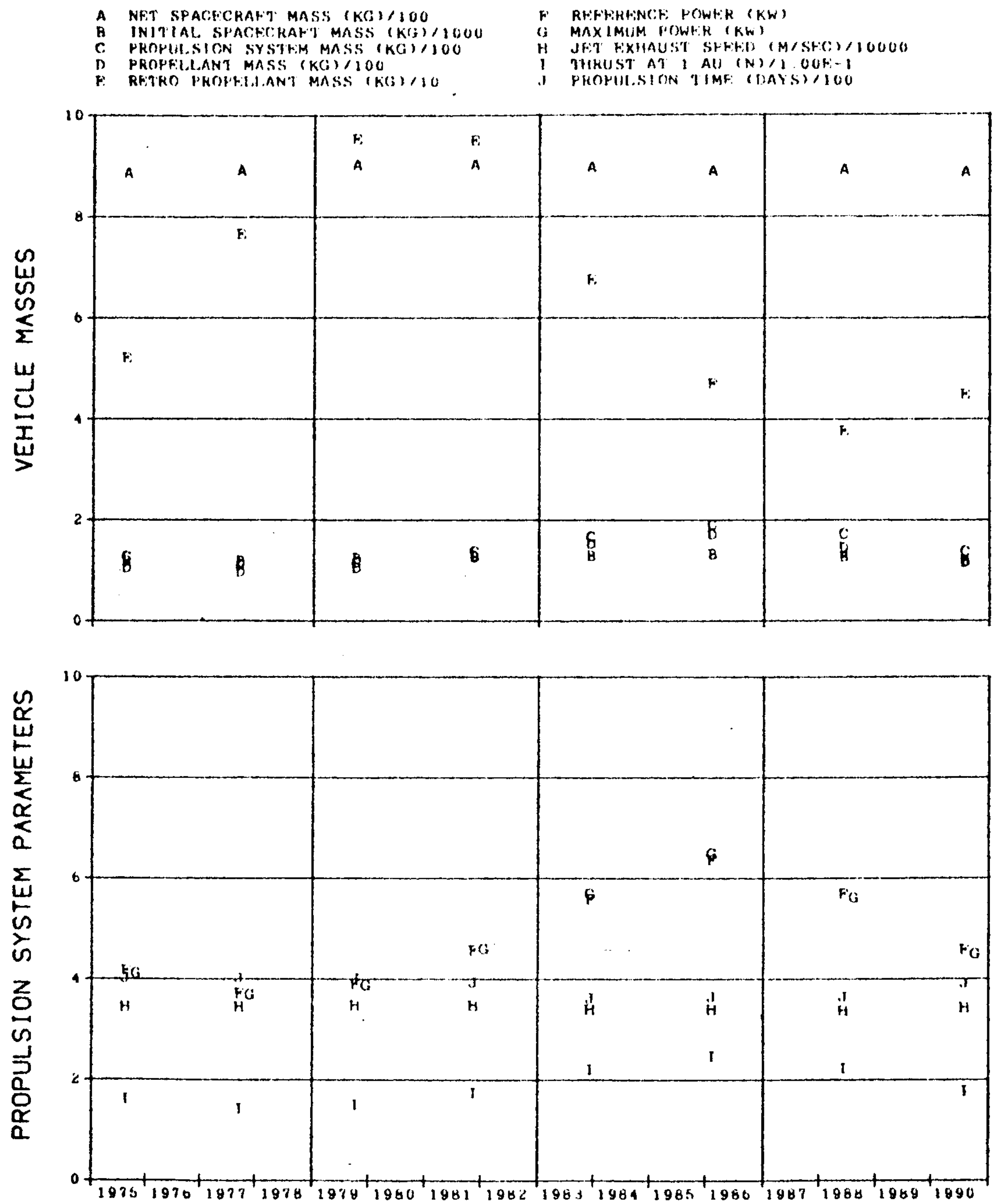

FIG. 8. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 400 DAYS

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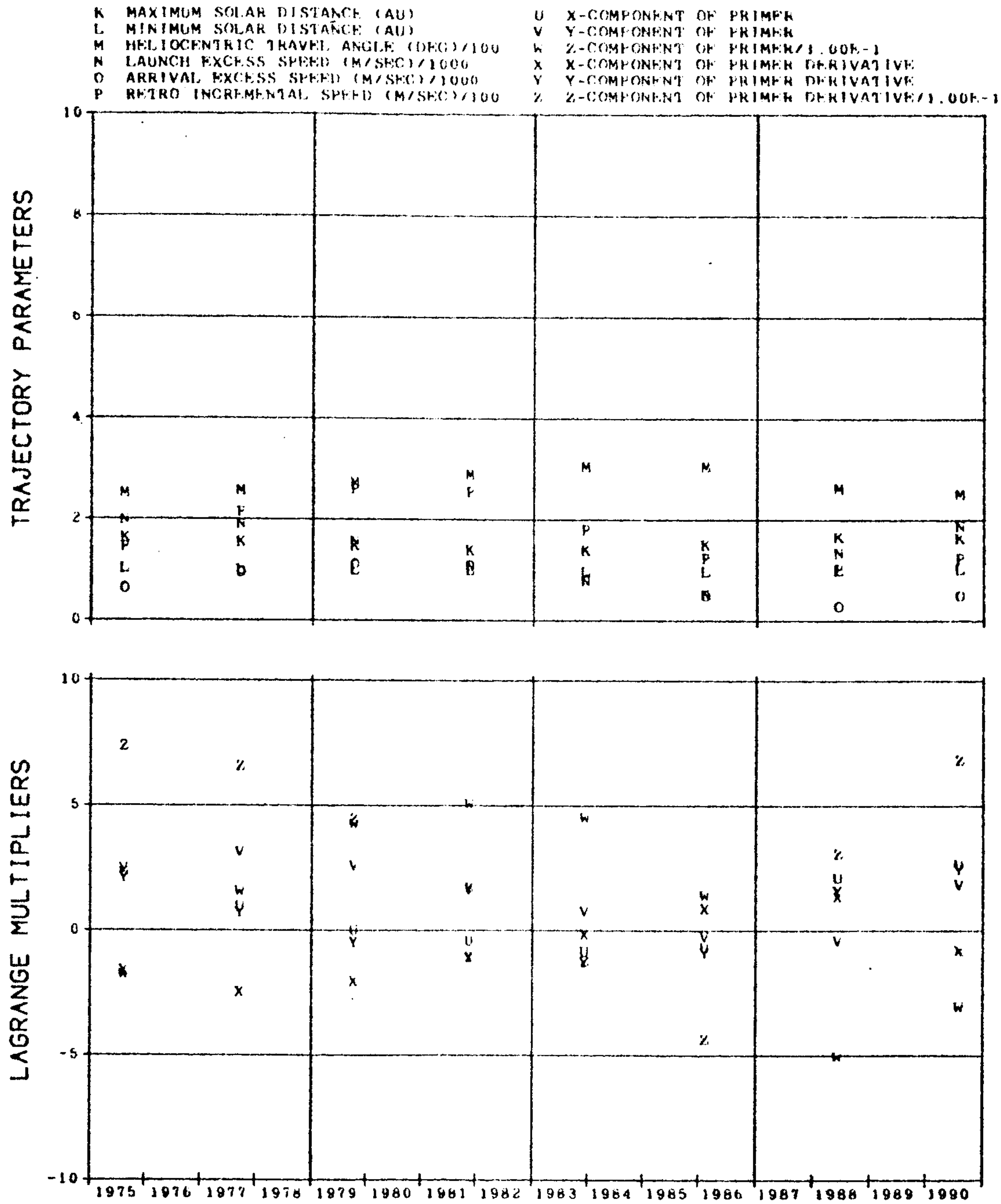

FIG. 8. (CONCLUDED)

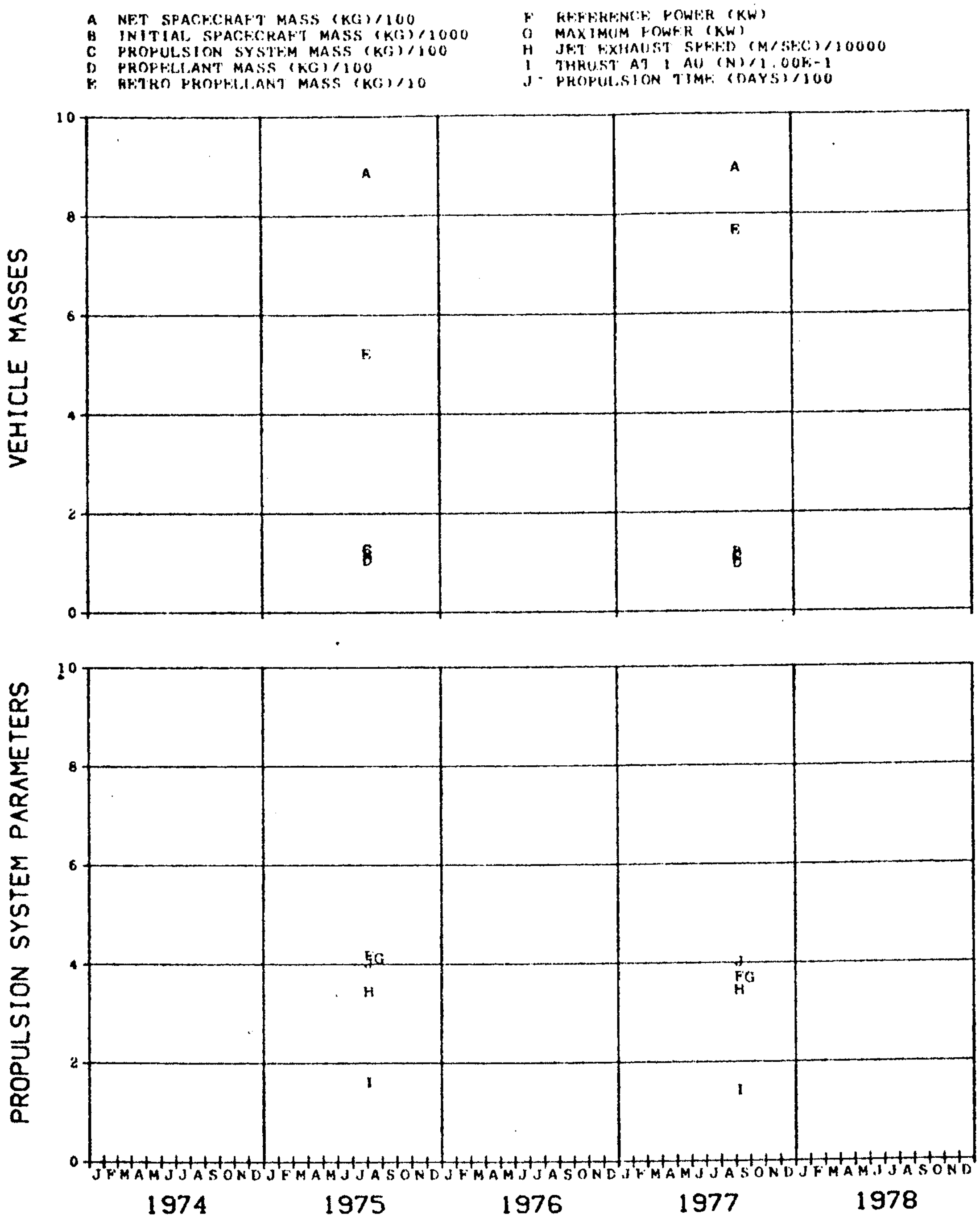

FIG. 8A. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 400 DAYS

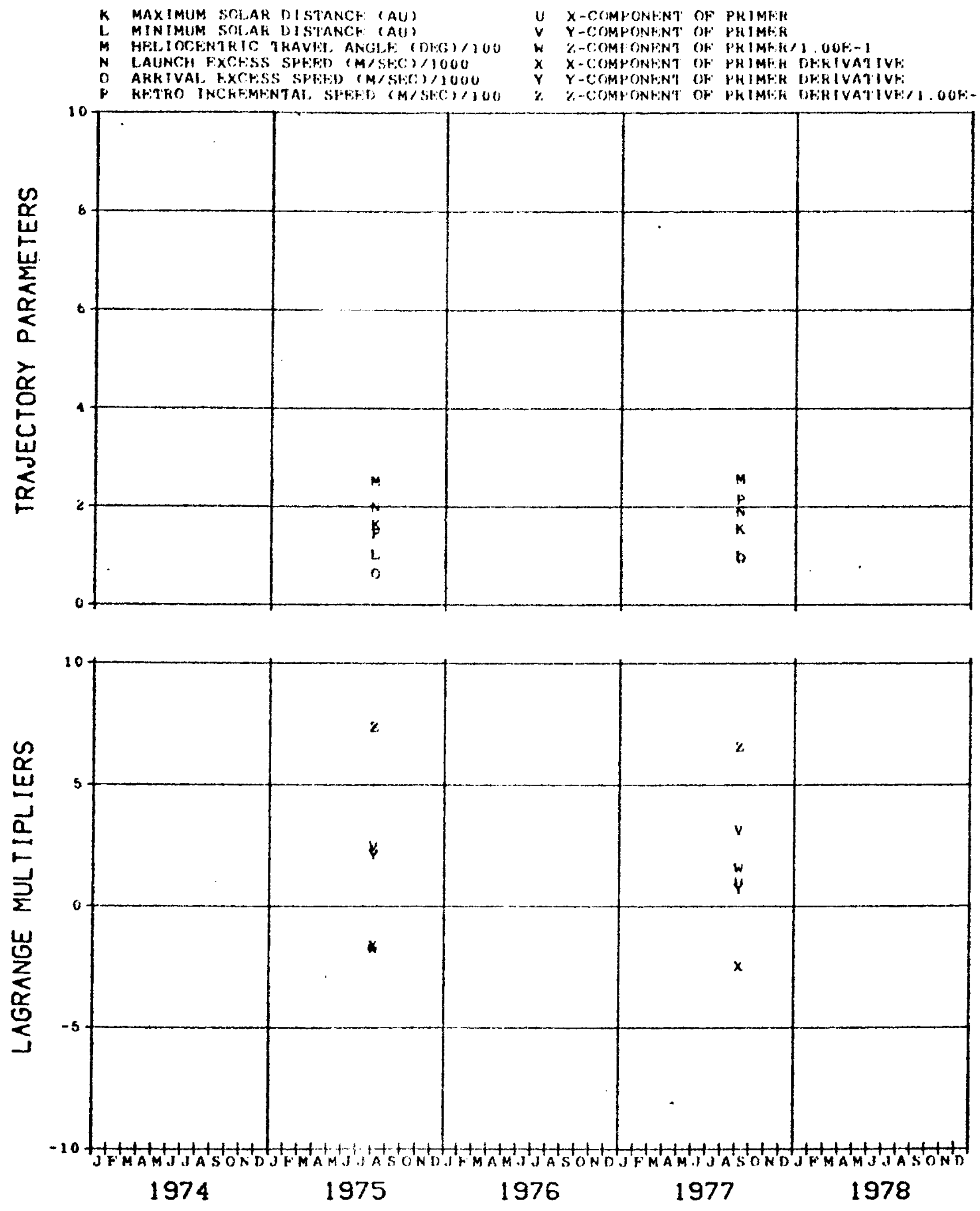

FIG. 8A. (CONCLUDED)

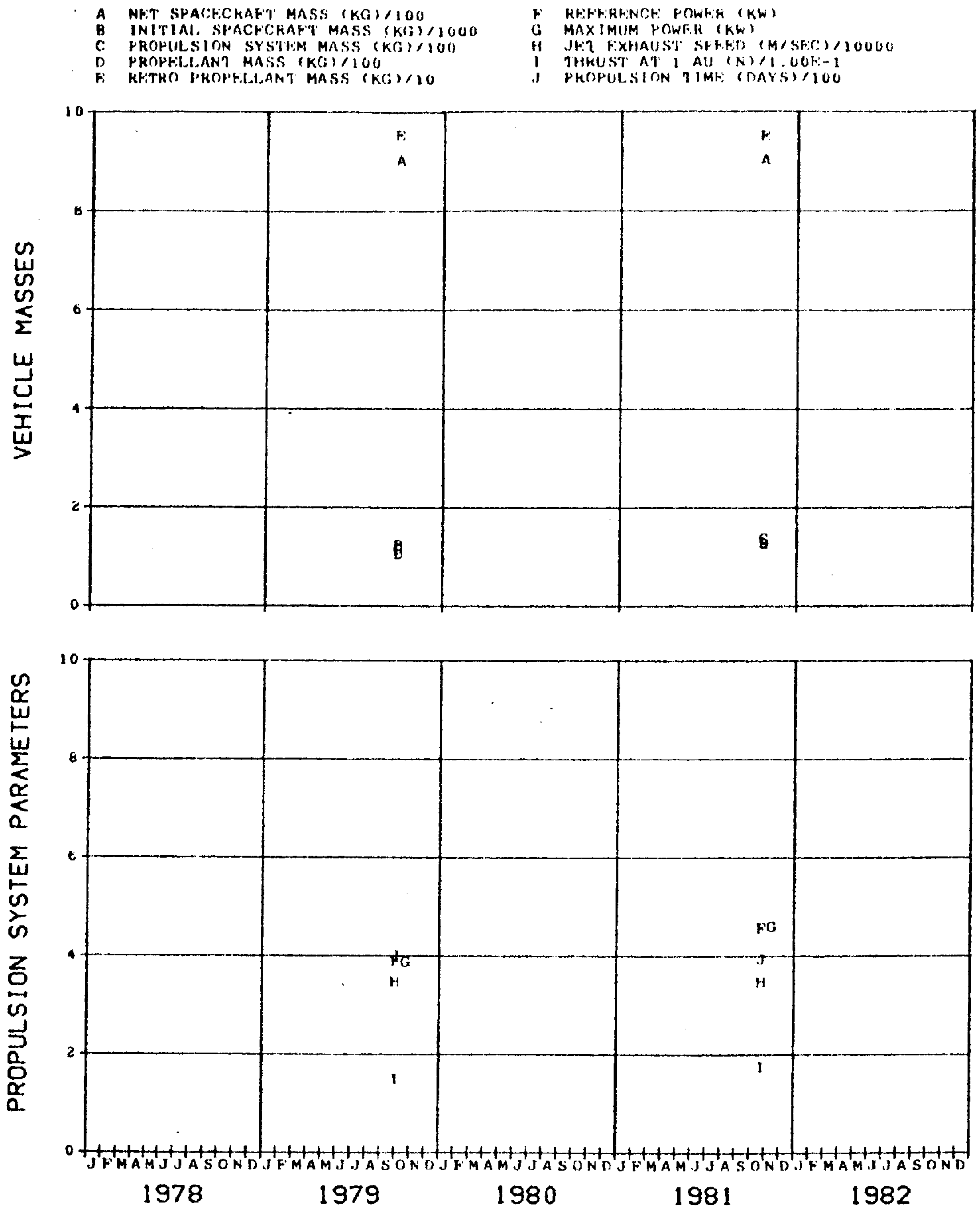

FIG. 8B. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 400 DAYS

XXXX 078

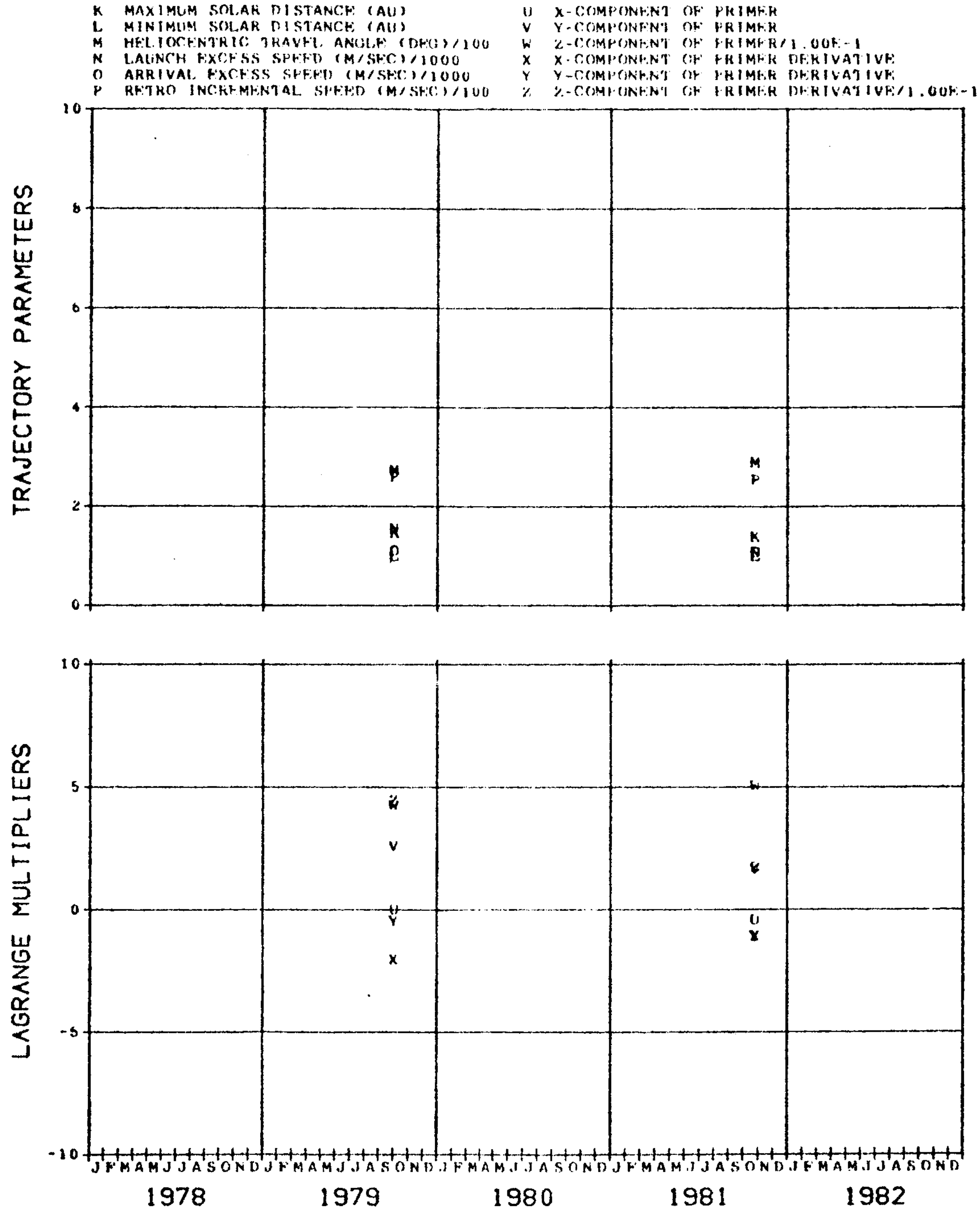

FIG. 8B. (CONCLUDED)

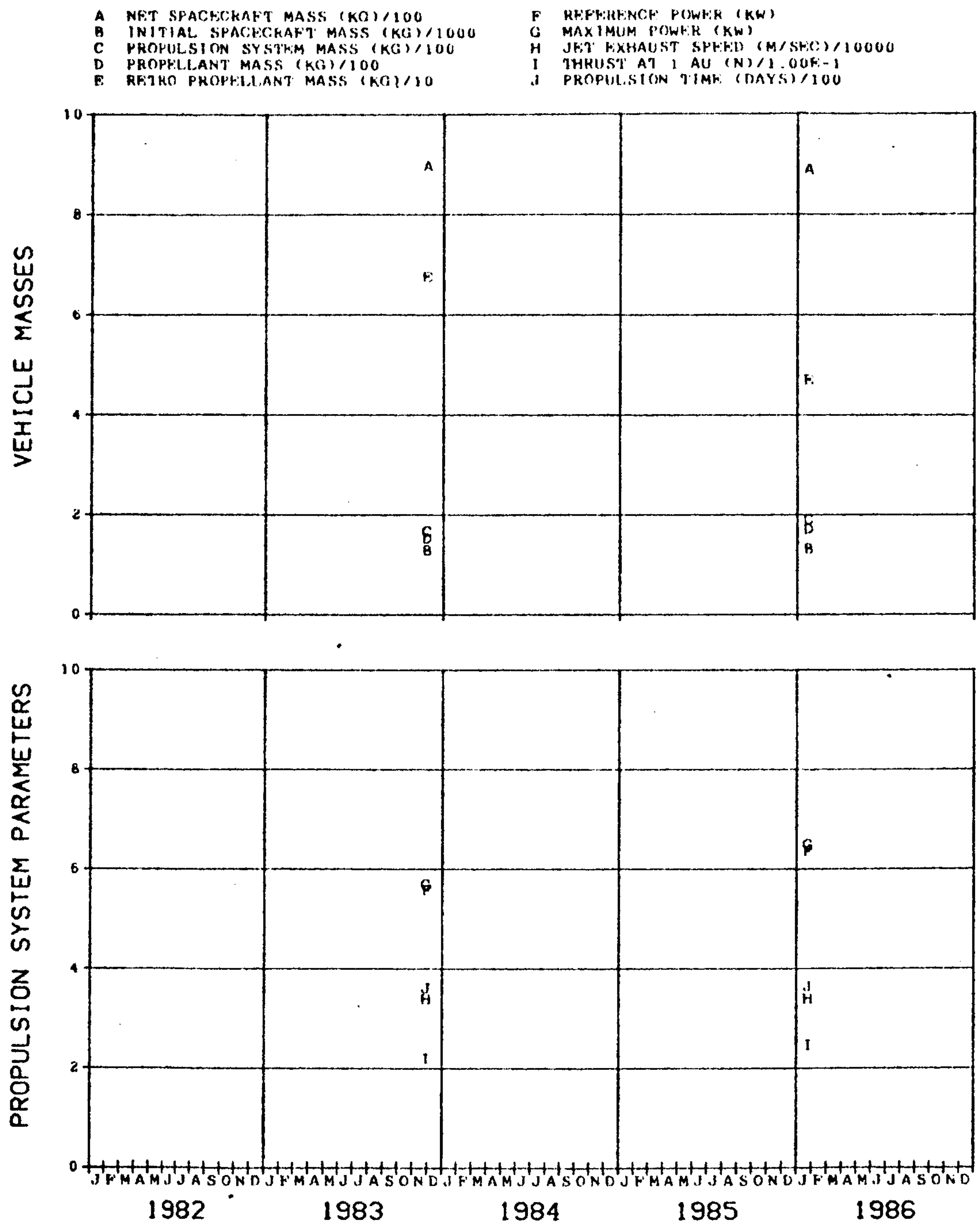

FIG. 8C. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 400 DAYS

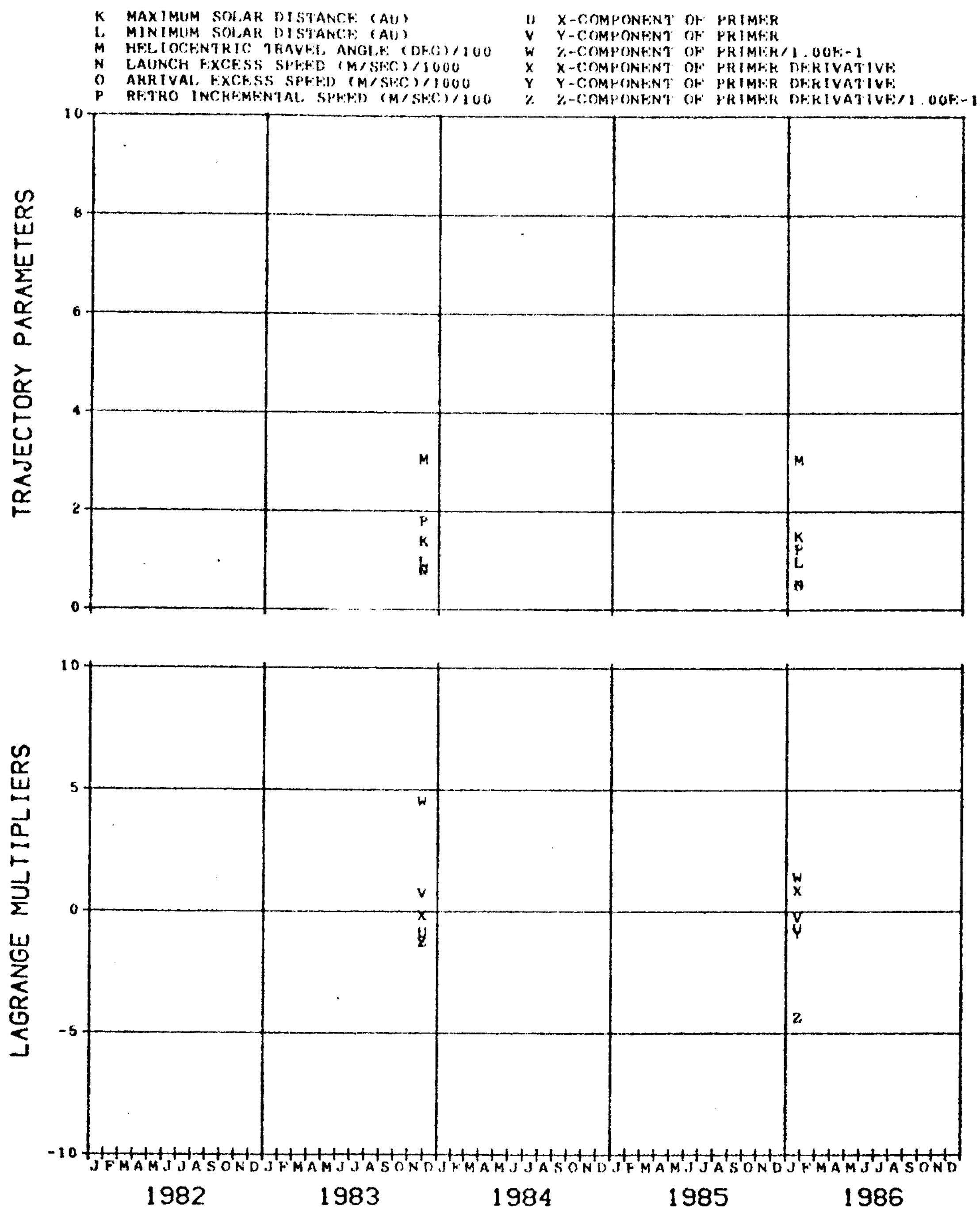

FIG. 8C. (CONCLUDED)

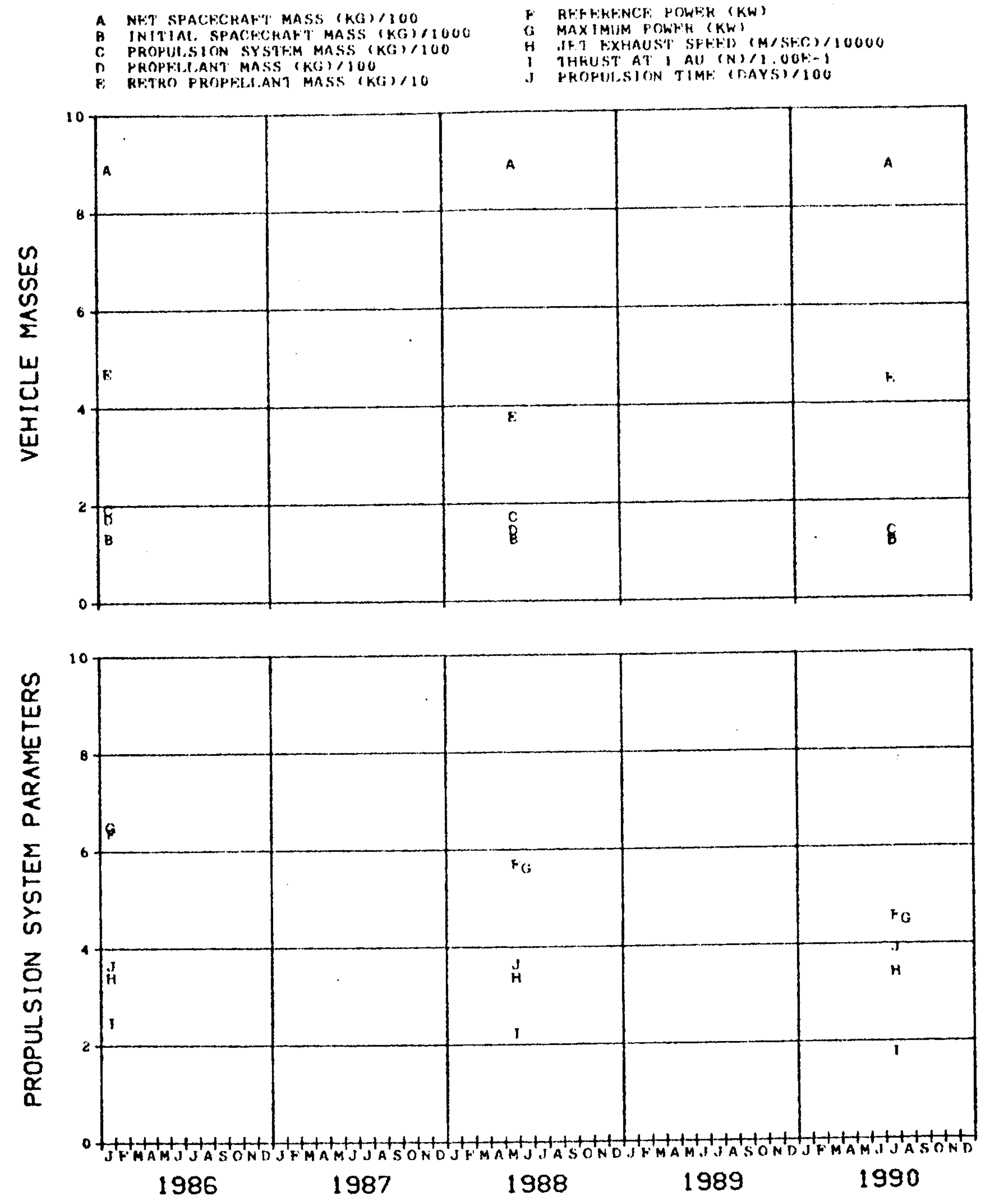

FIG. 8D. MARS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 400 DAYS

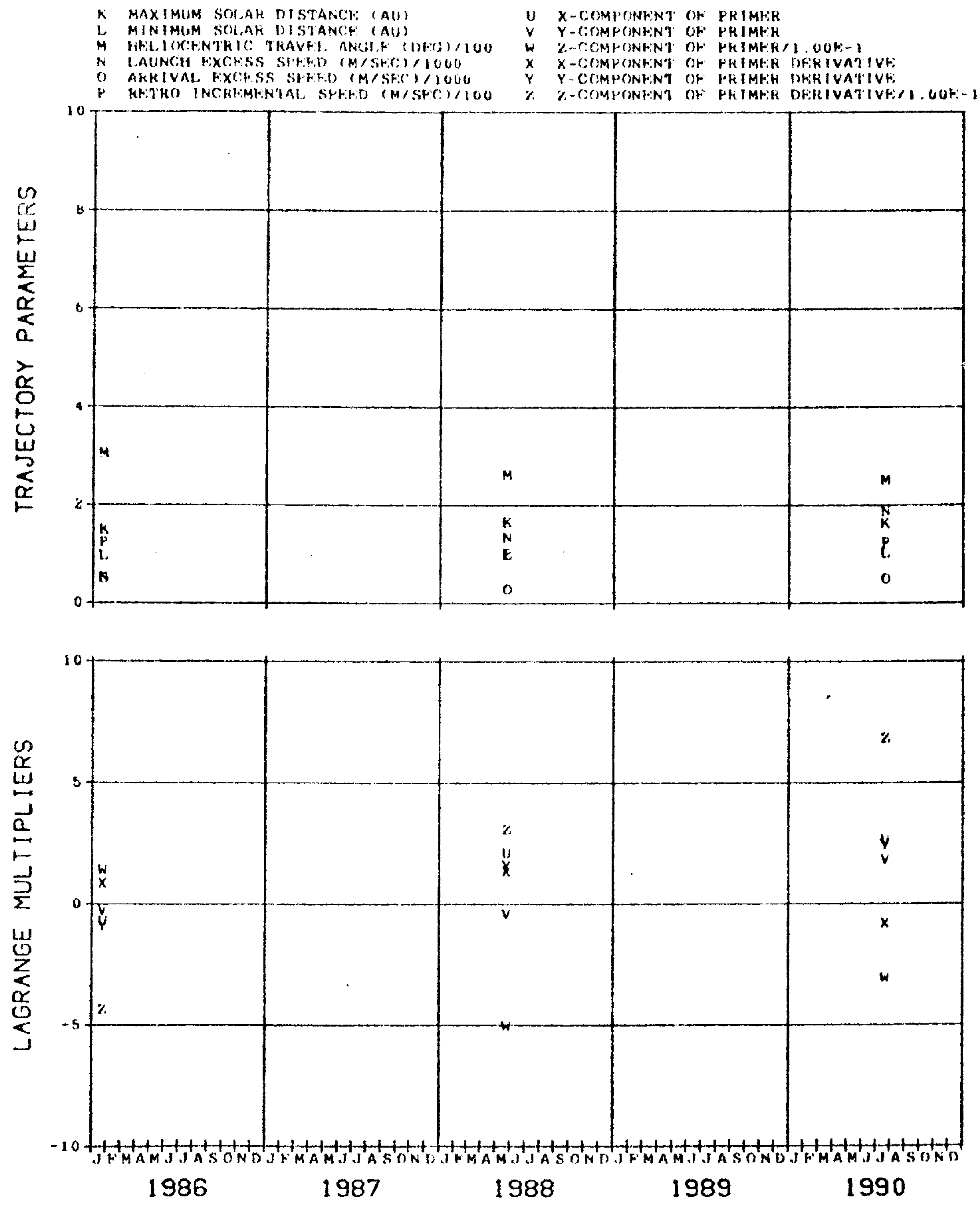

FIG. 8D. (CONCLUDED)

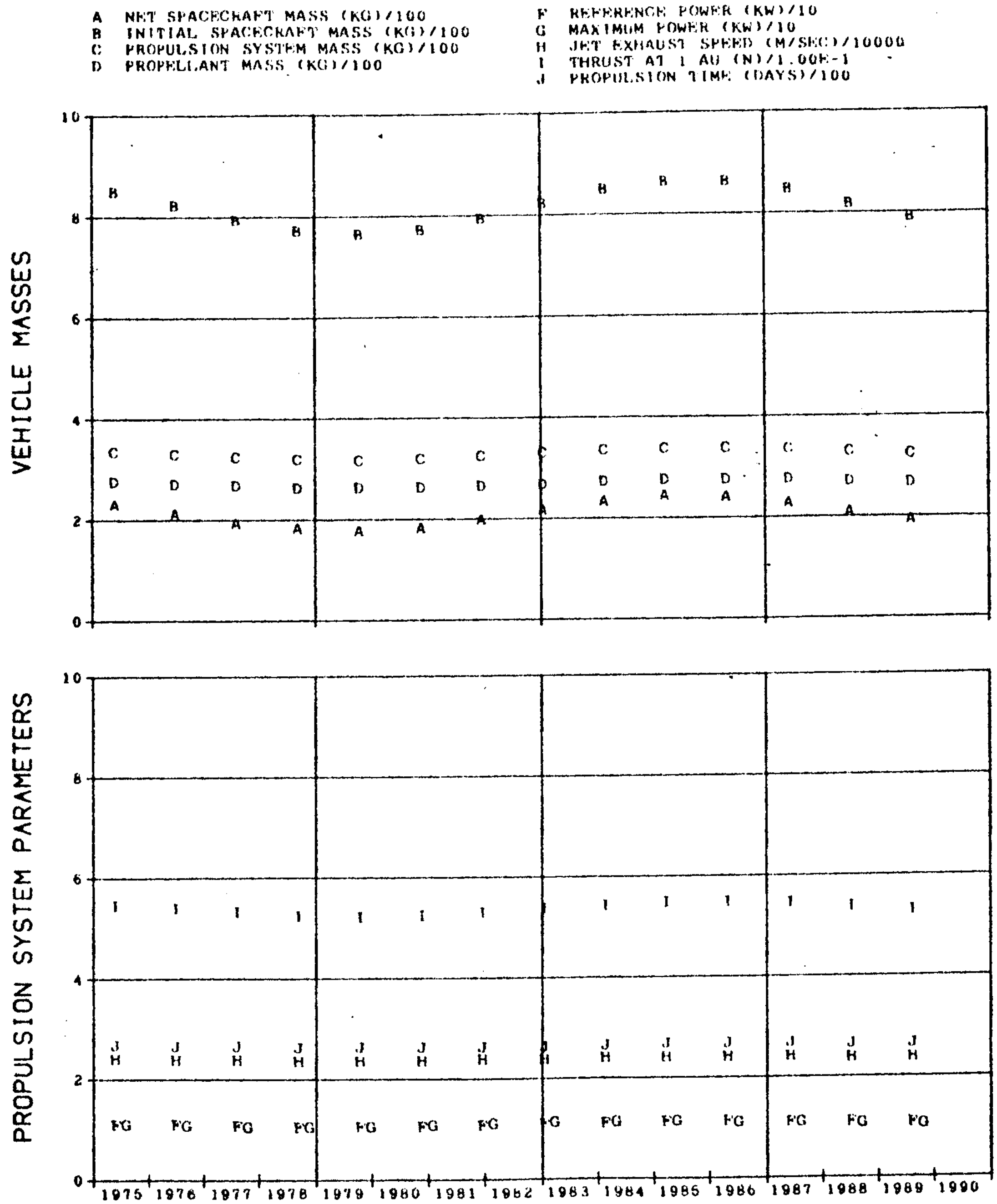

FIG. 9. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 500 DAYS

XXXX 084

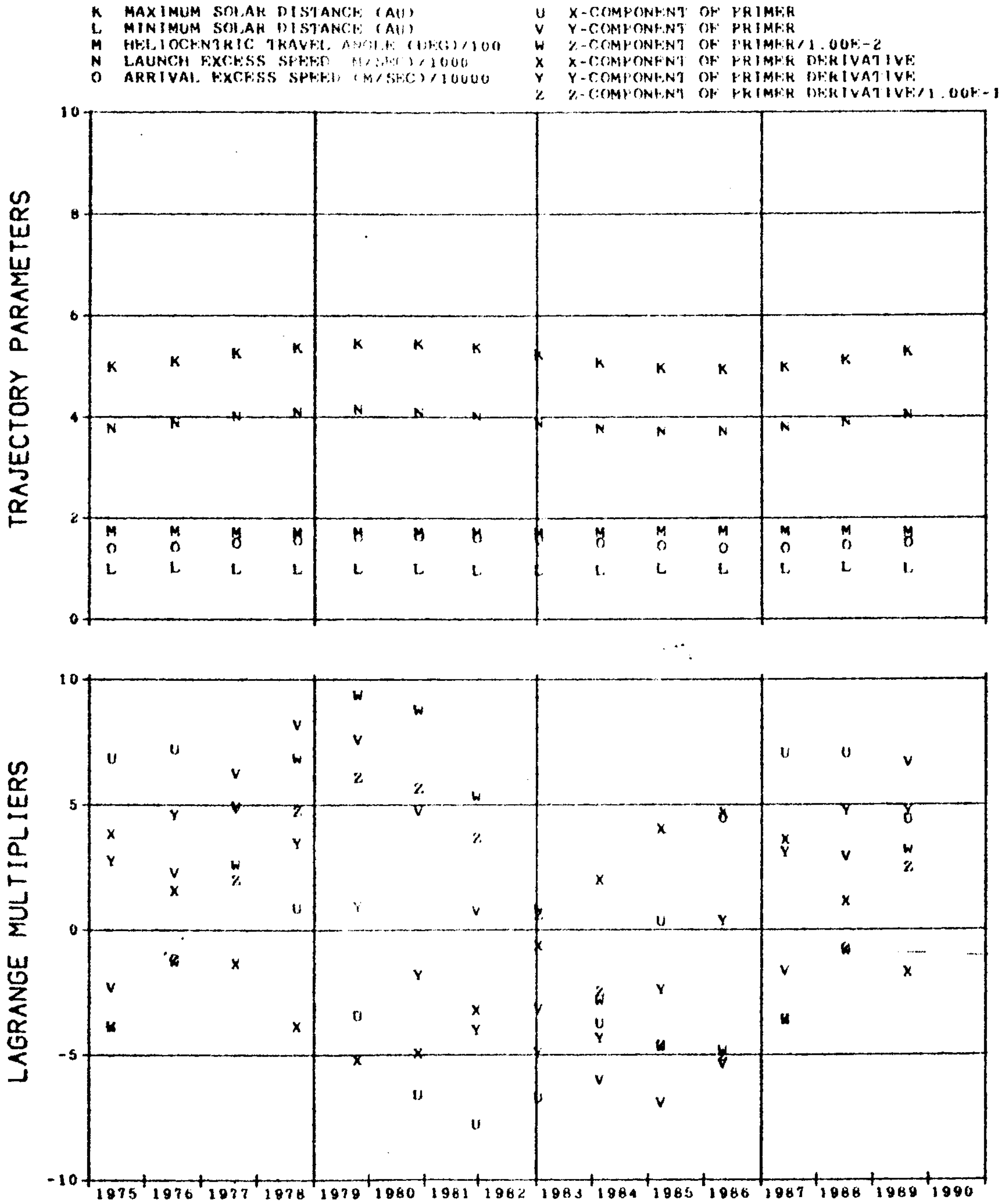

FIG. 9. (CONCLUDED)

XXXX 085

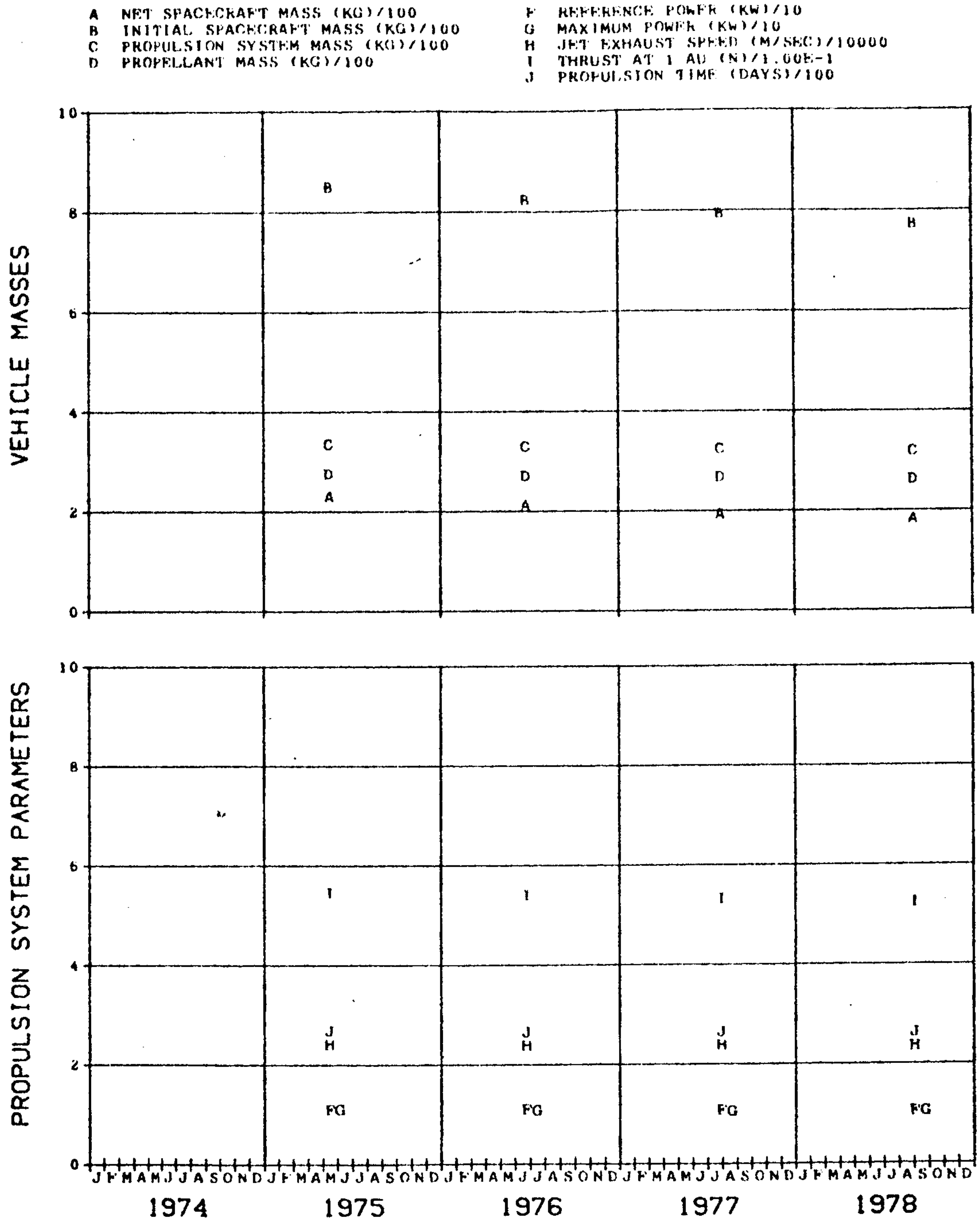

FIG. 9A. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 500 DAYS

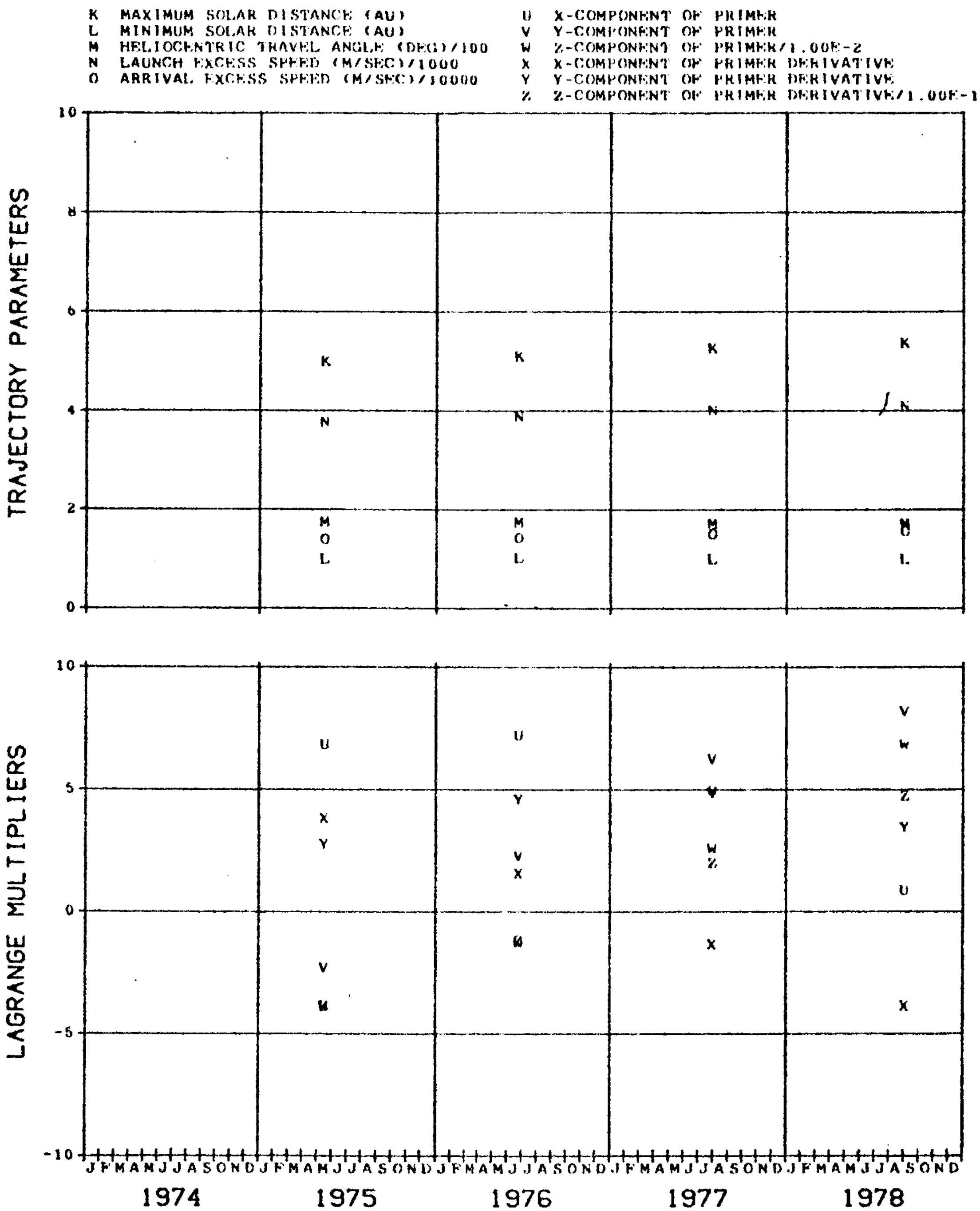

FIG. 9A. (CONCLUDED)

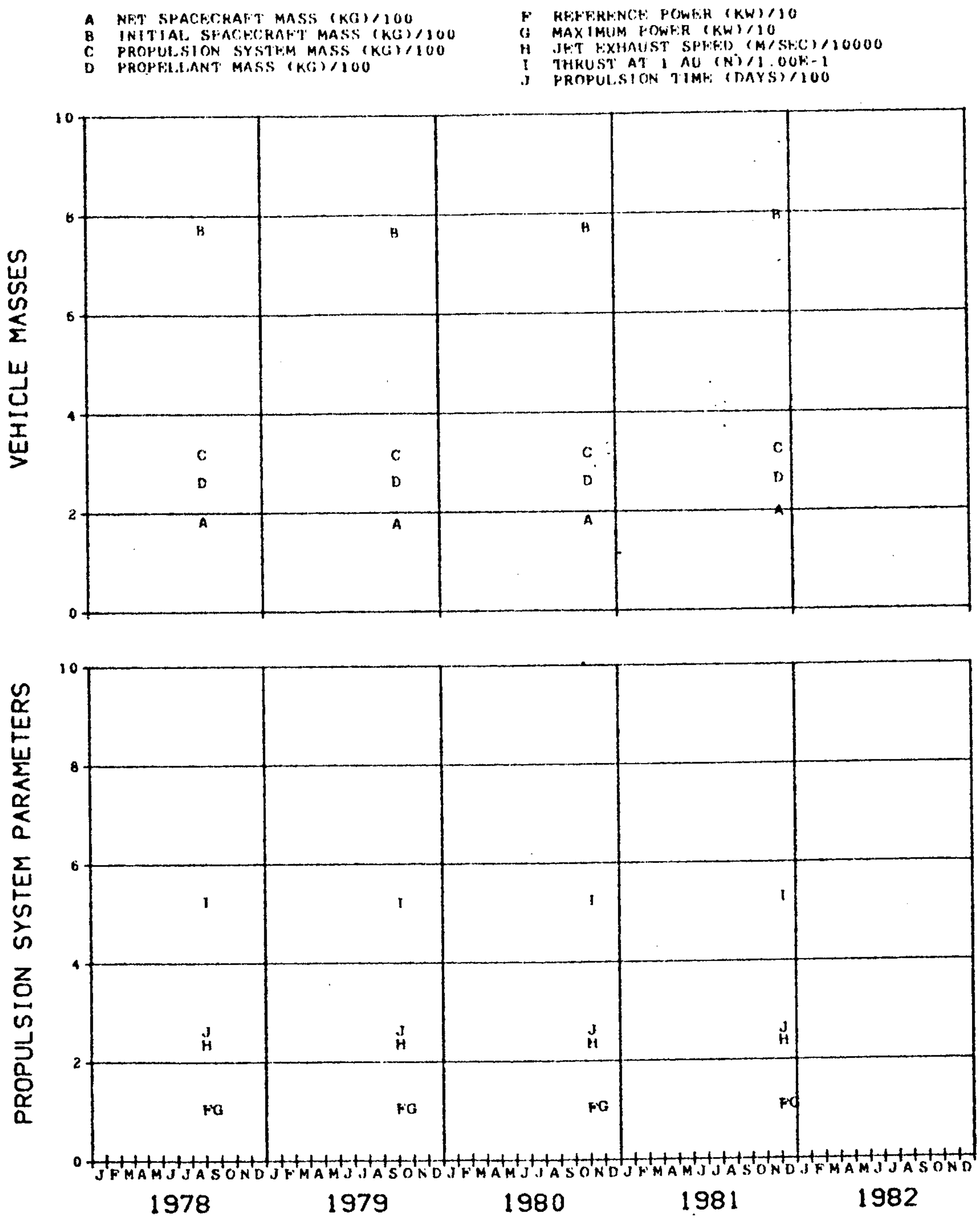

FIG. 9B. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 500 DAYS

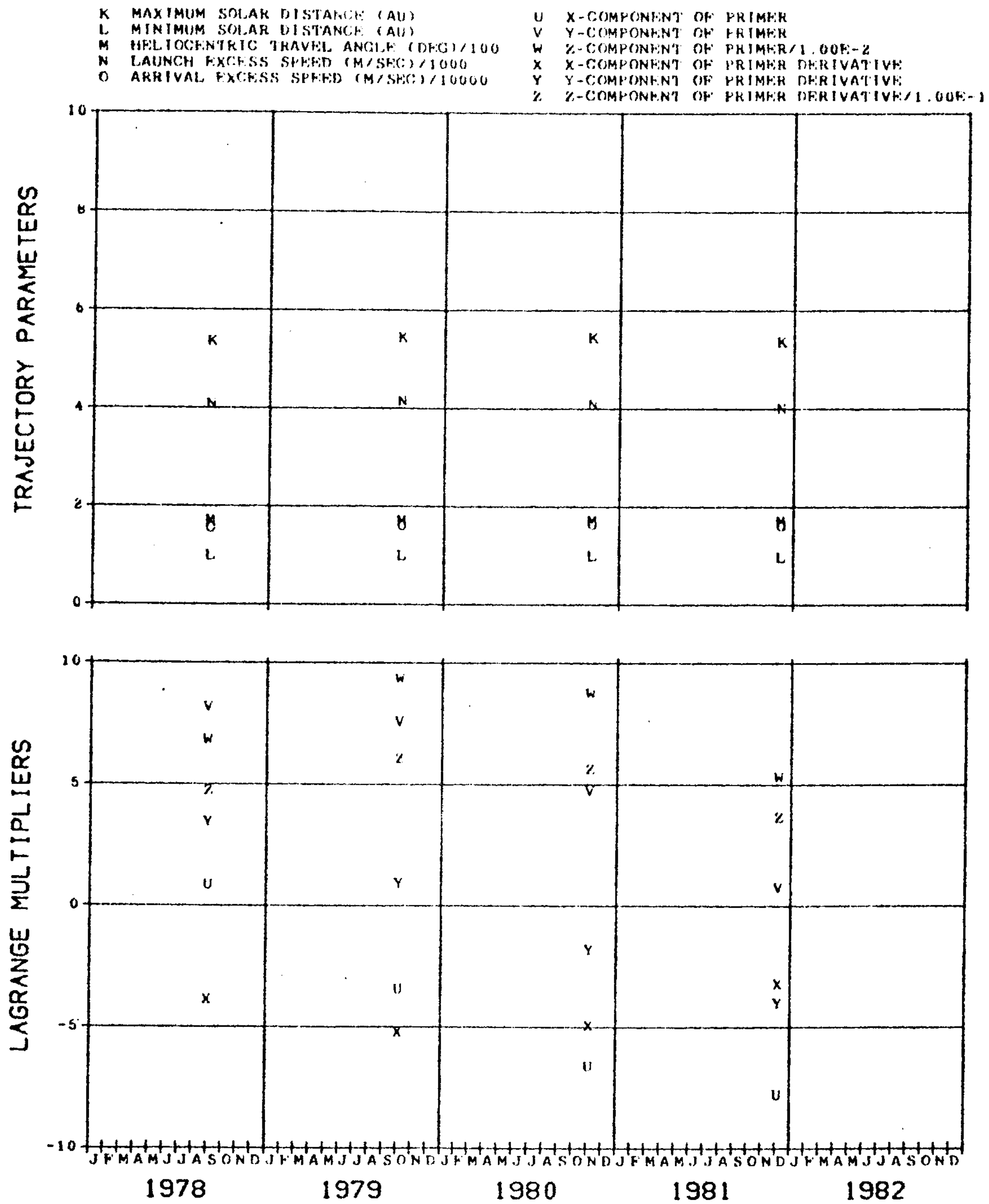

FIG. 9B. (CONCLUDED)

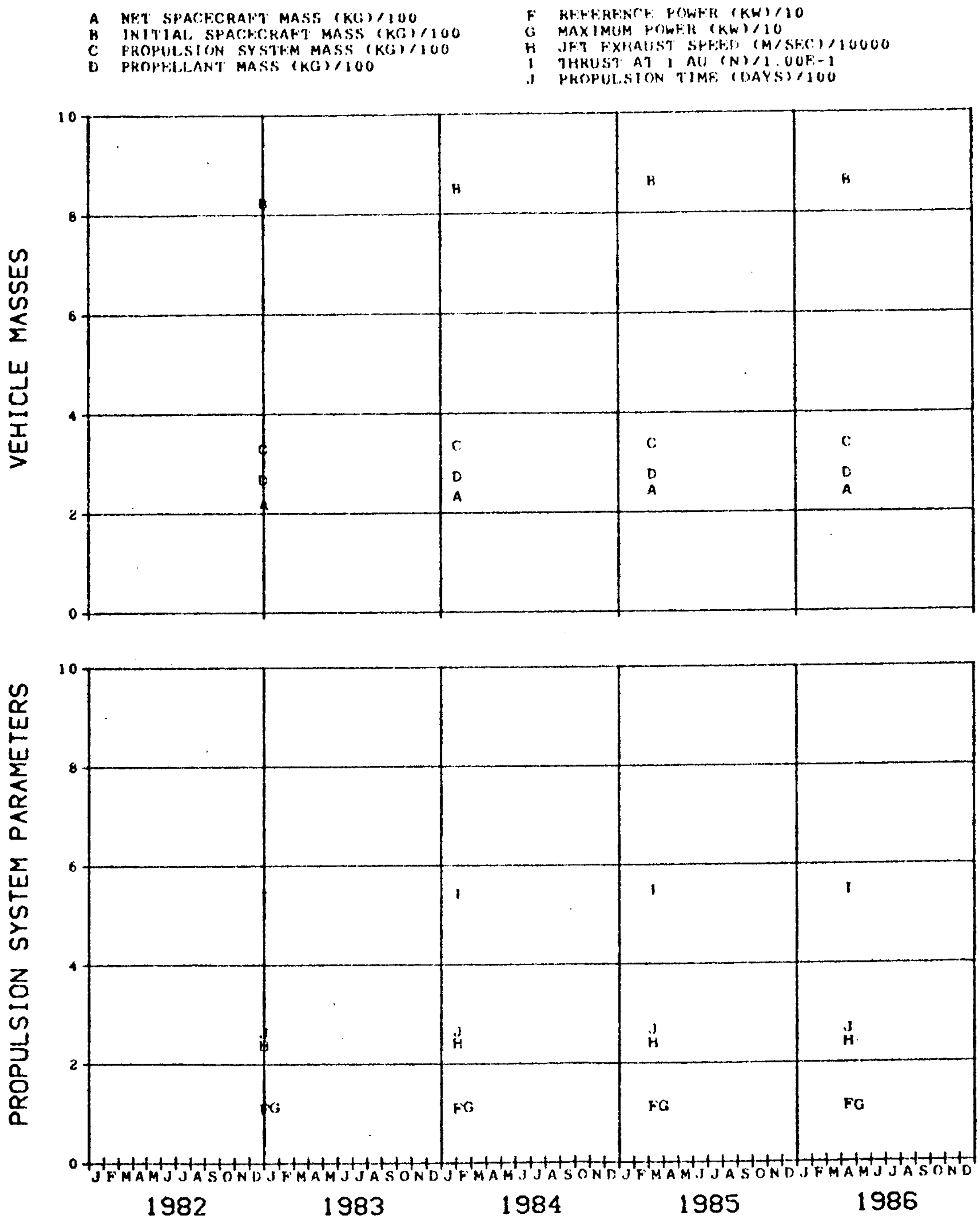

FIG. 9C. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 500 DAYS

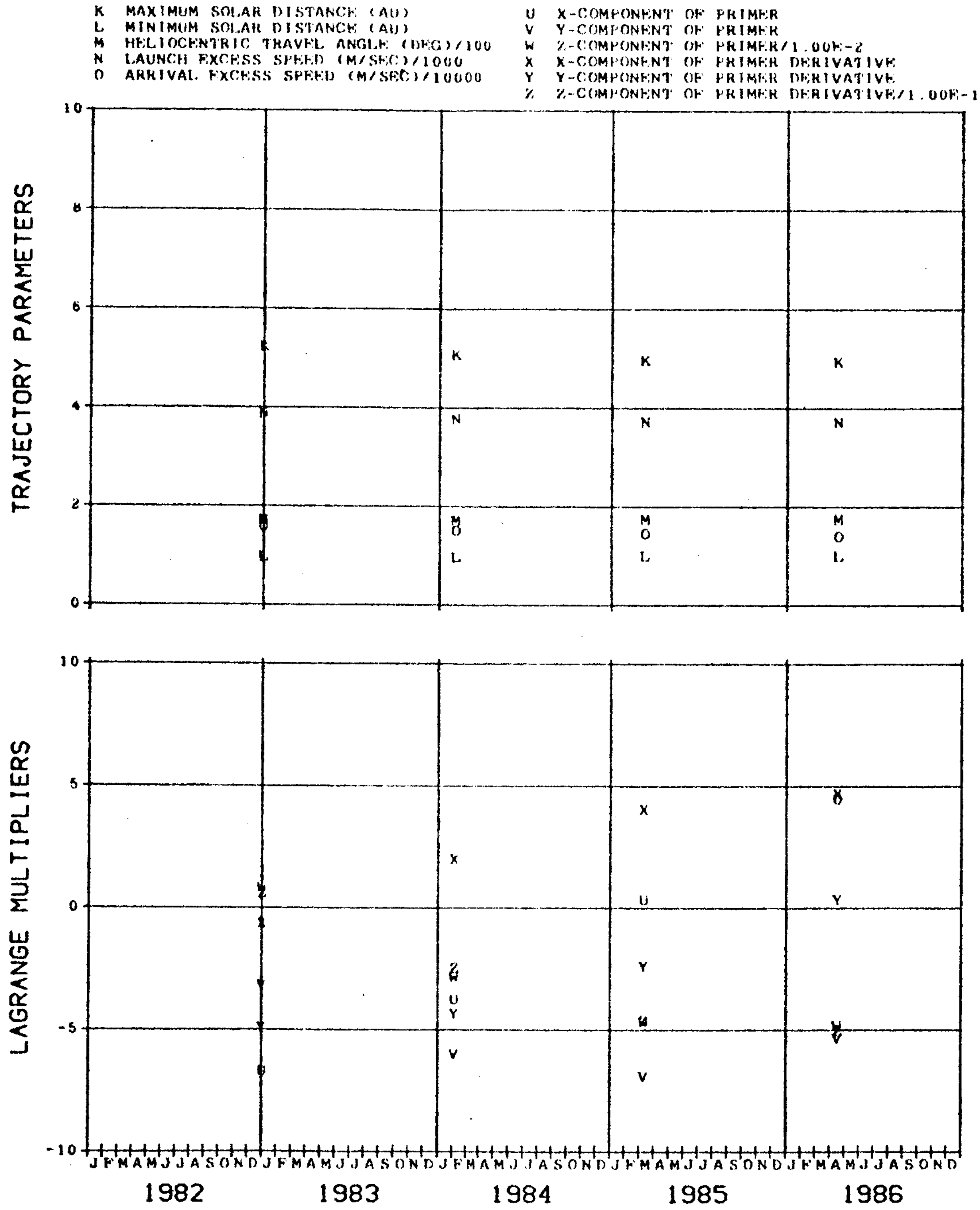

FIG. 9C. (CONCLUDED)

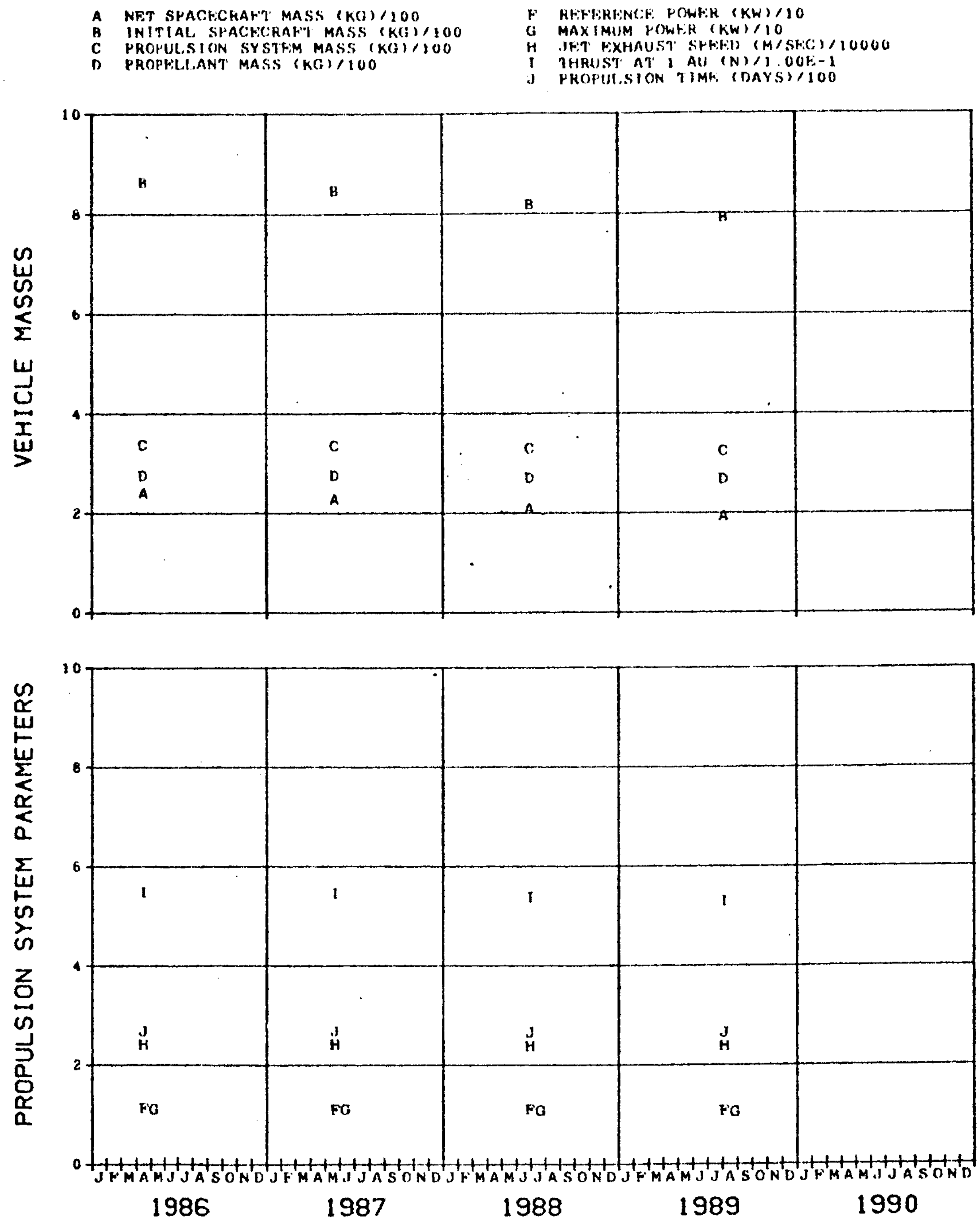

FIG. 9D. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 500 DAYS

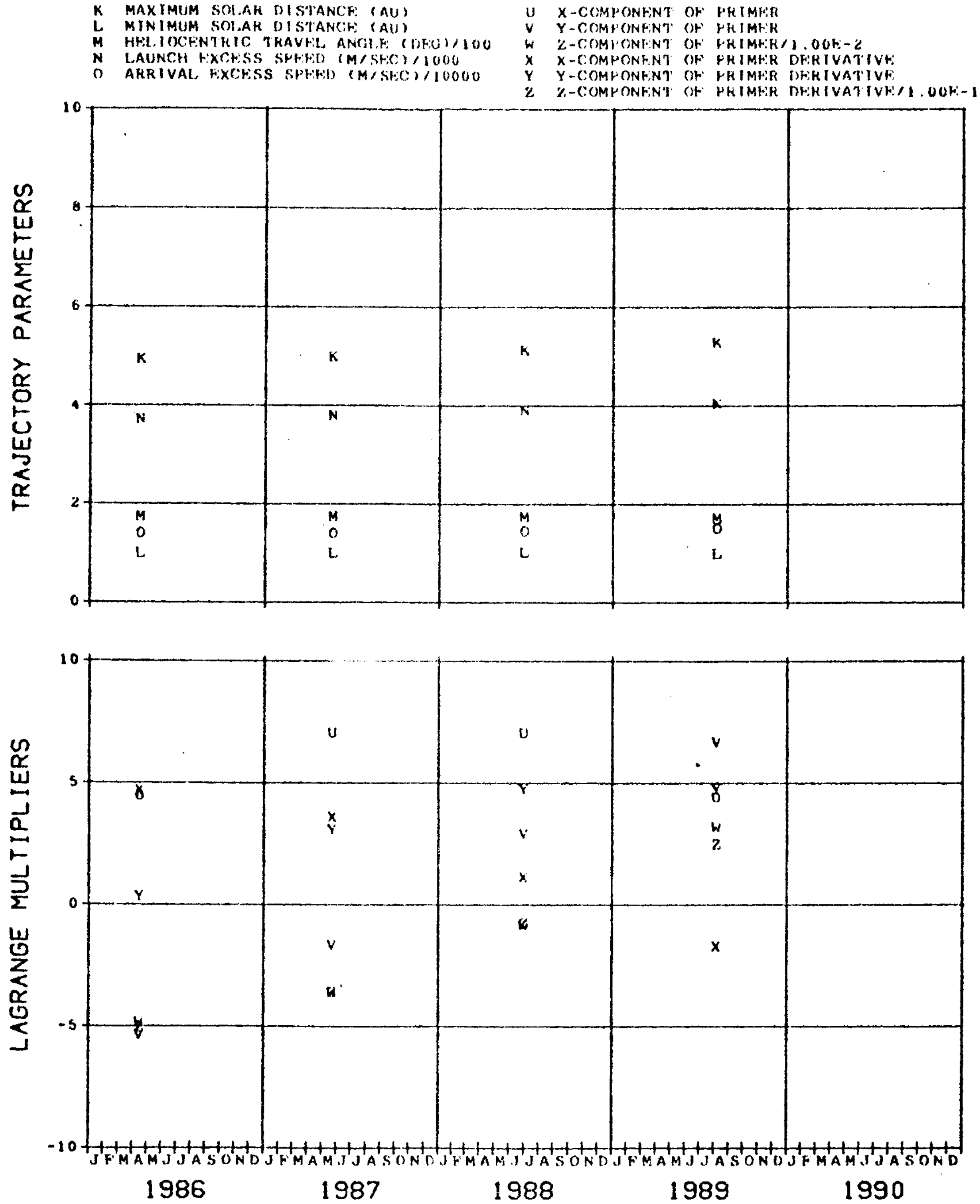

FIG. 9D. (CONCLUDED)

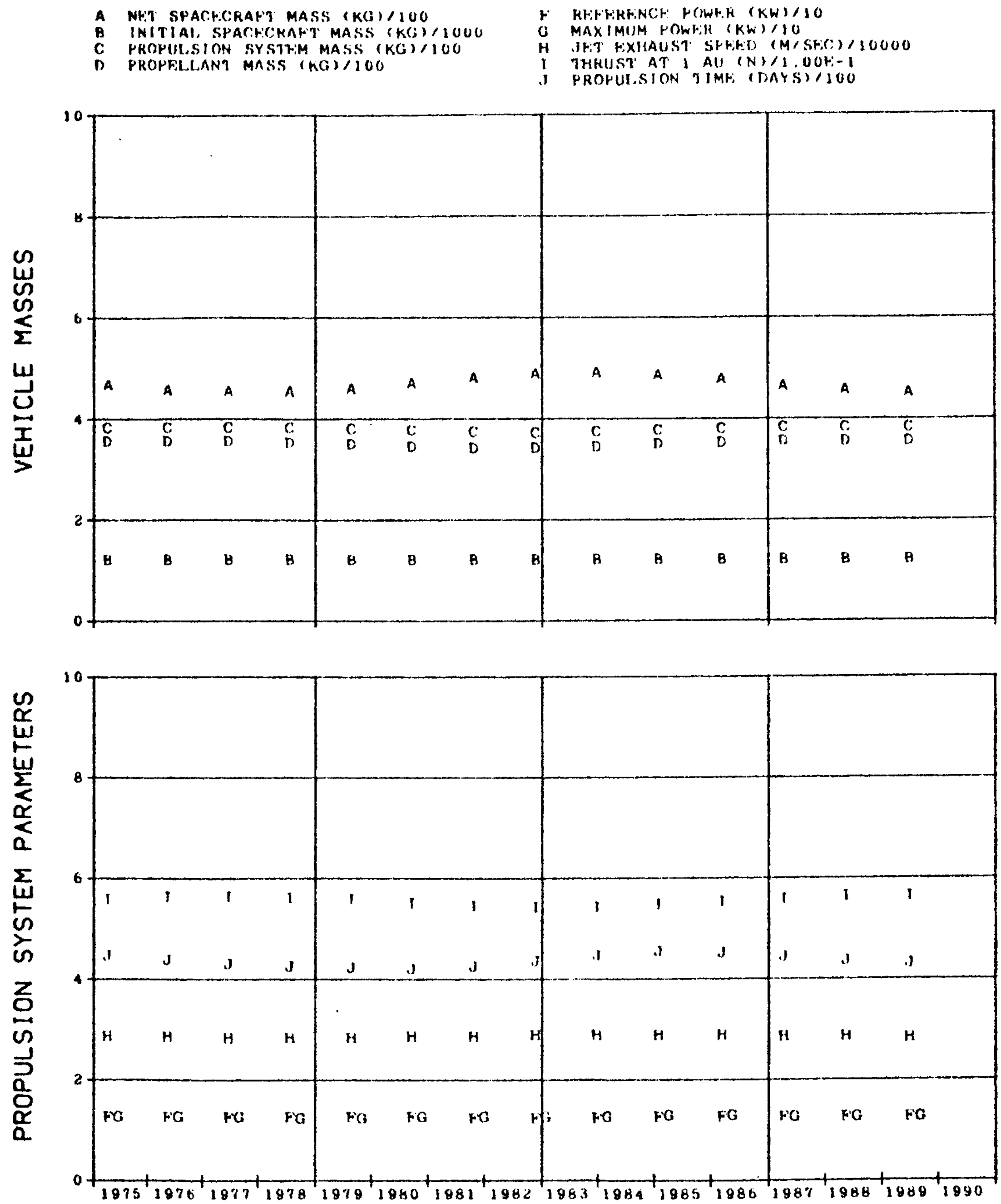

FIG. 10. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1000 DAYS

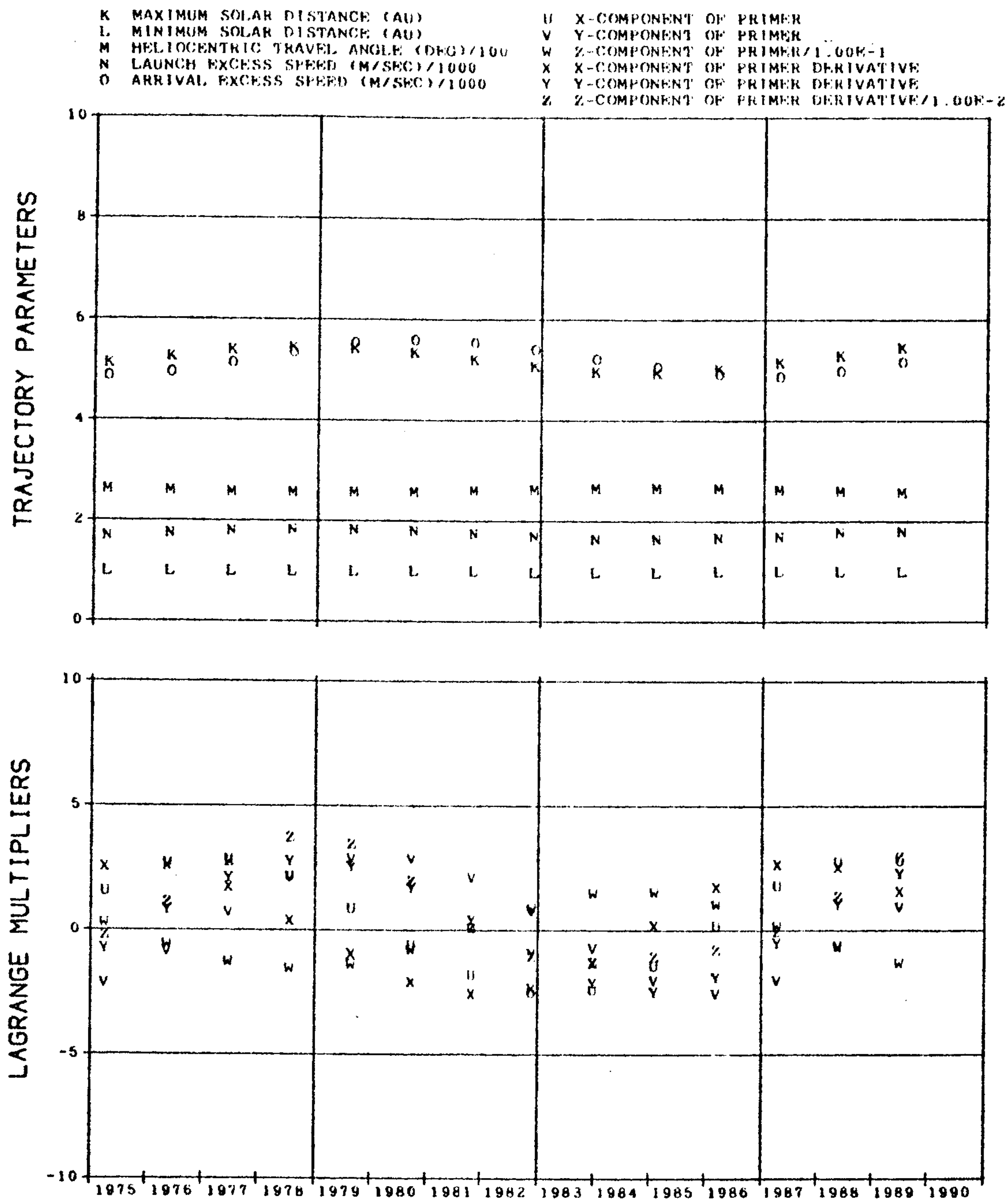

FIG. 10. (CONCLUDED)

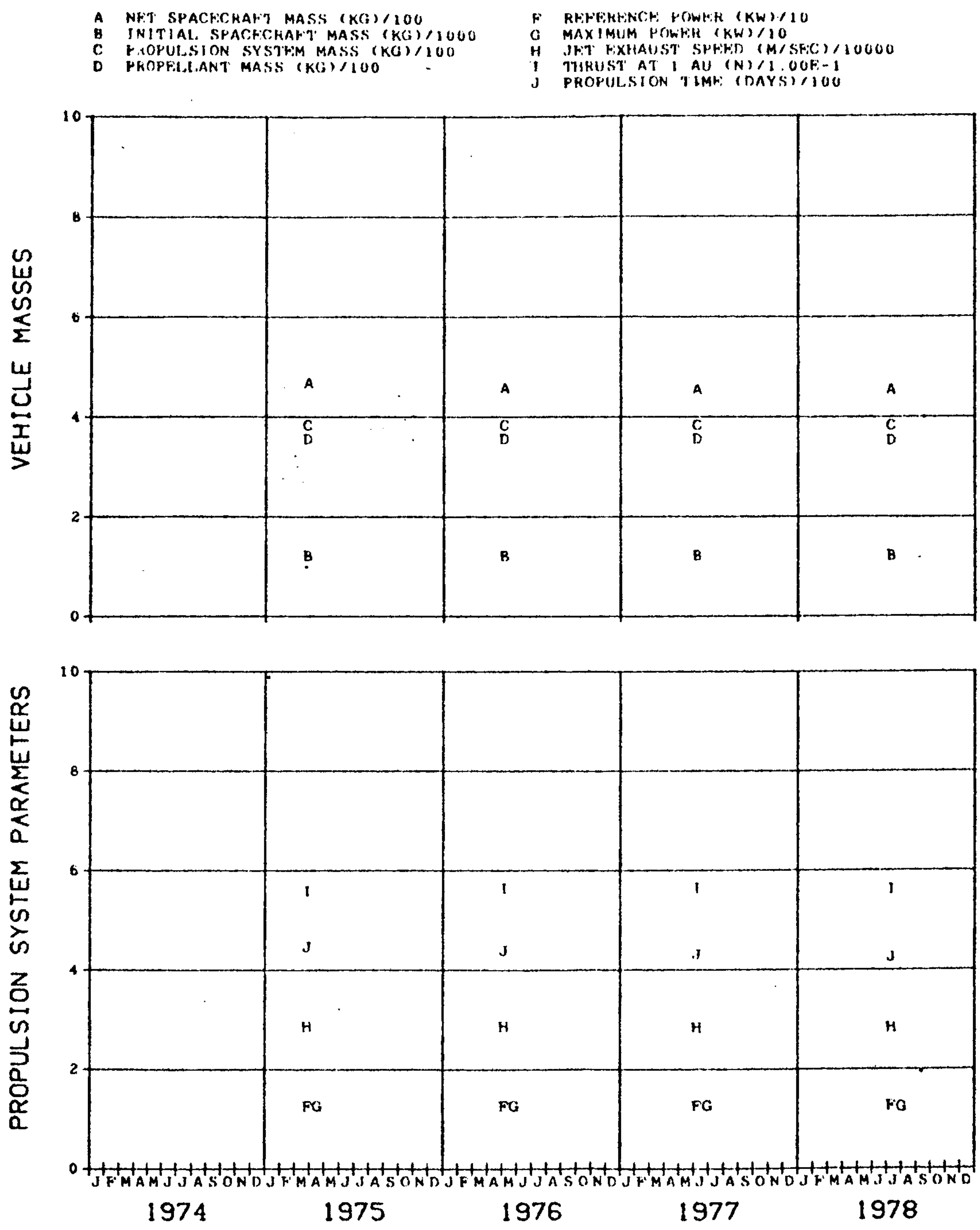

FIG. 10A. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1000 DAYS

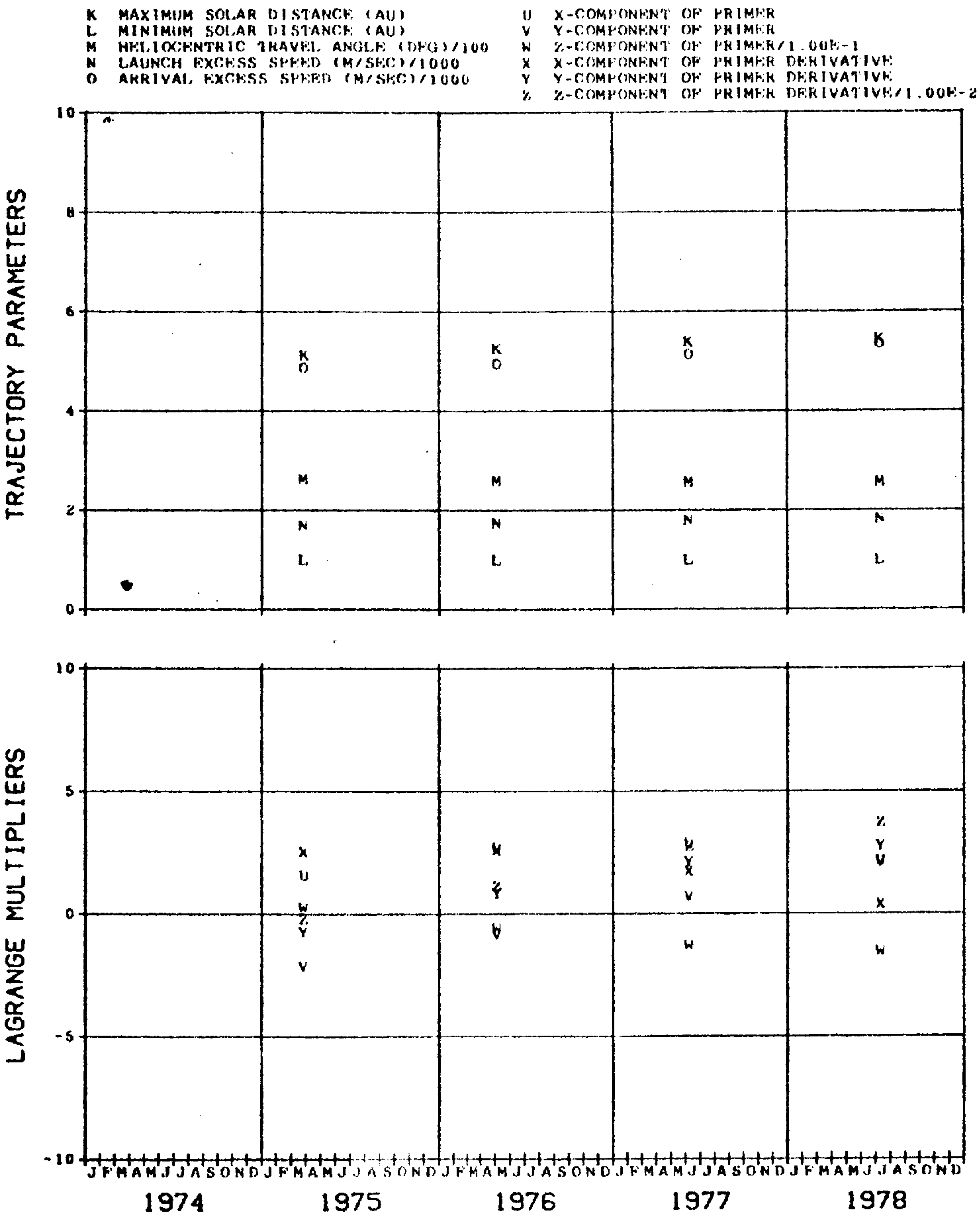

FIG. 10A. (CONCLUDED)

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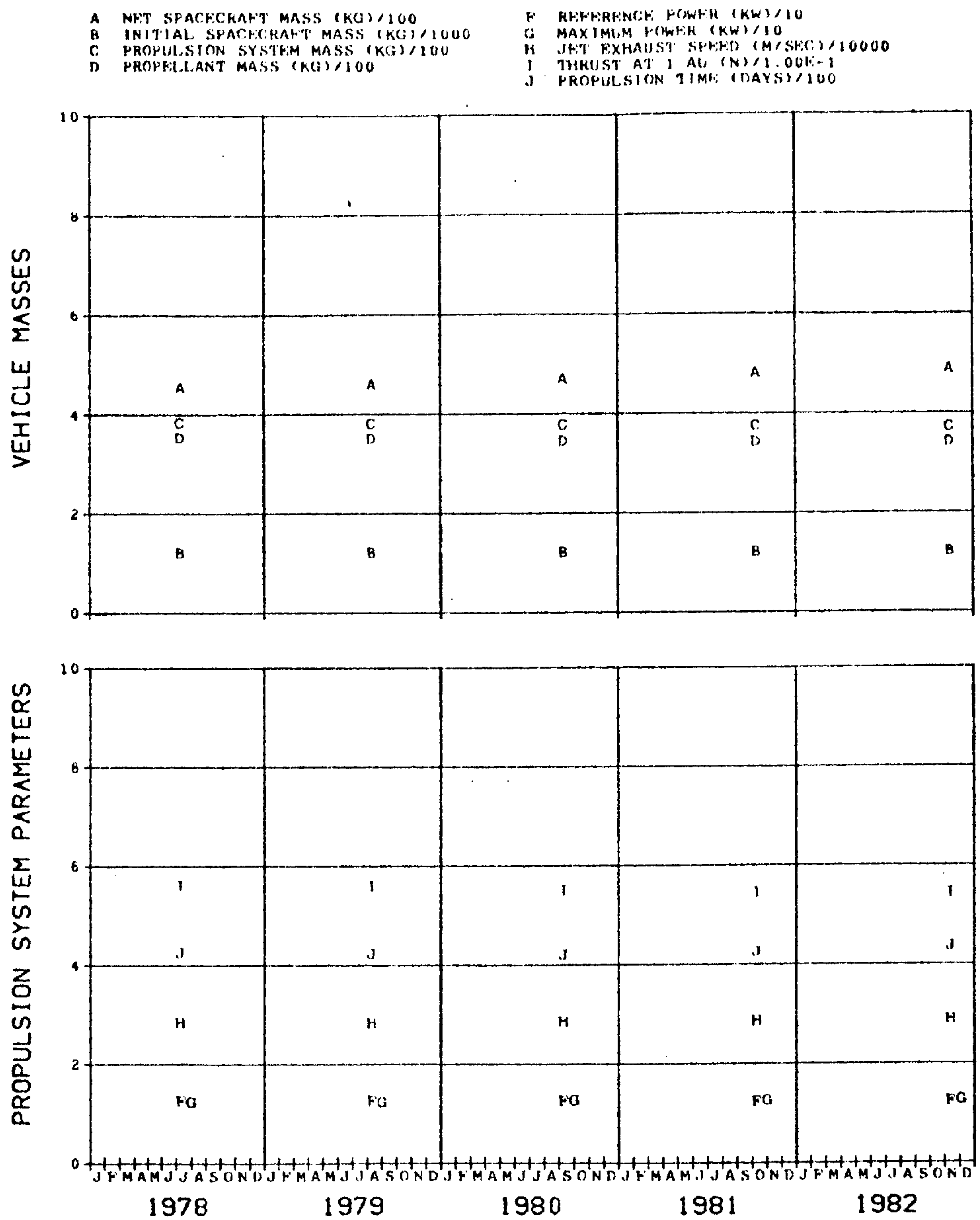

FIG. 10B. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1000 DAYS

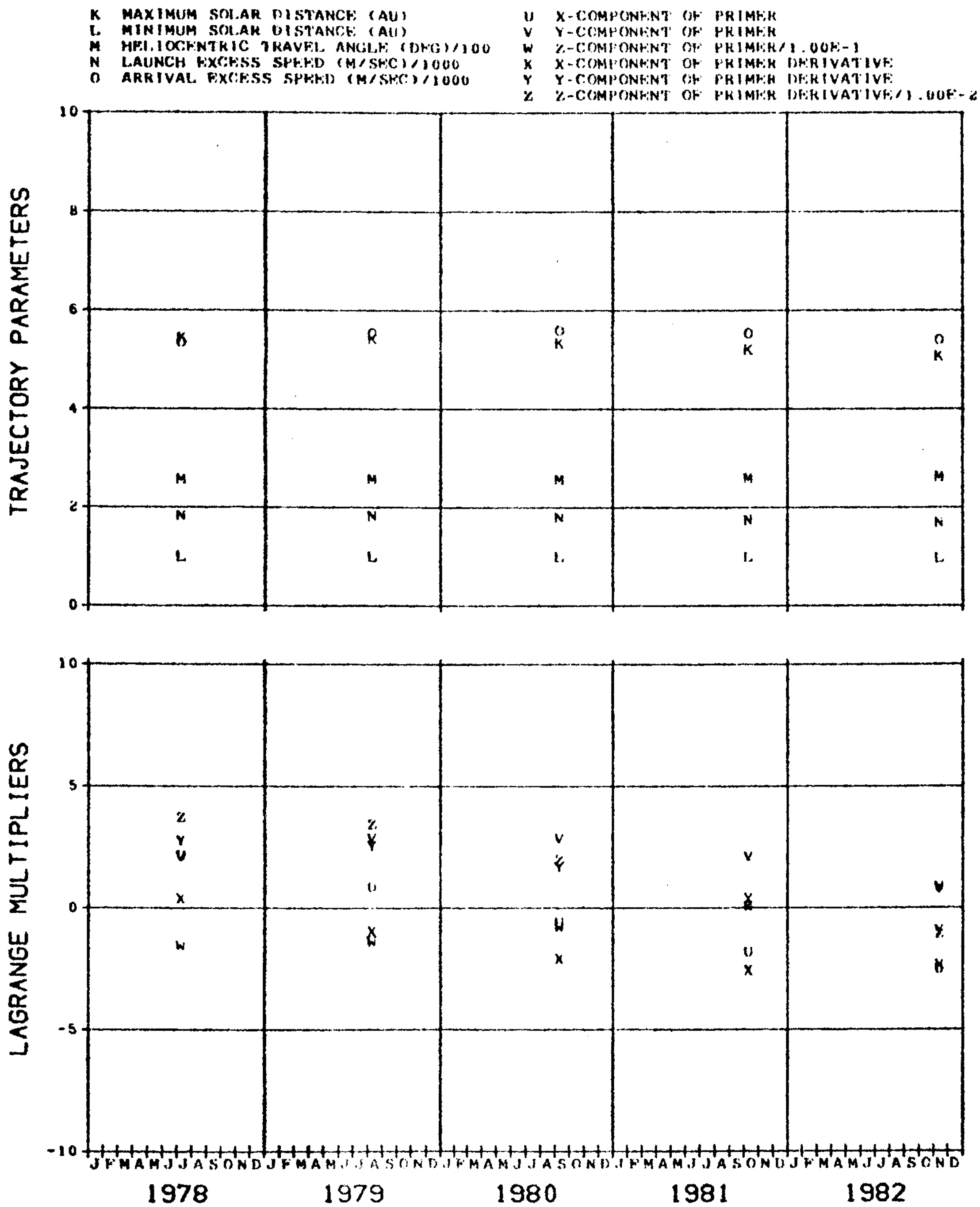

FIG. 10B. (CONCLUDED)

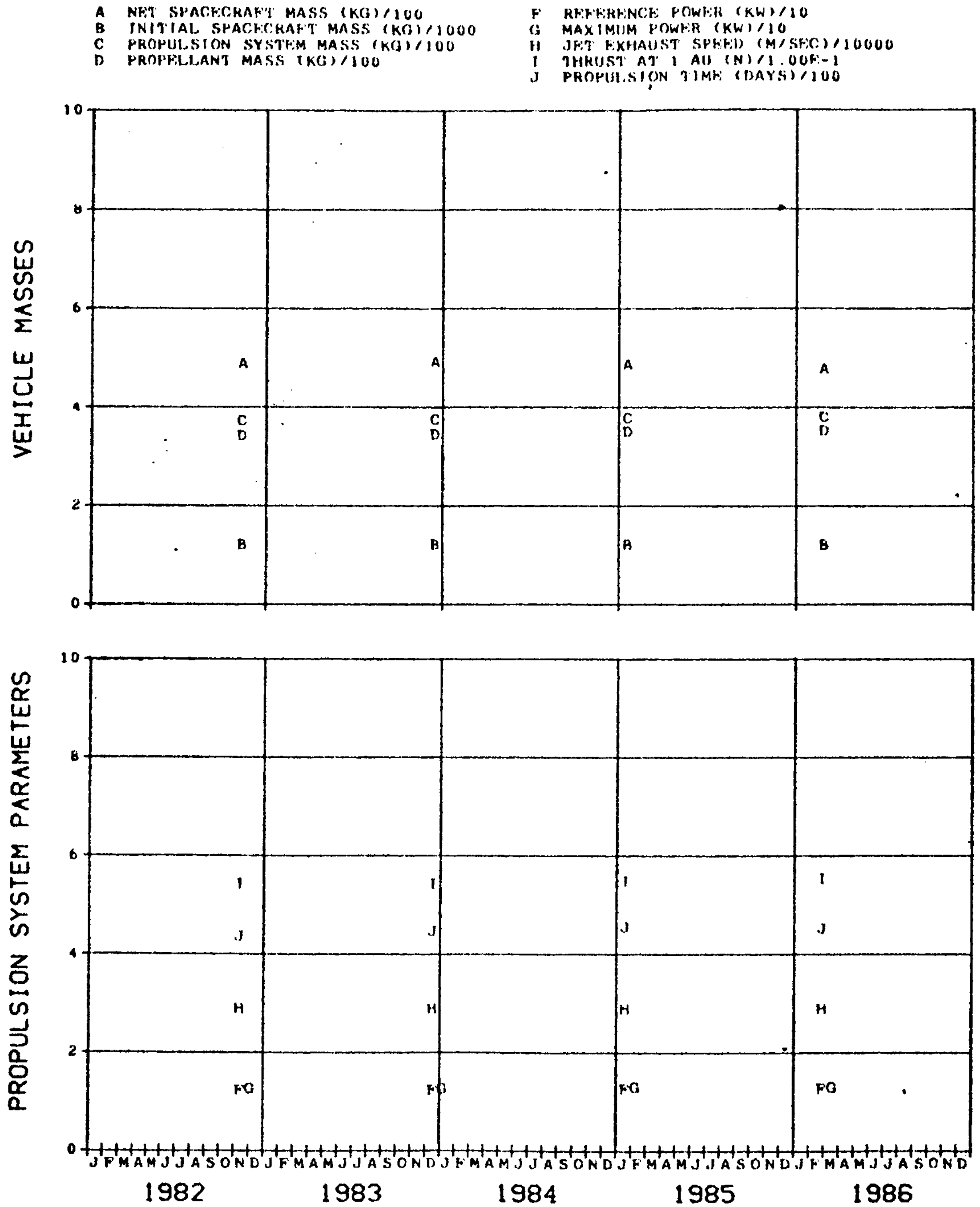

FIG. 10C. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1000 DAYS

XXXX 100

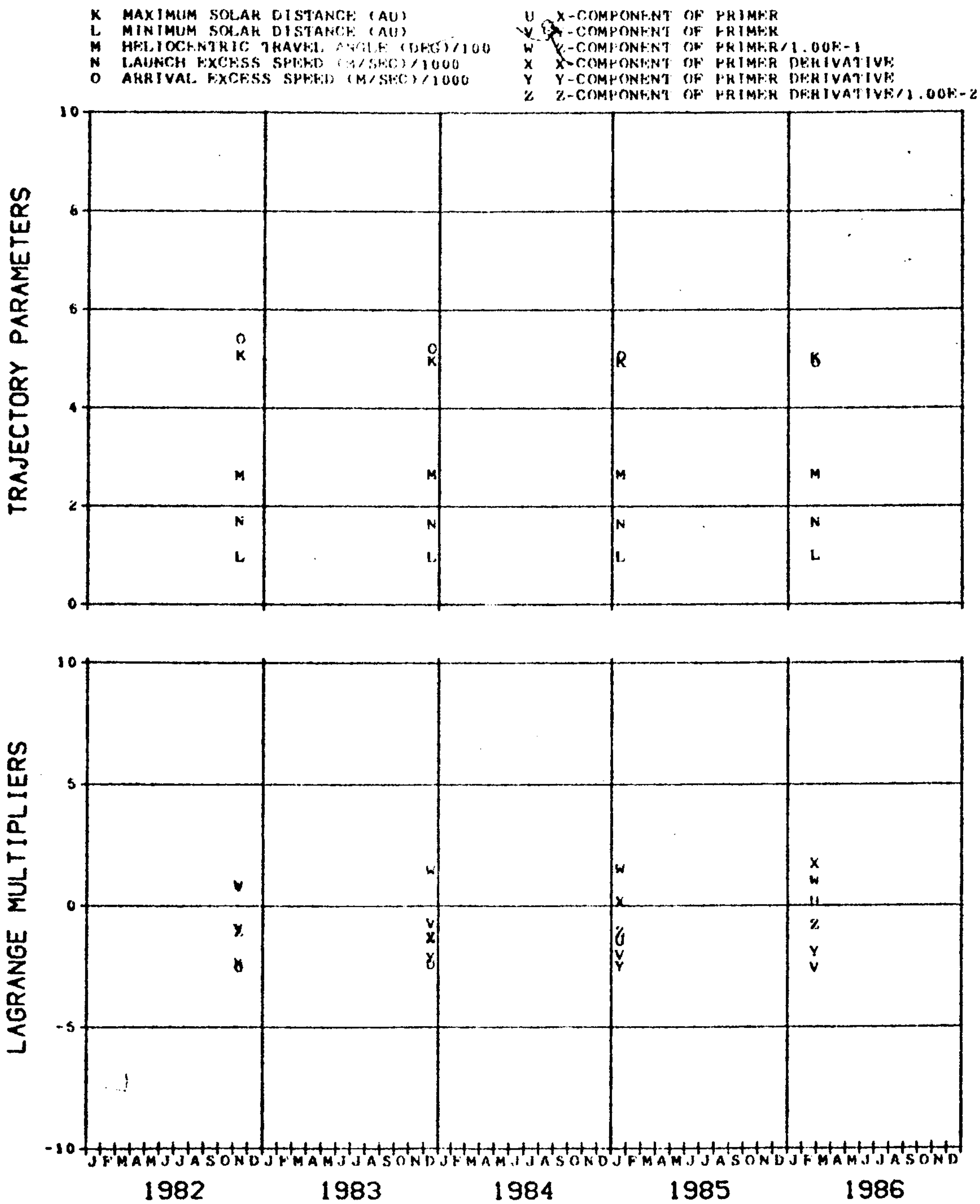

FIG. 10C. (CONCLUDED)

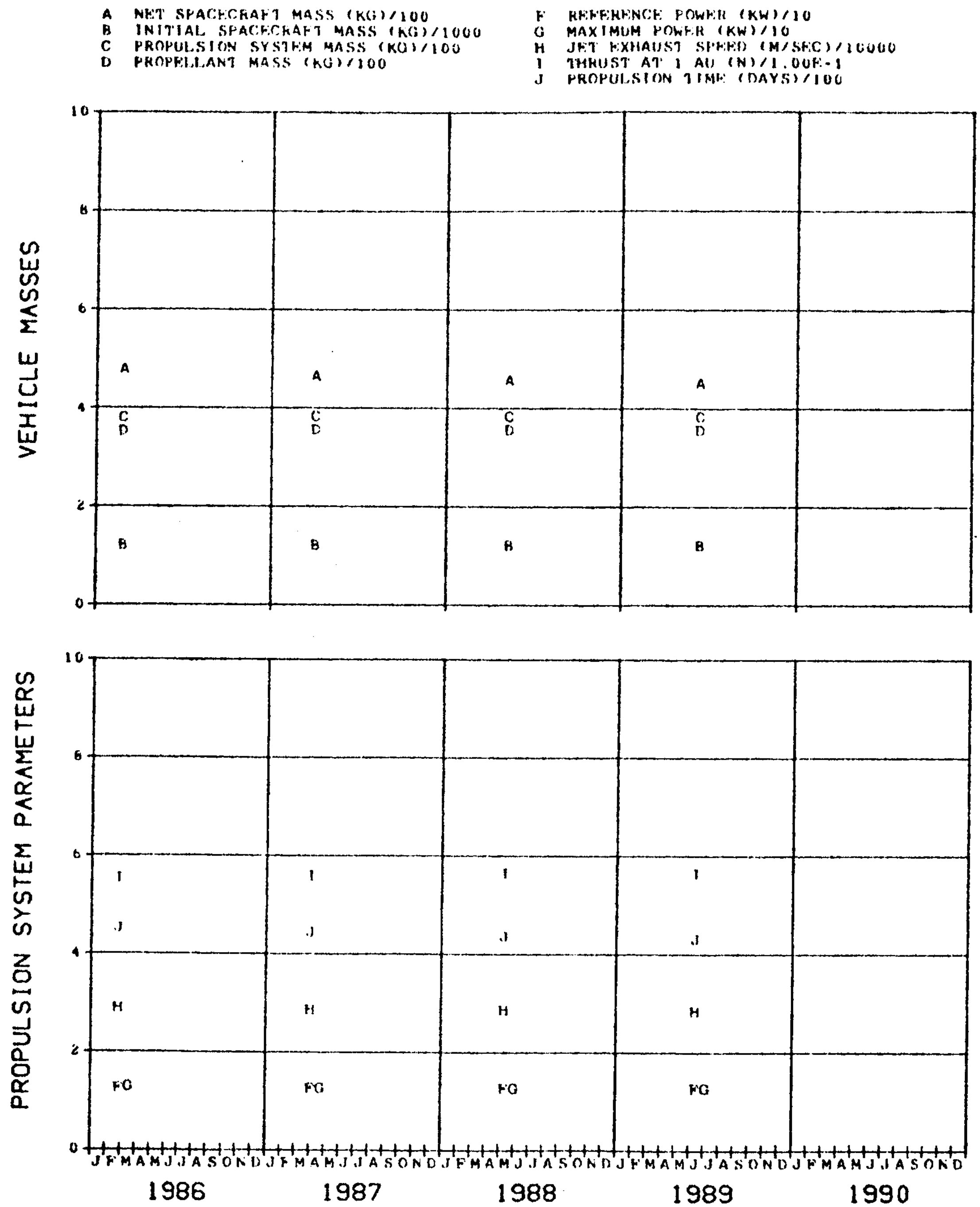

FIG. 10D. JUPITER MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1000 DAYS

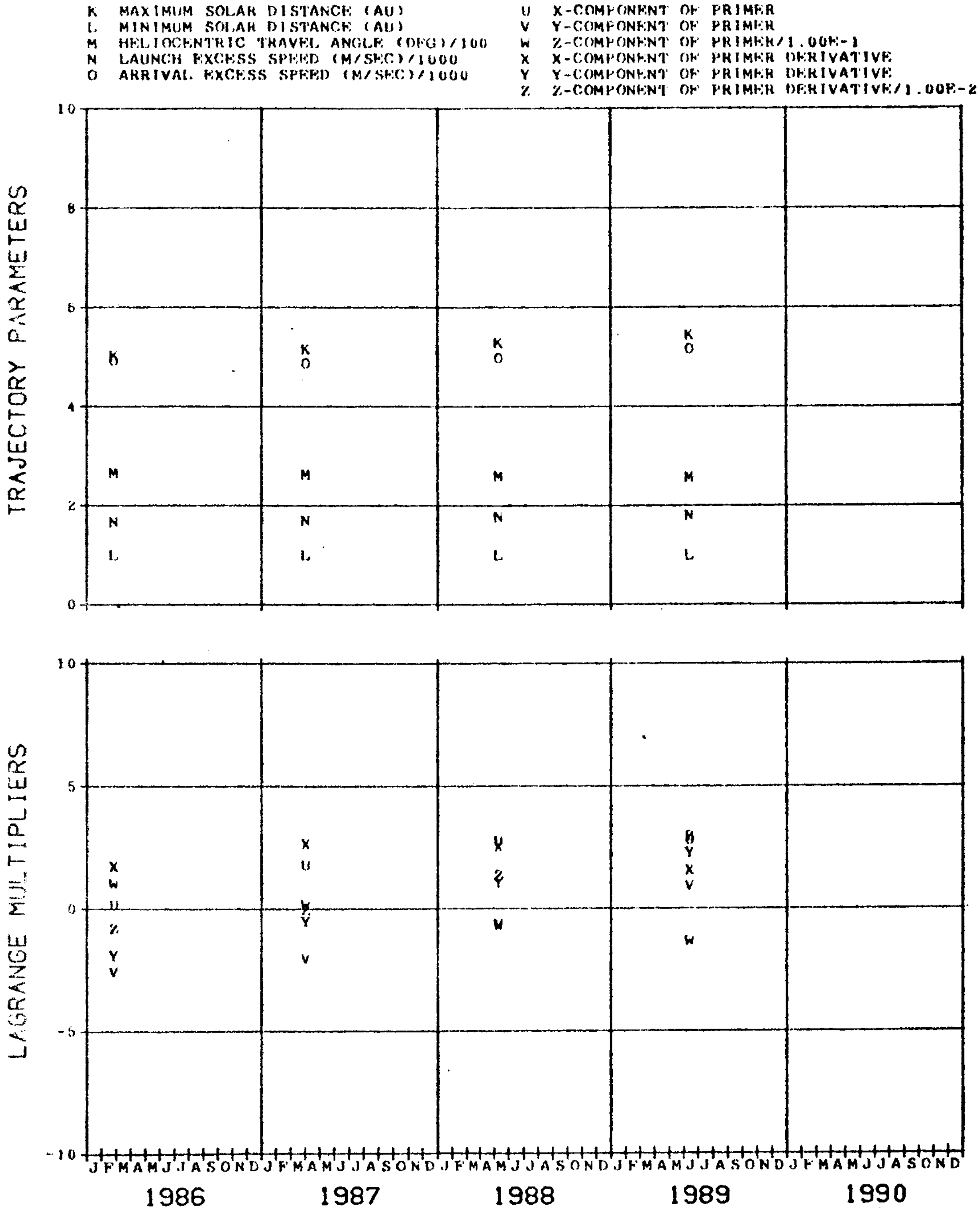

FIG. 10D. (CONCLUDED)

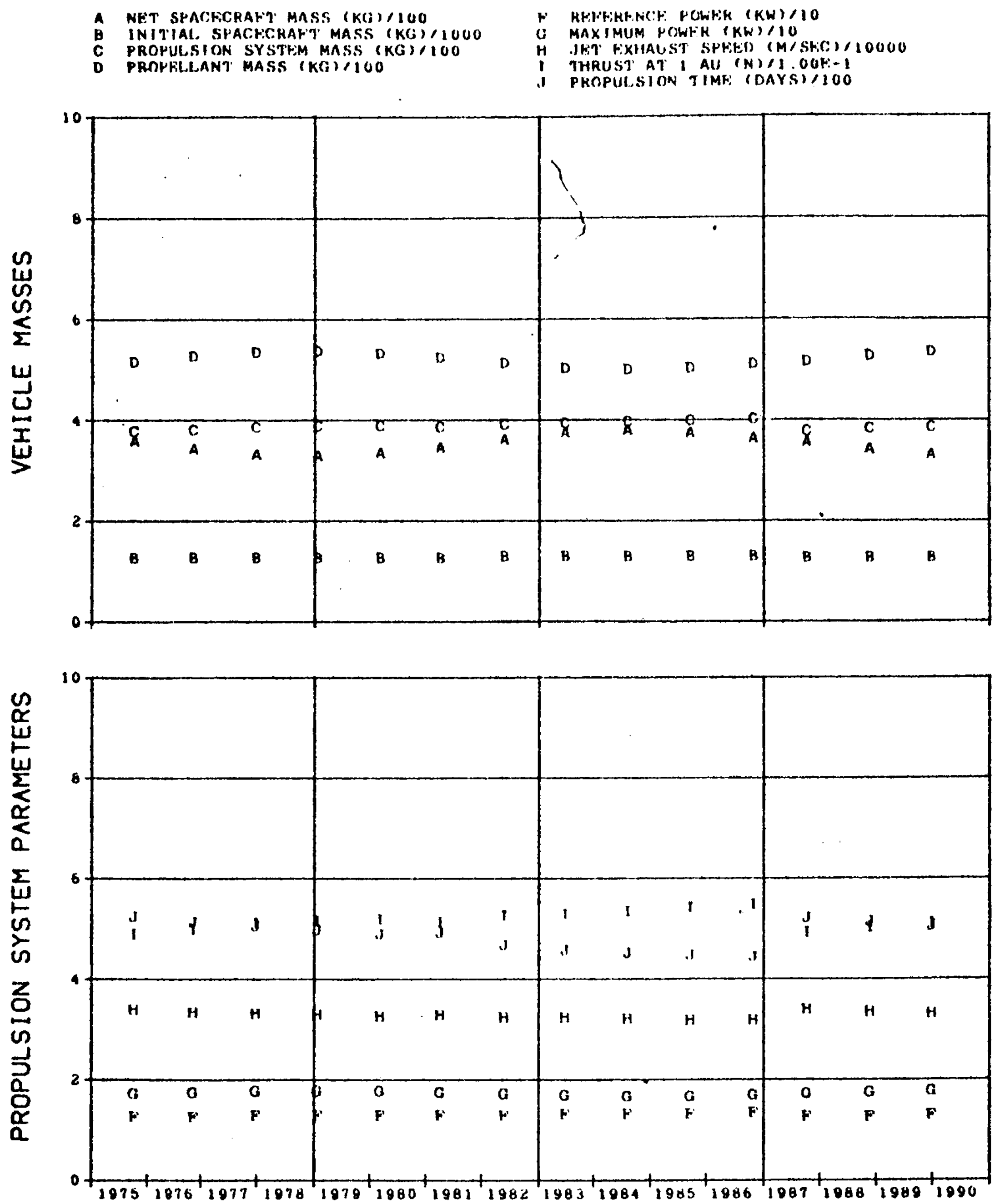

FIG. 11. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 800 DAYS

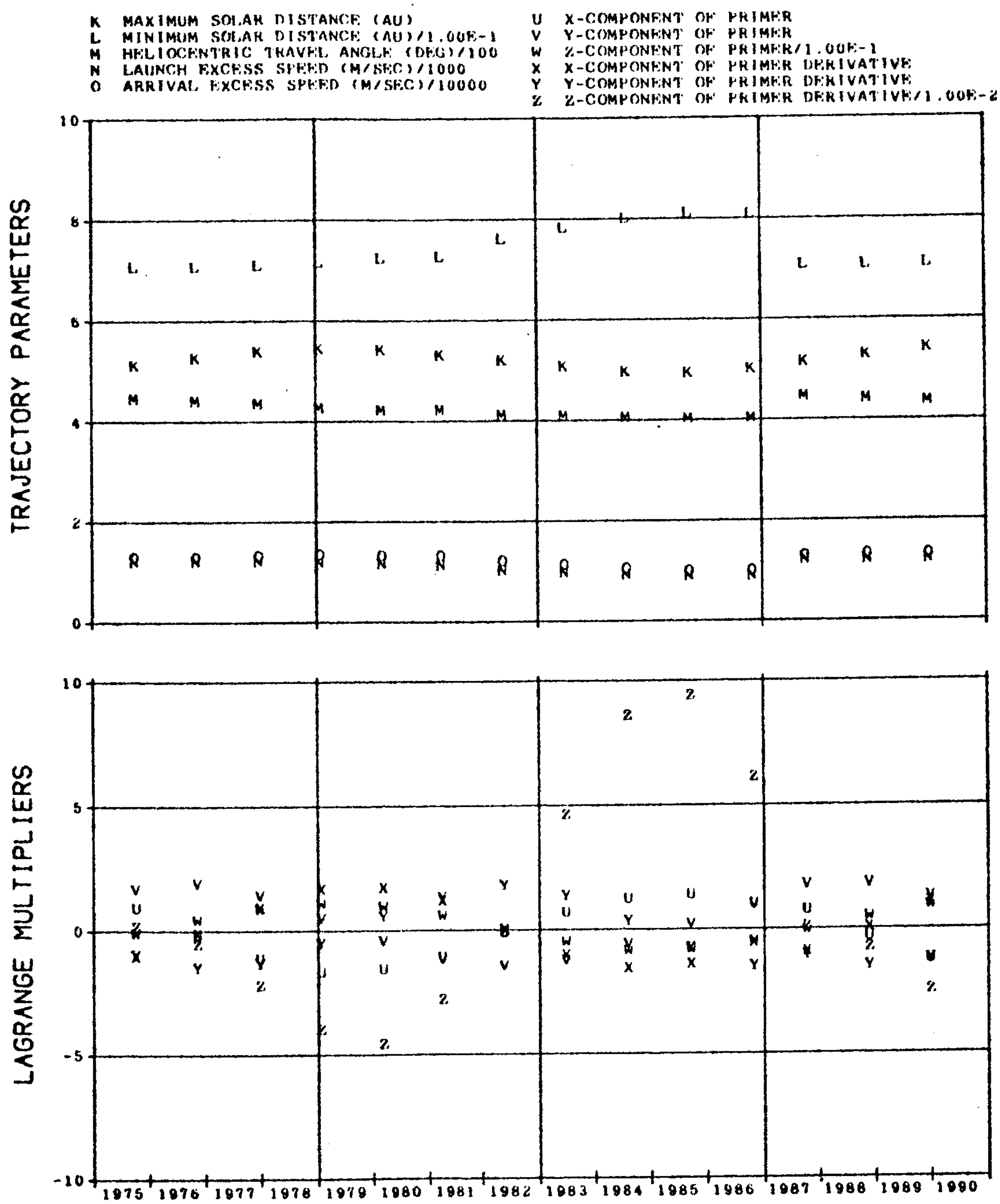

FIG. 11. (CONCLUDED)

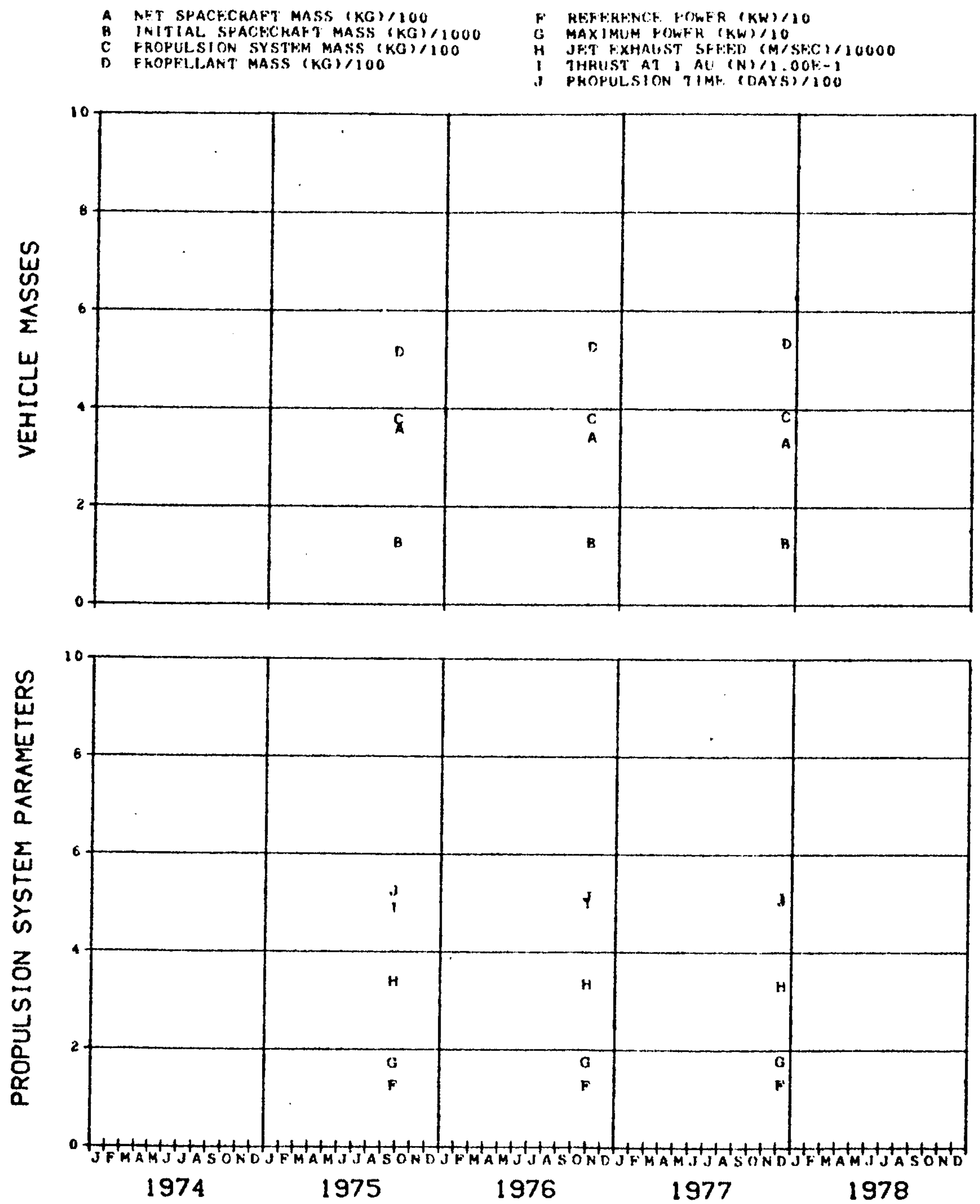

FIG. 11A. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 800 DAYS

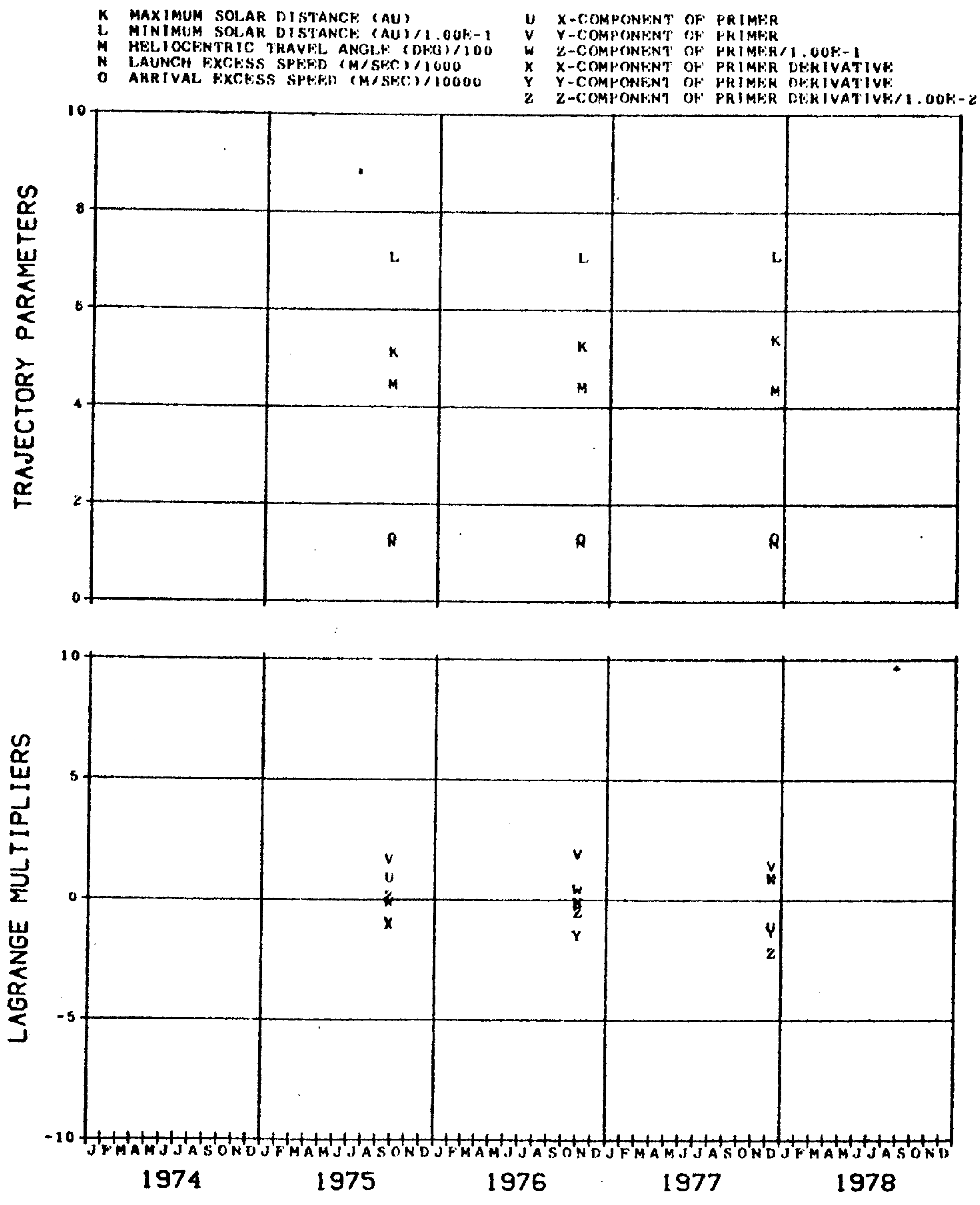

FIG. 11A. (CONCLUDED)

XXXX 107

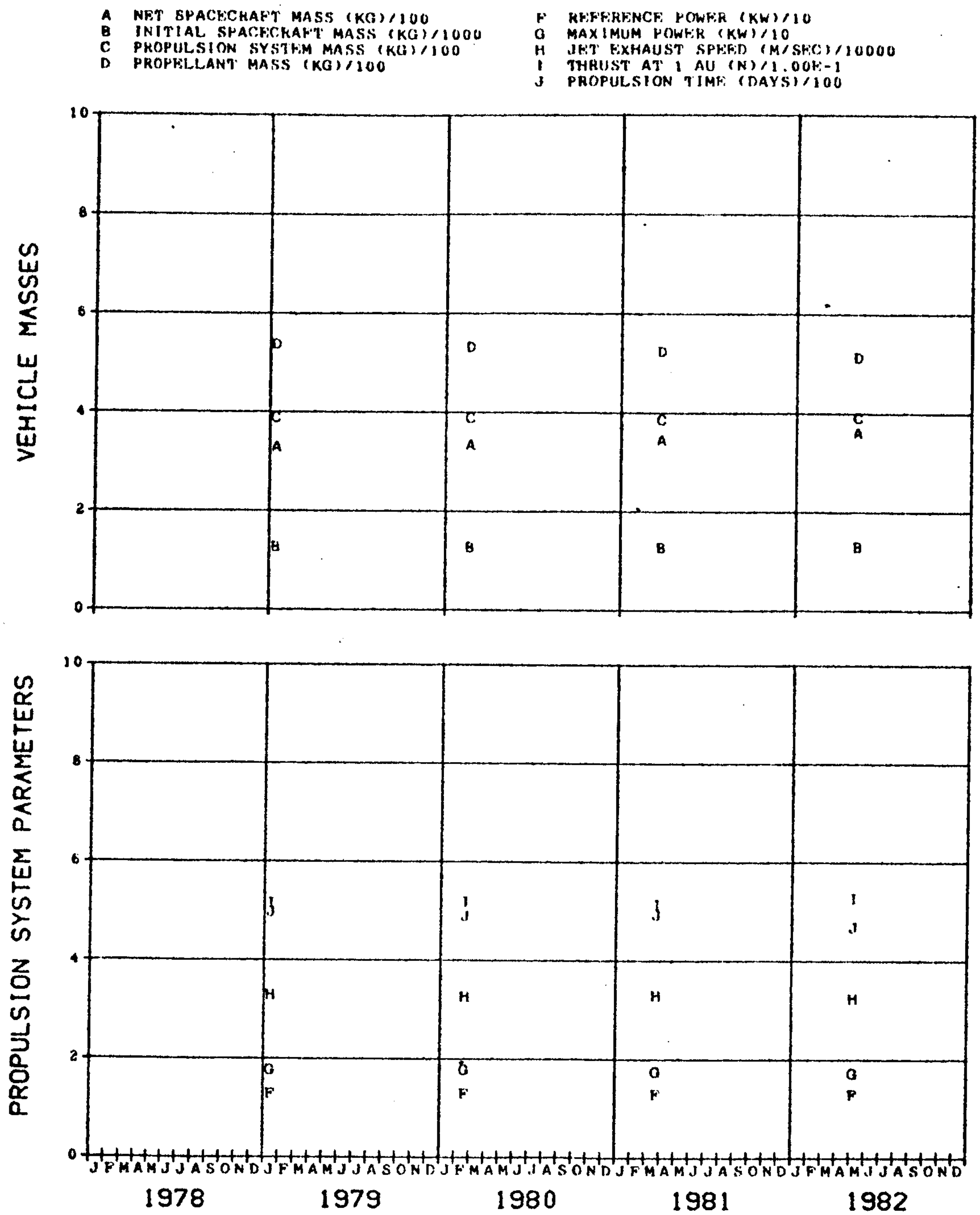

FIG. 11B. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 800 DAYS

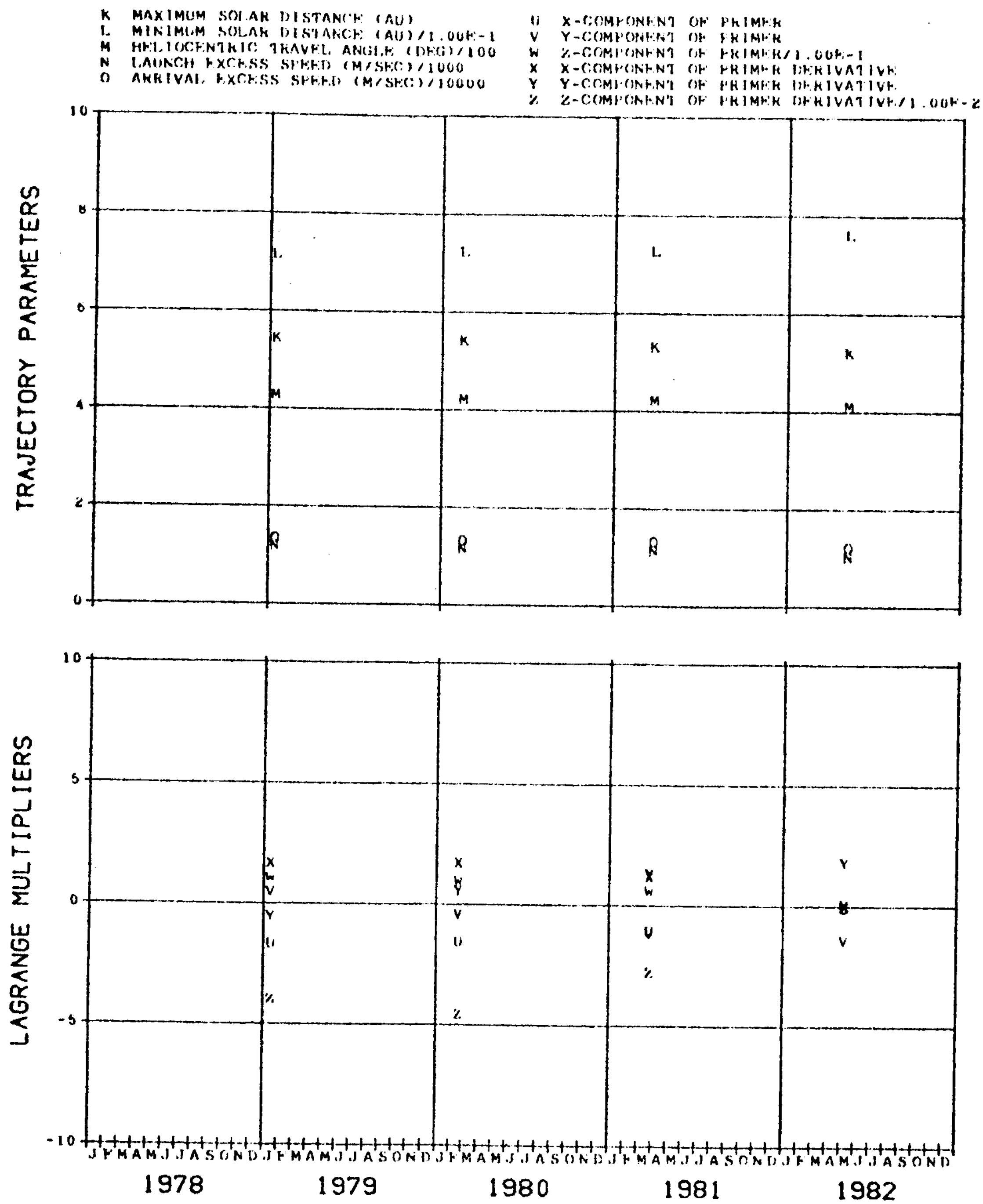

FIG. 11B. (CONCLUDED)

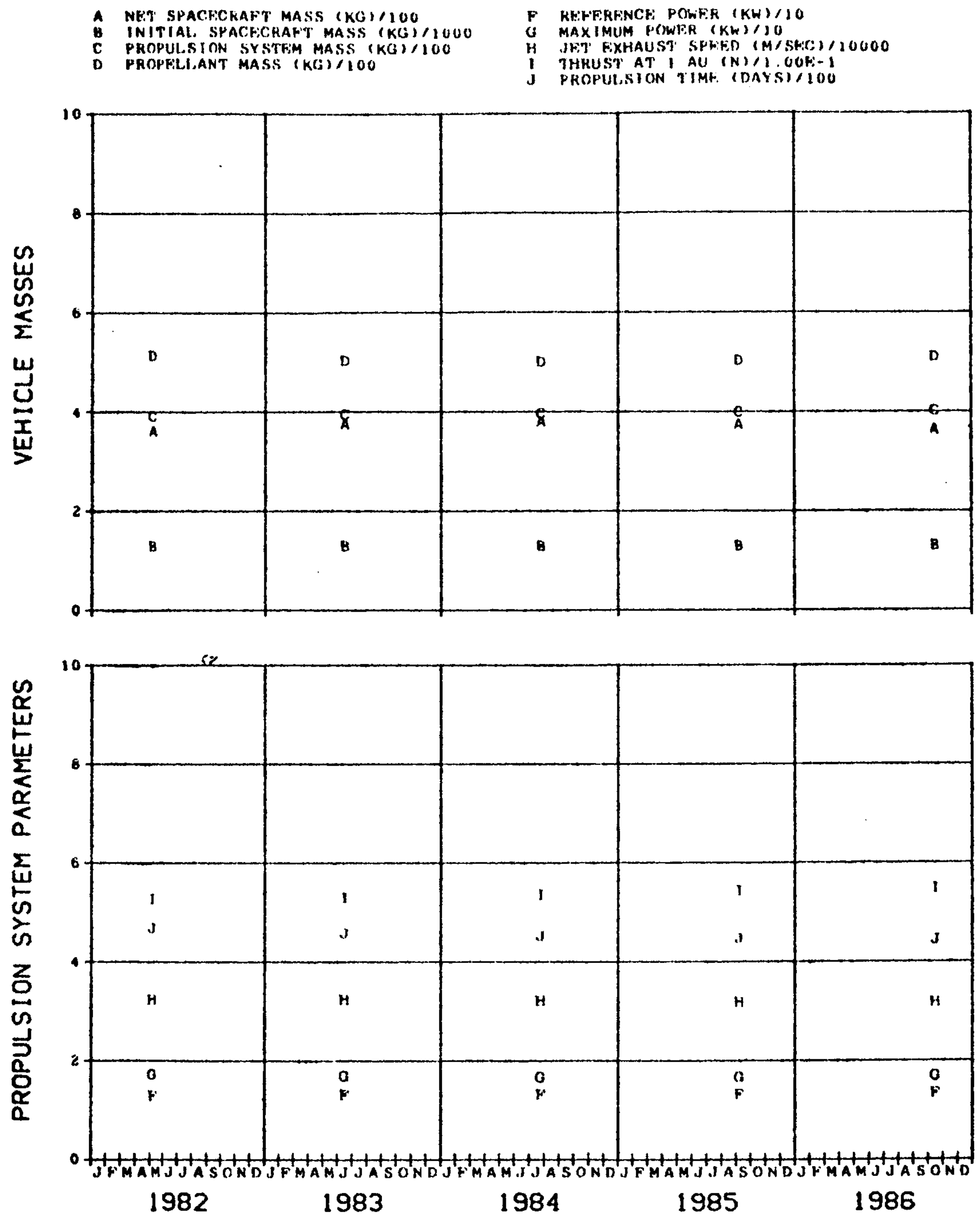

FIG. 11C. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 800 DAYS

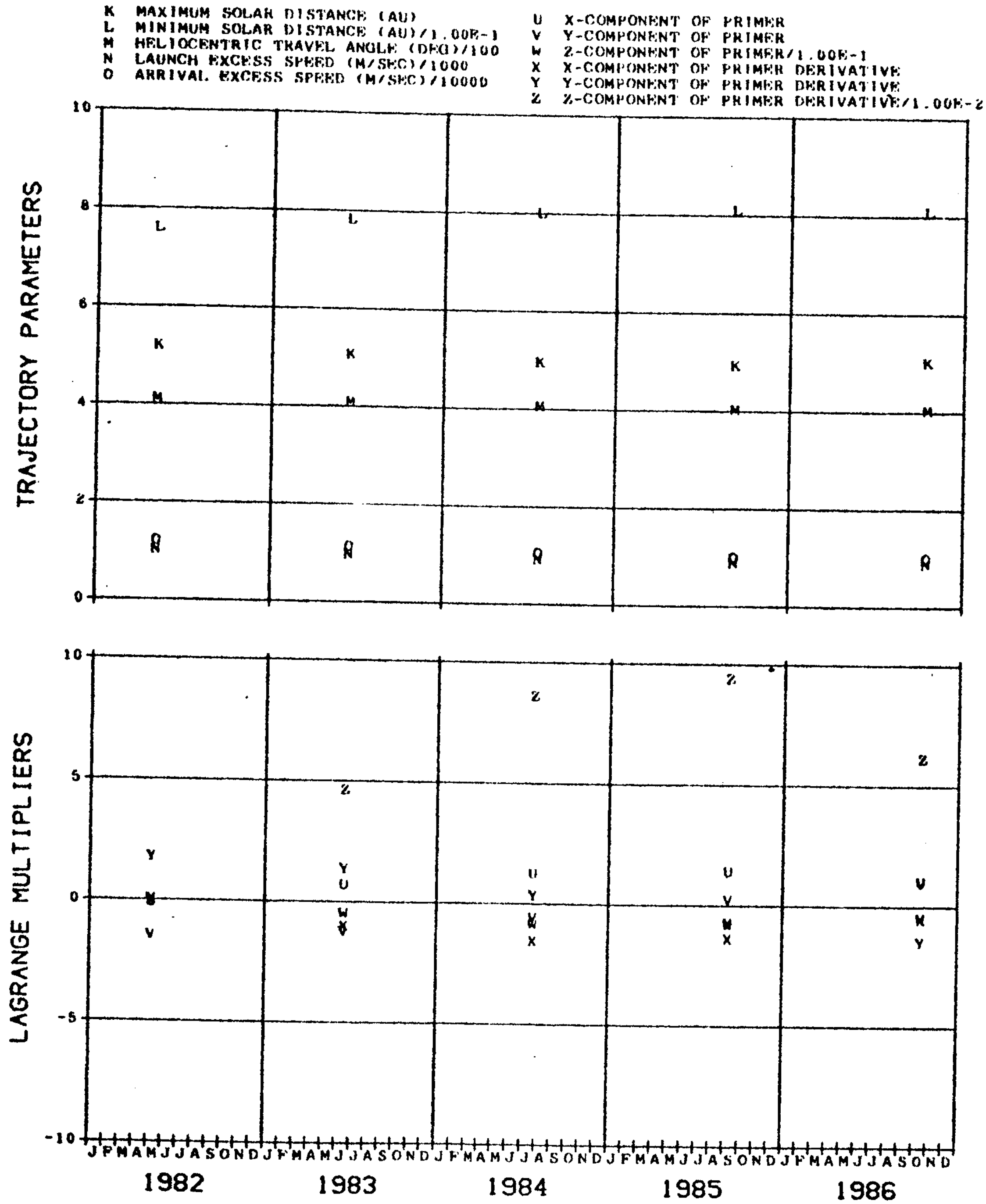

FIG. 11C. (CONCLUDED)

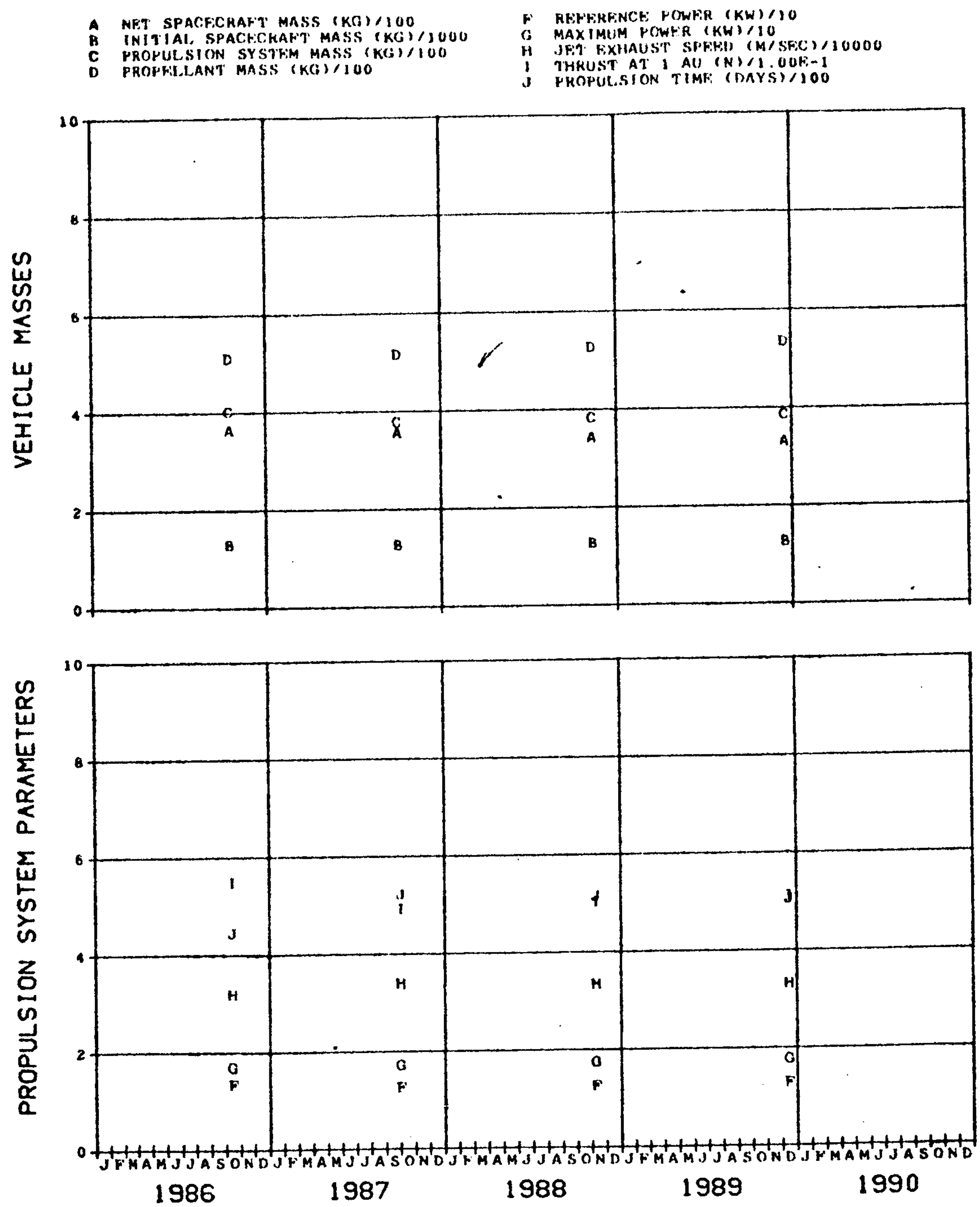

FIG. 11D. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 800 DAYS

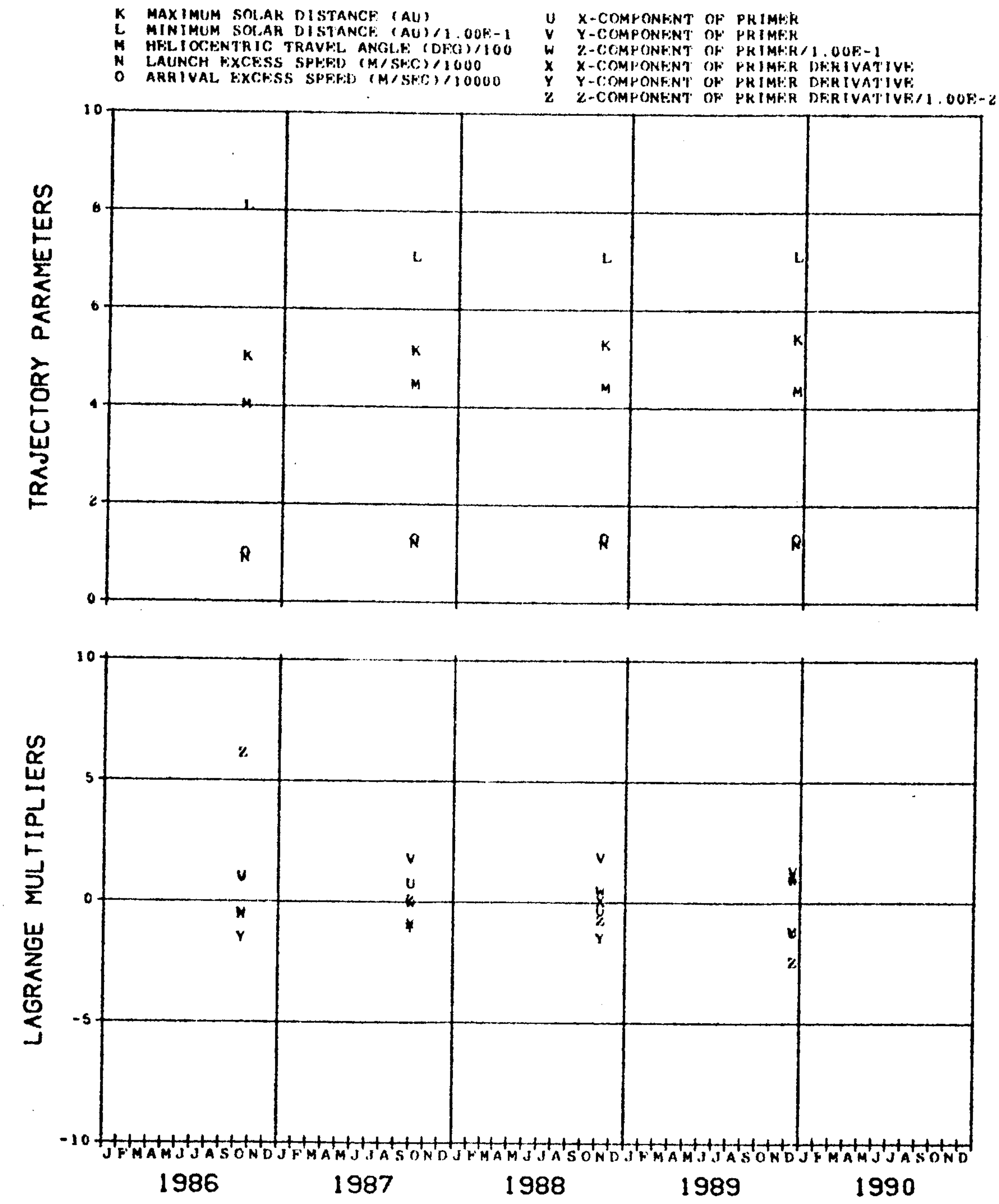

FIG. 11D. (CONCLUDED)

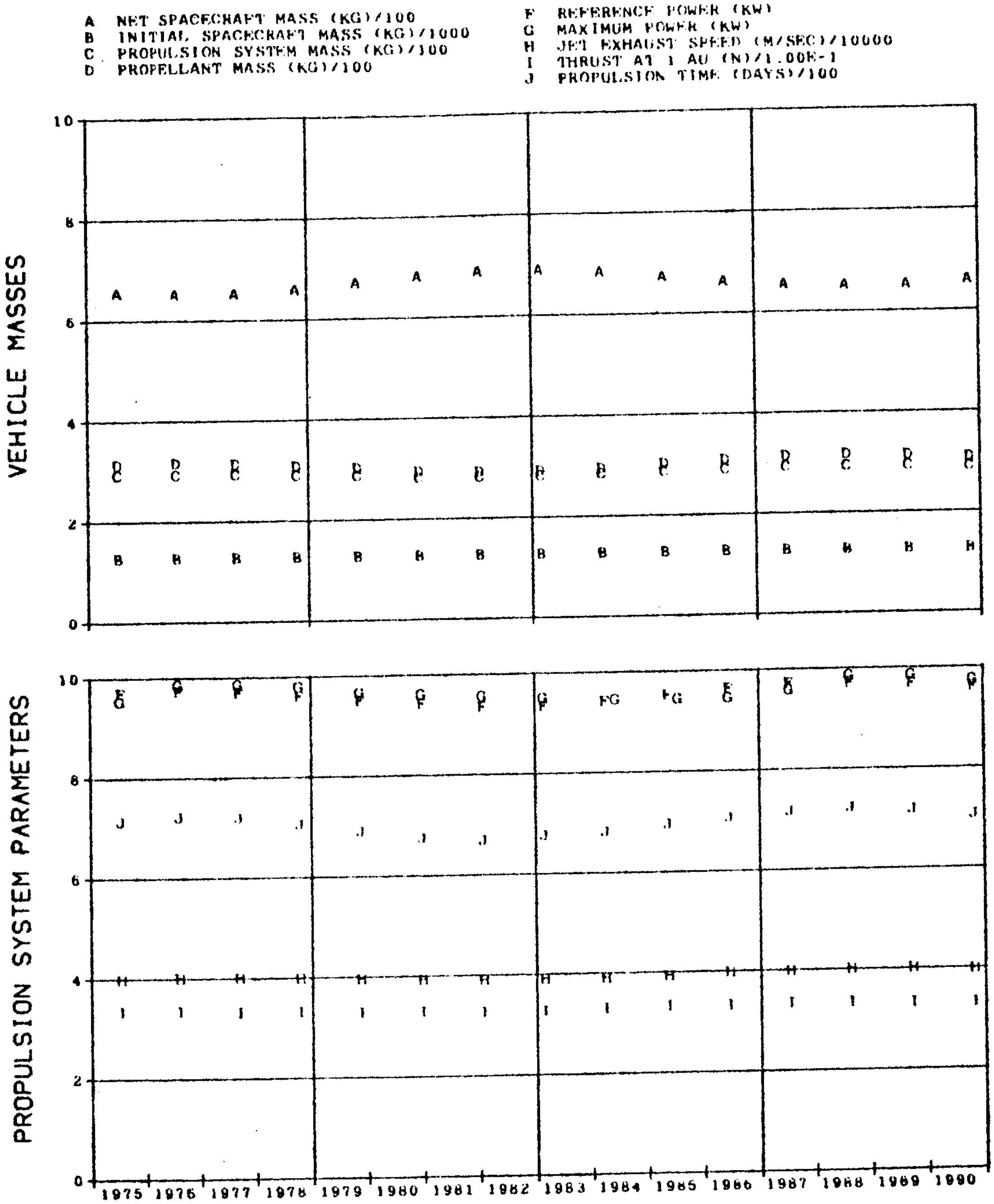

FIG. 12. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1400 DAYS

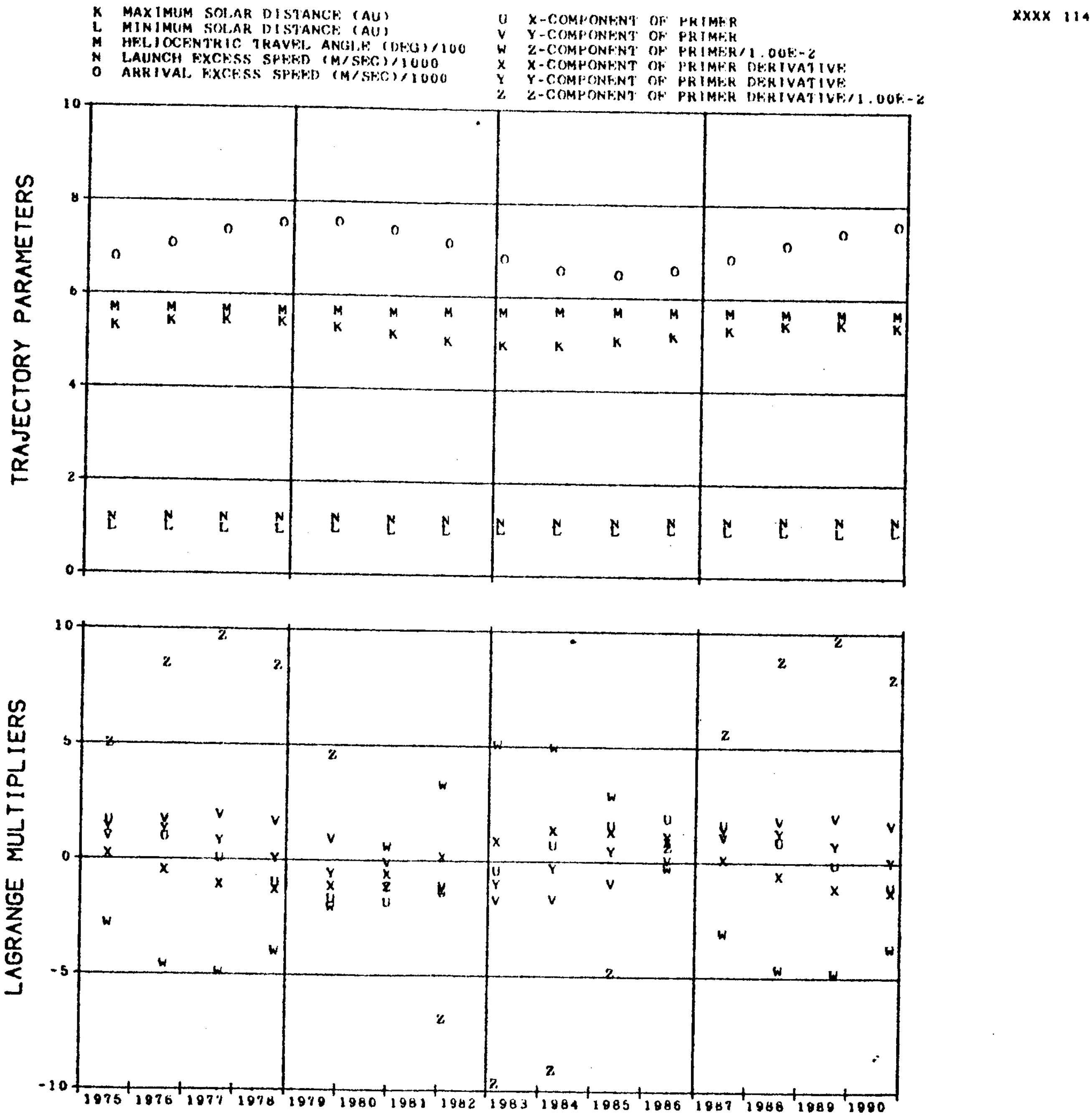

FIG. 12. (CONCLUDED)

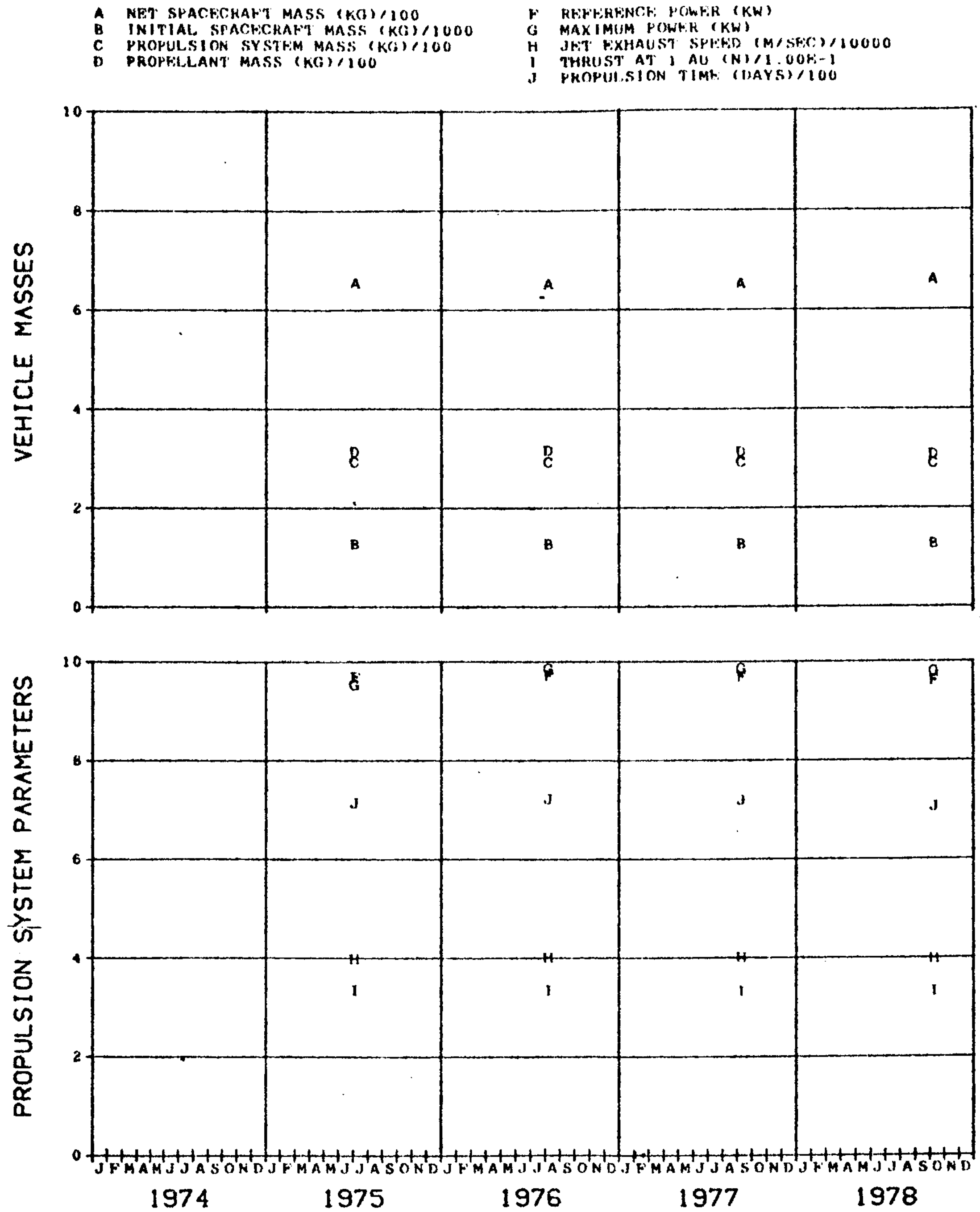

FIG. 12A. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1400 DAYS

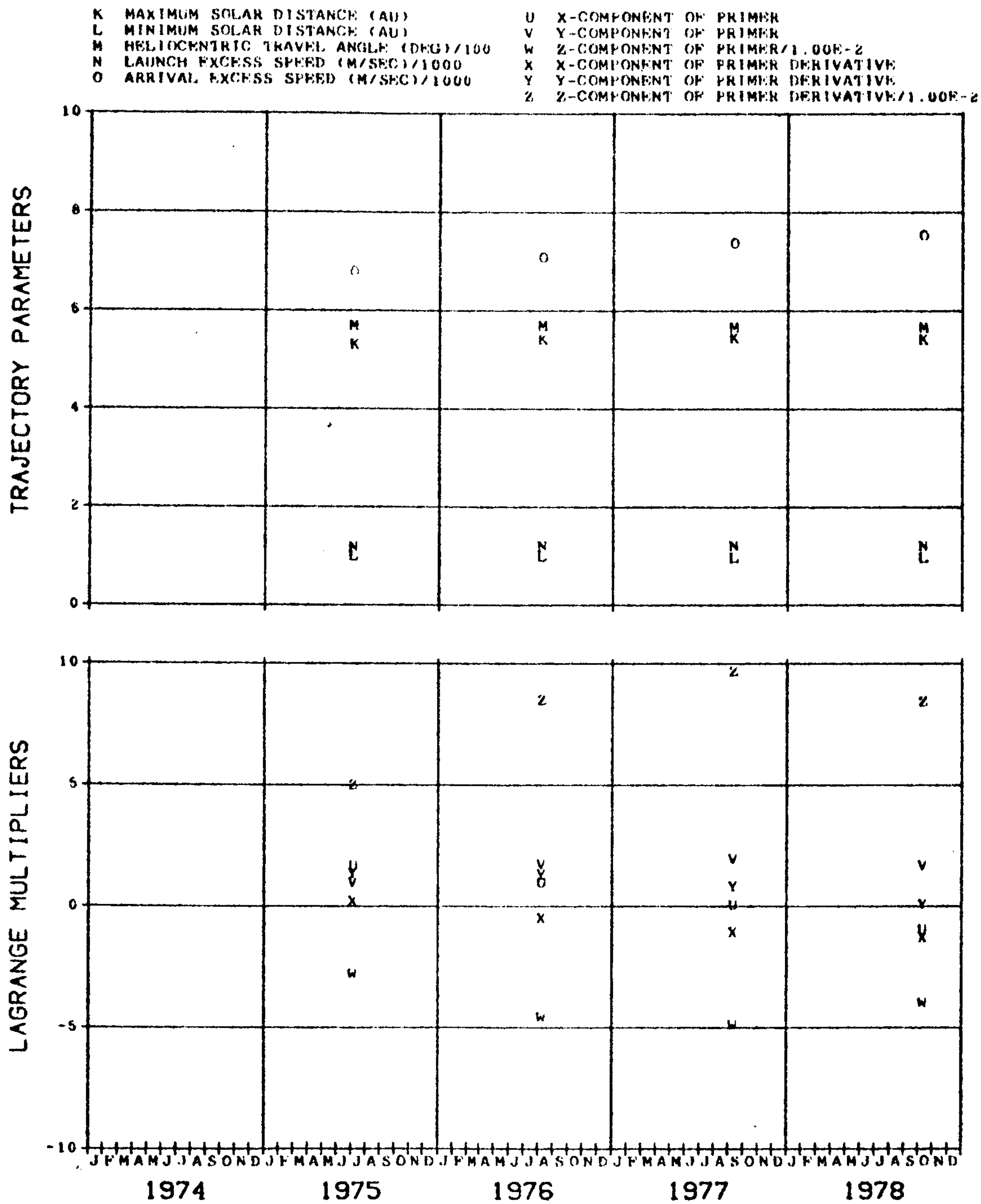

FIG. 12A. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100

F REFERENCE POWER (KW)
G MAXIMUM POWER (KW)
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

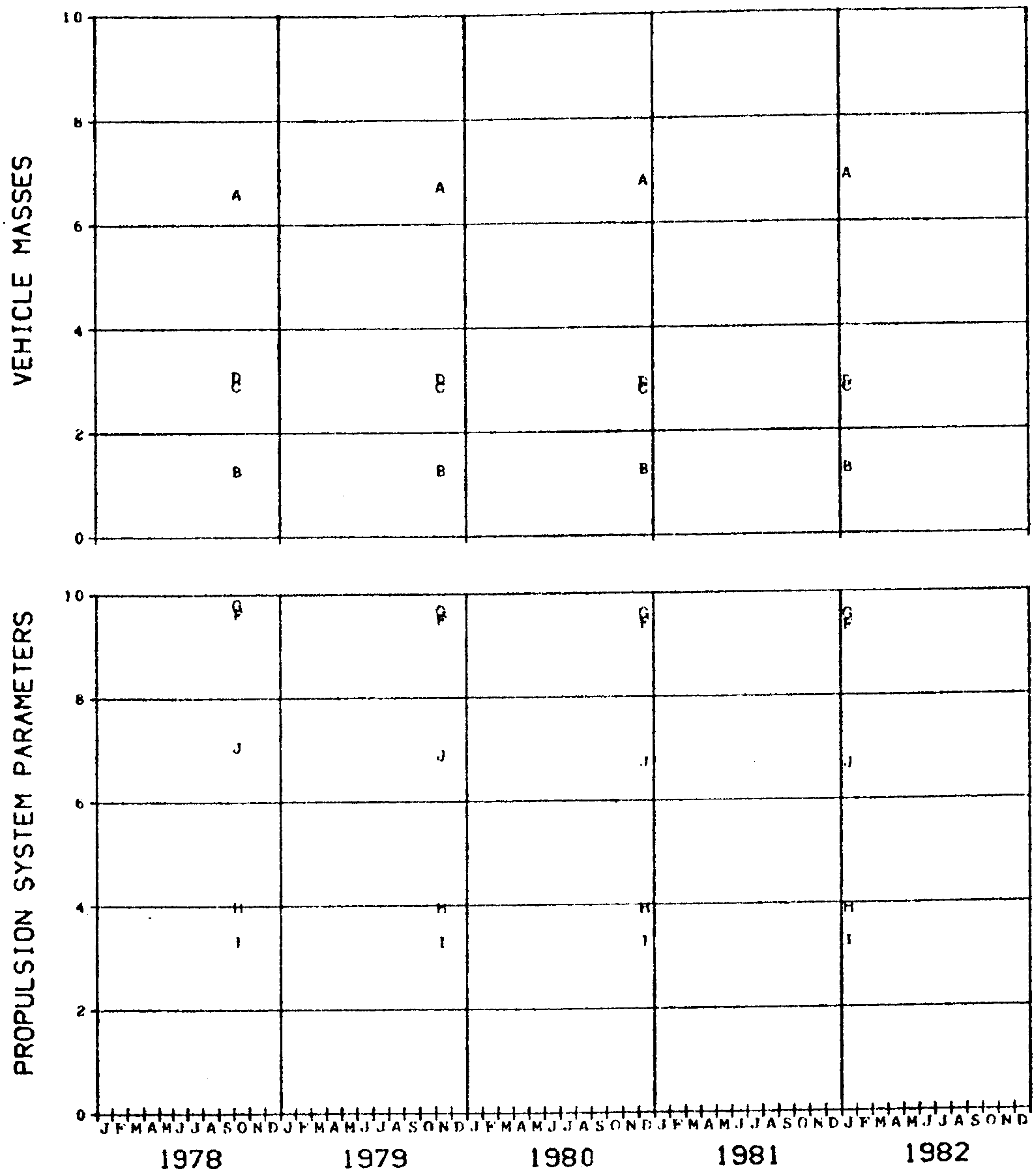

FIG. 12B. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1400 DAYS

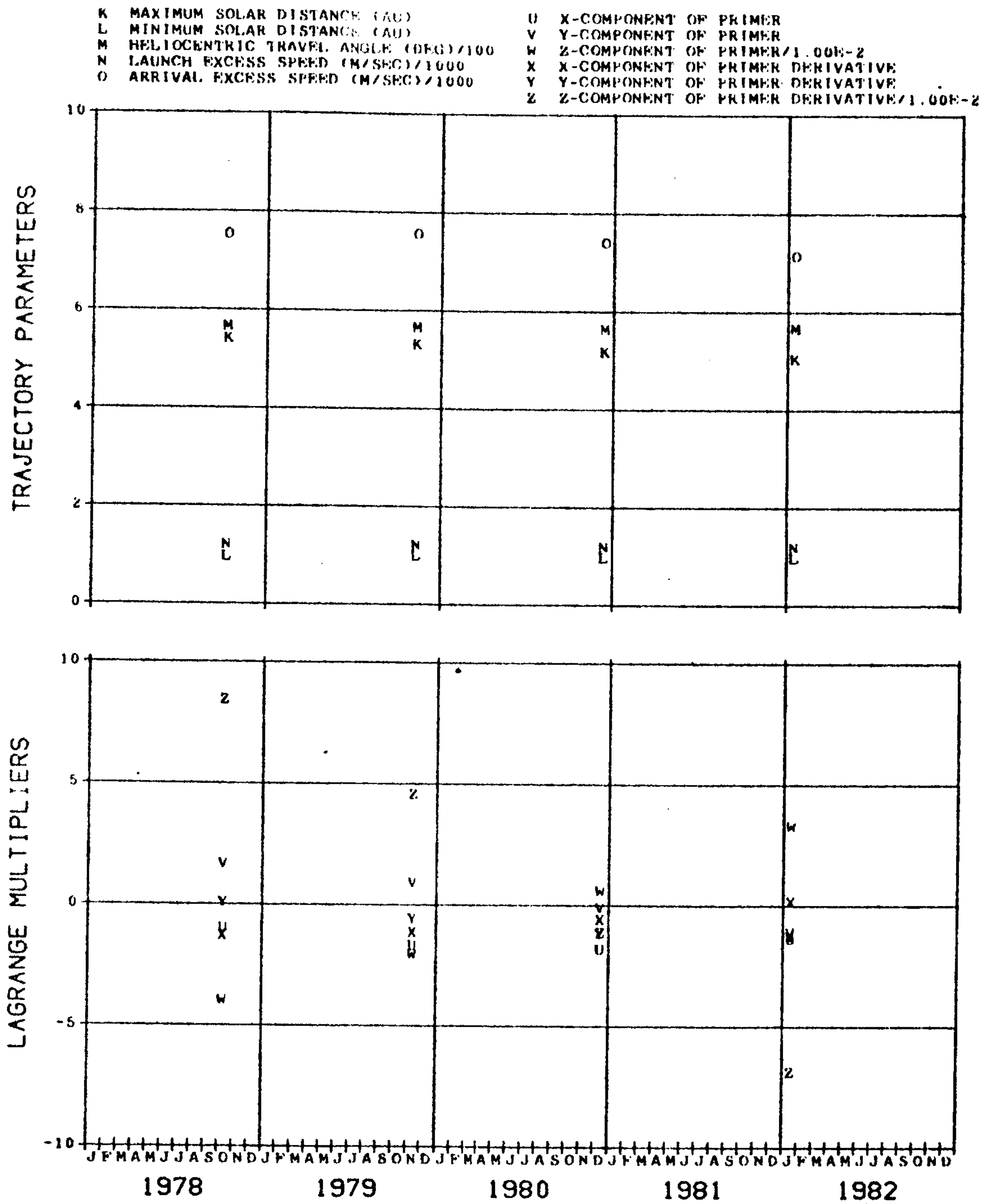

FIG. 12B. (CONCLUDED)

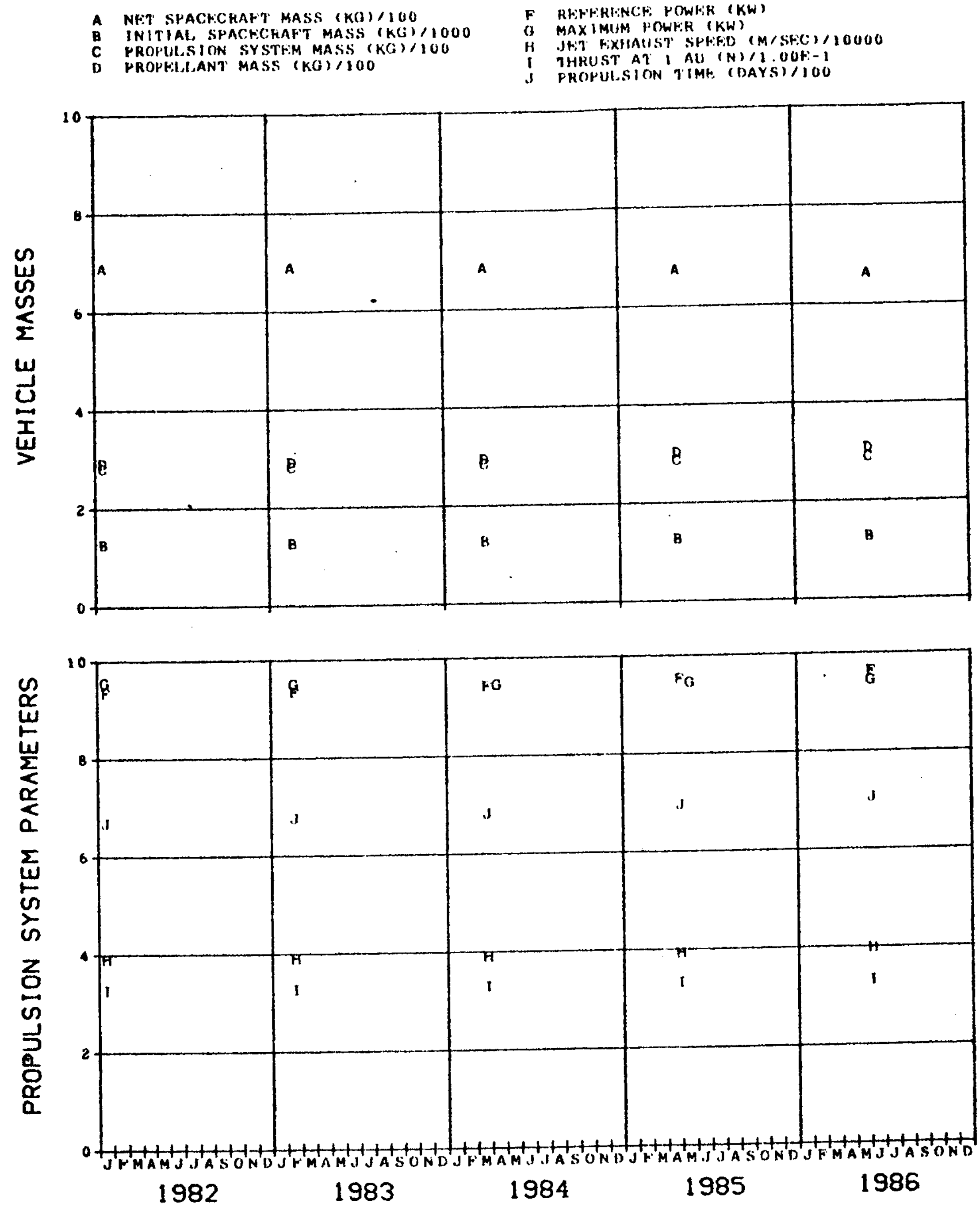

FIG. 12C. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1400 DAYS

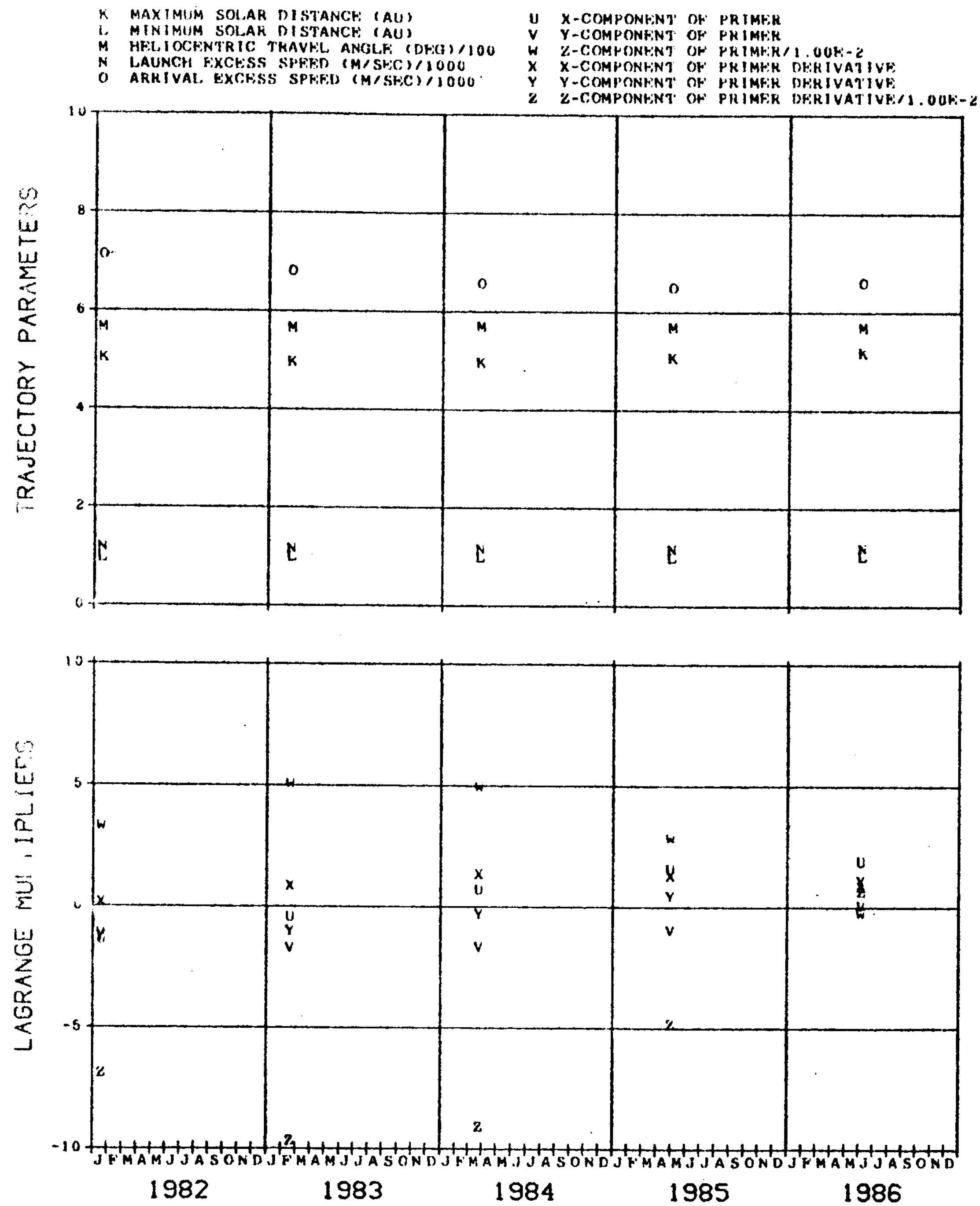

FIG. 12C. (CONCLUDED)

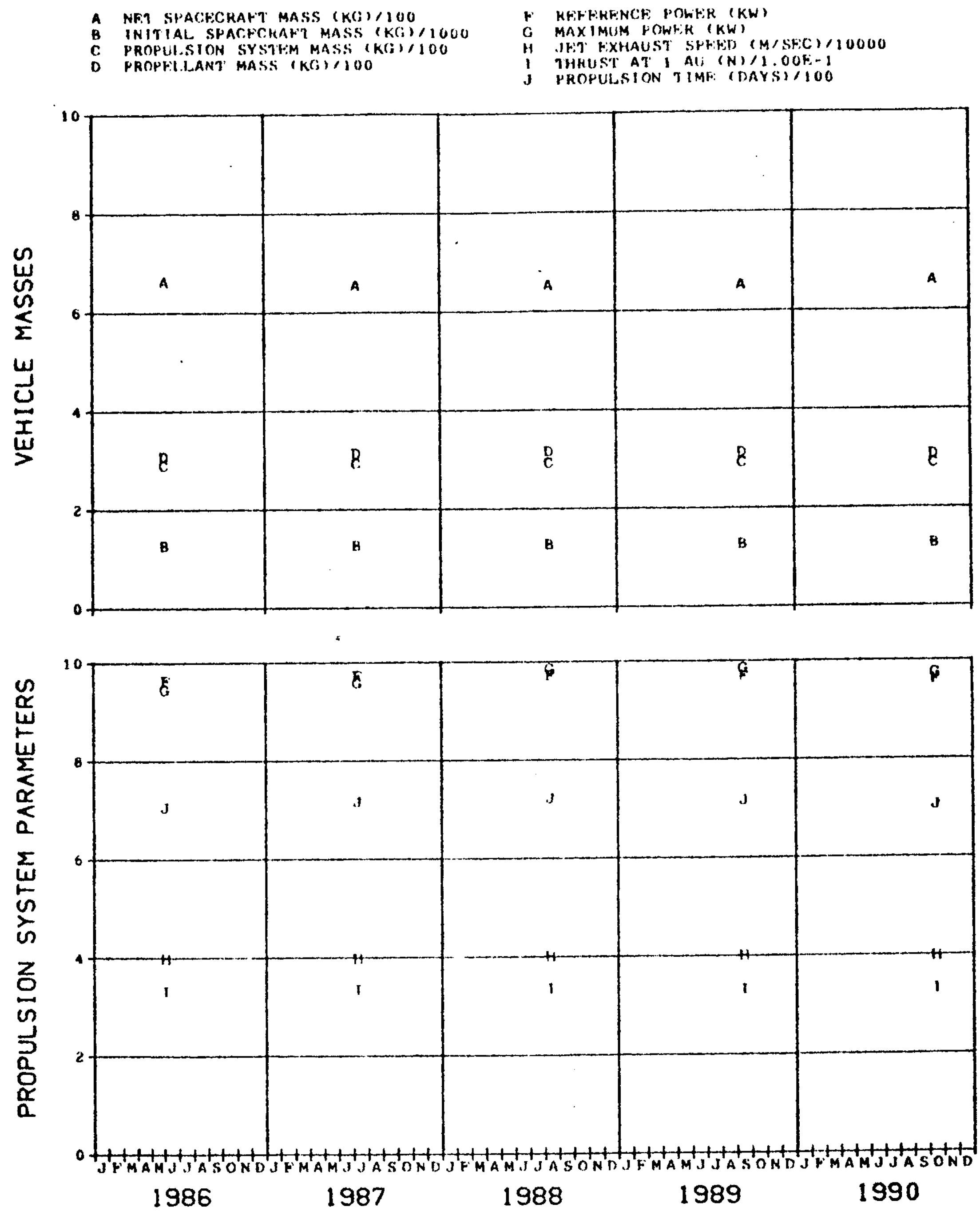

FIG. 12D. JUPITER MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1400 DAYS

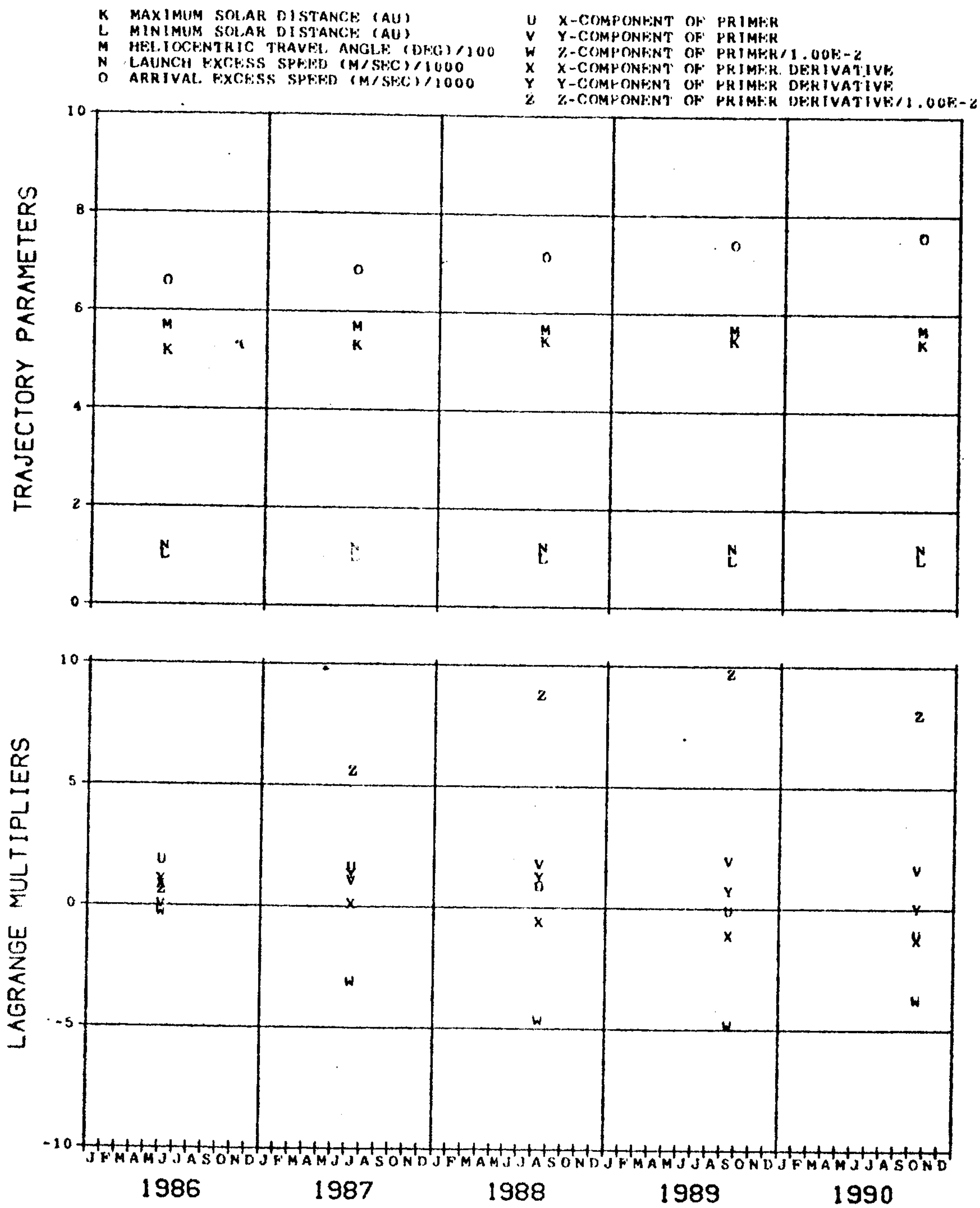

FIG. 12D. (CONCLUDED)

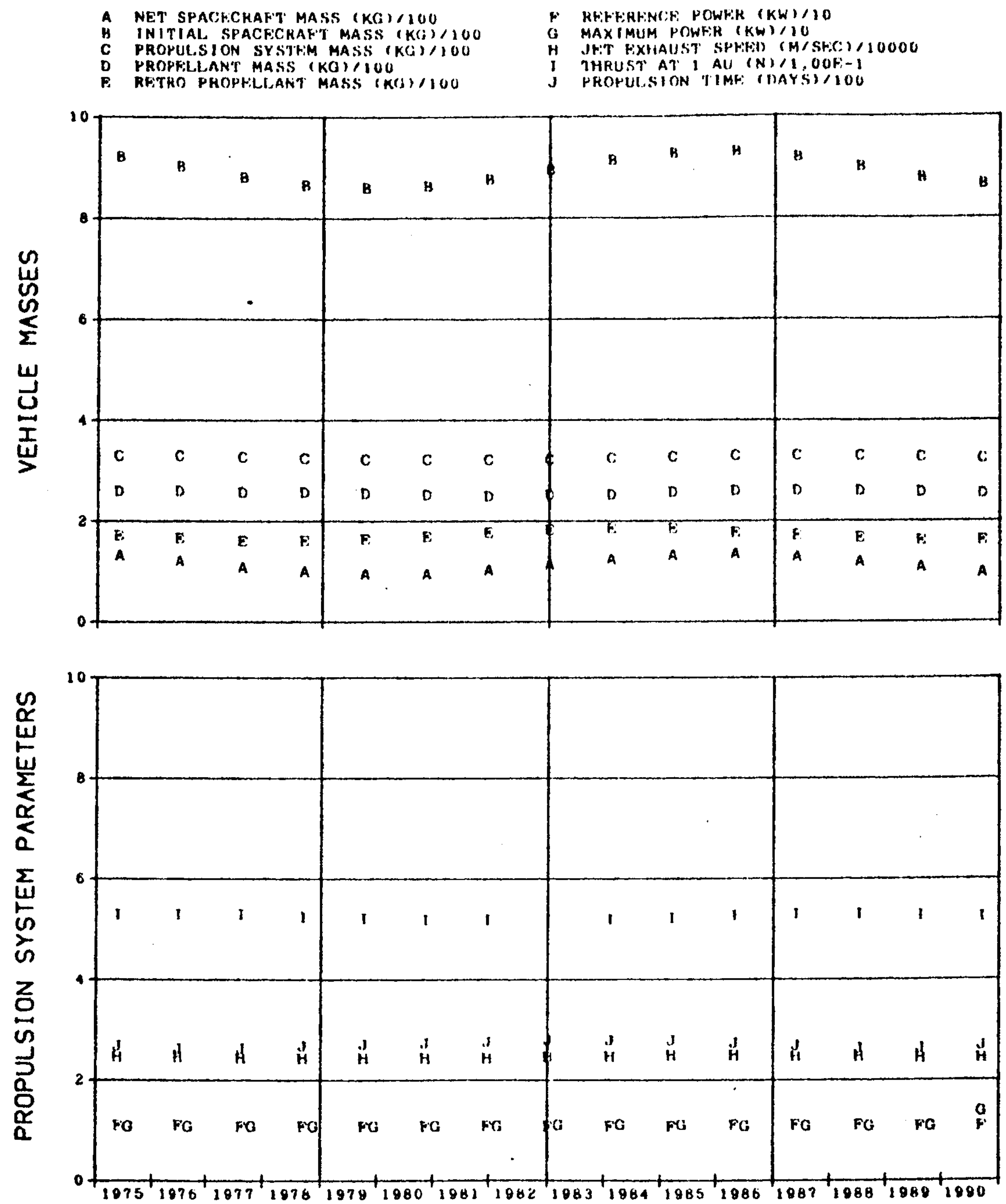

FIG. 13. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 600 DAYS

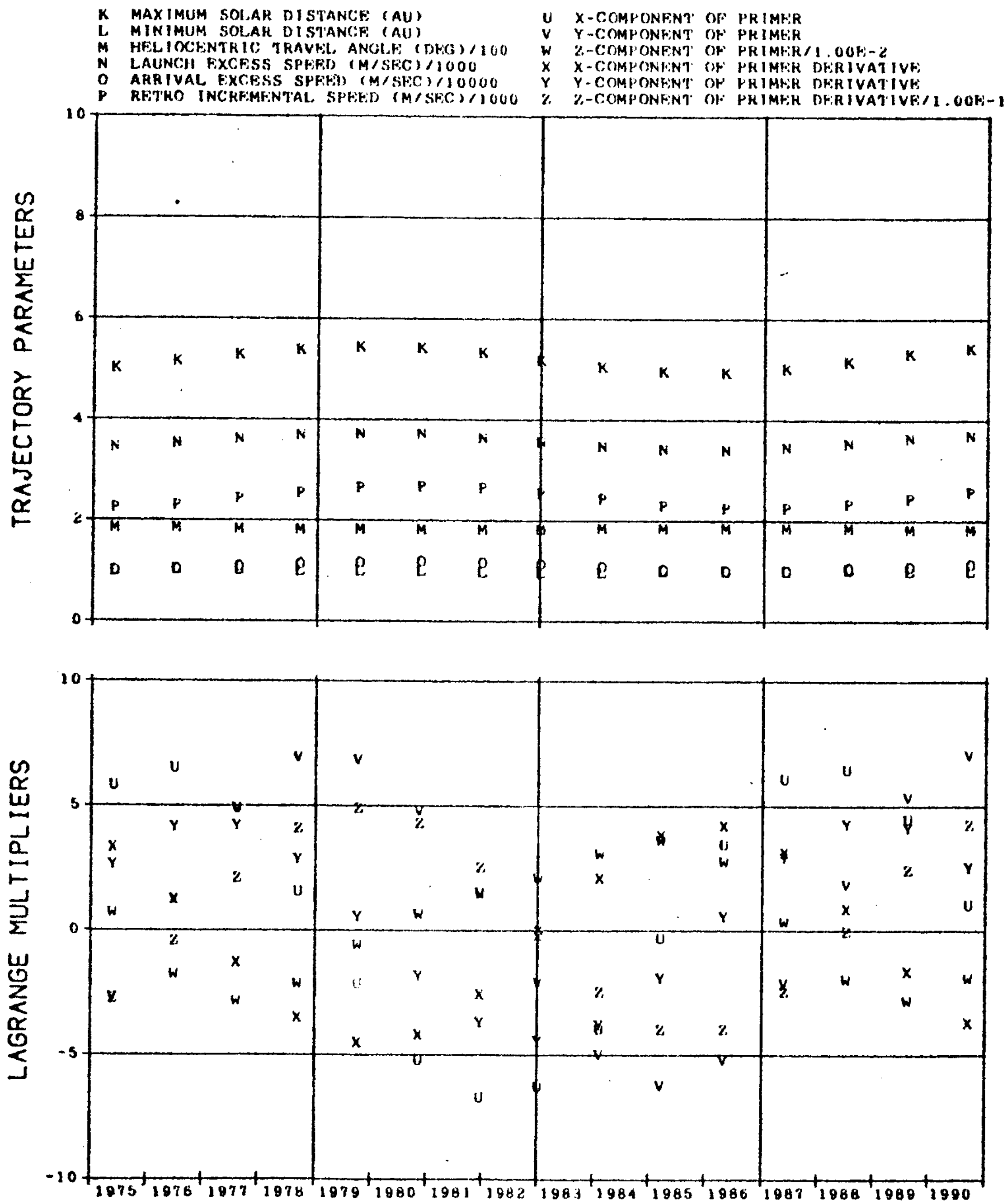

FIG. 13. (CONCLUDED)

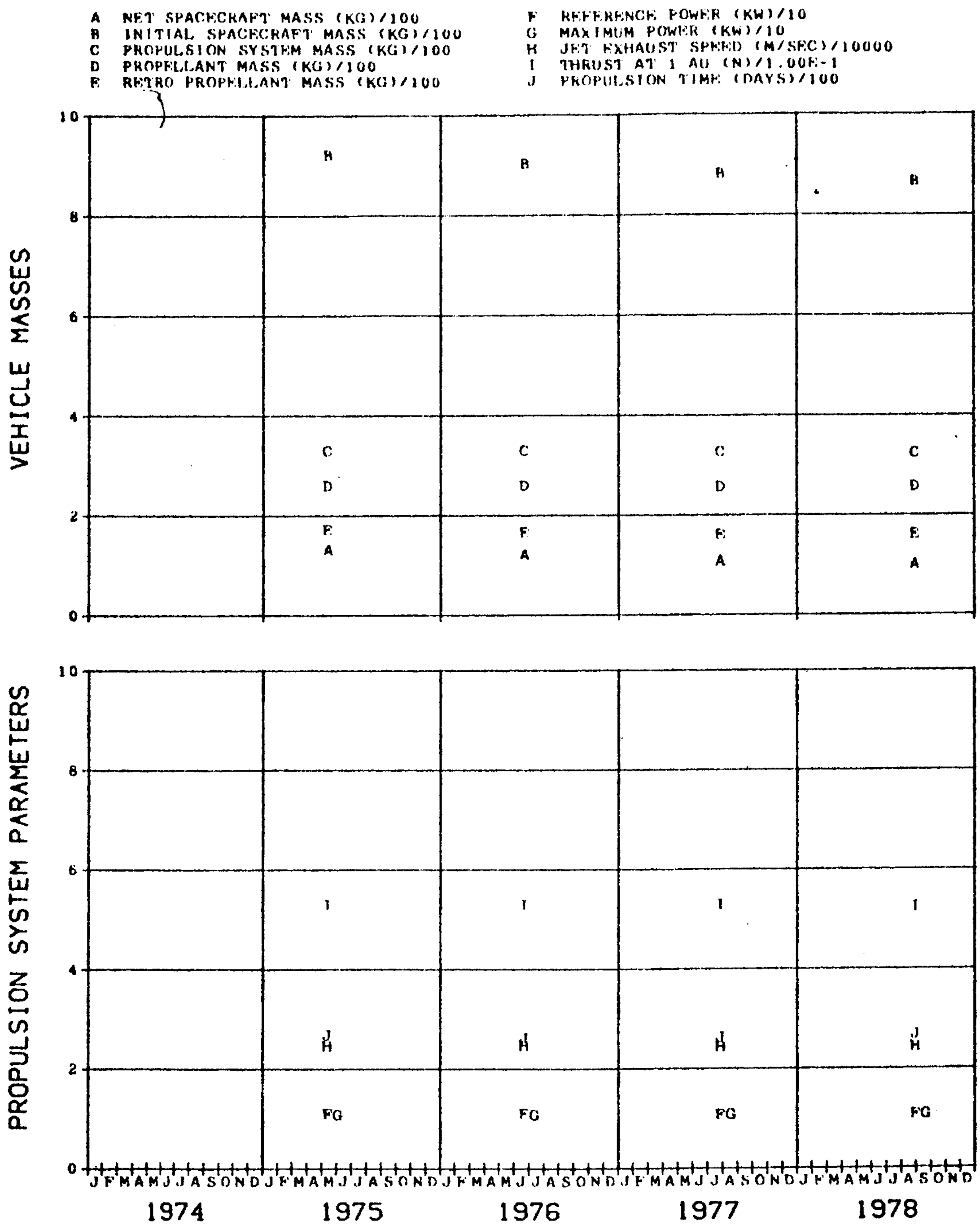

FIG. 13A. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 600 DAYS

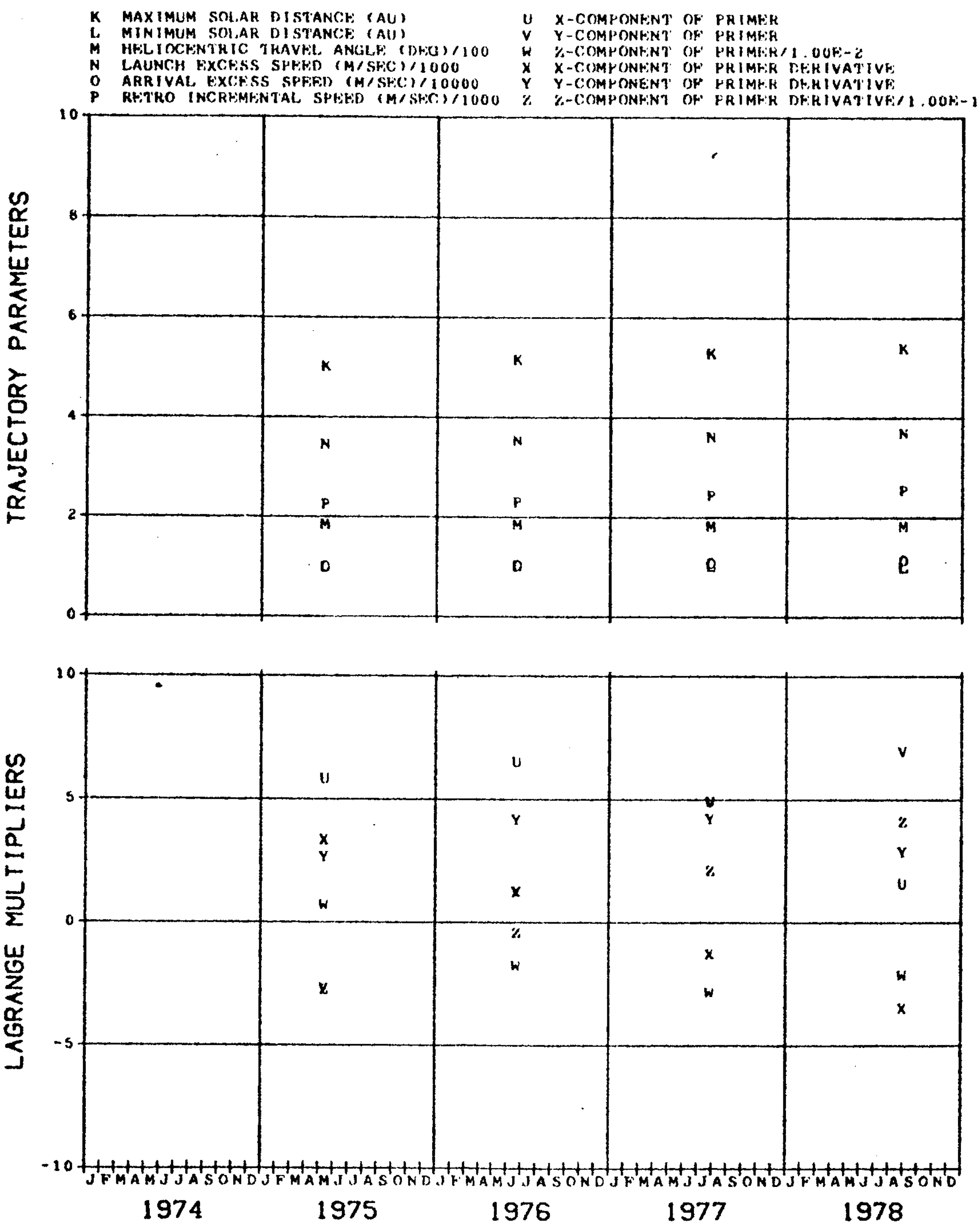

FIG. 13A. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/100
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

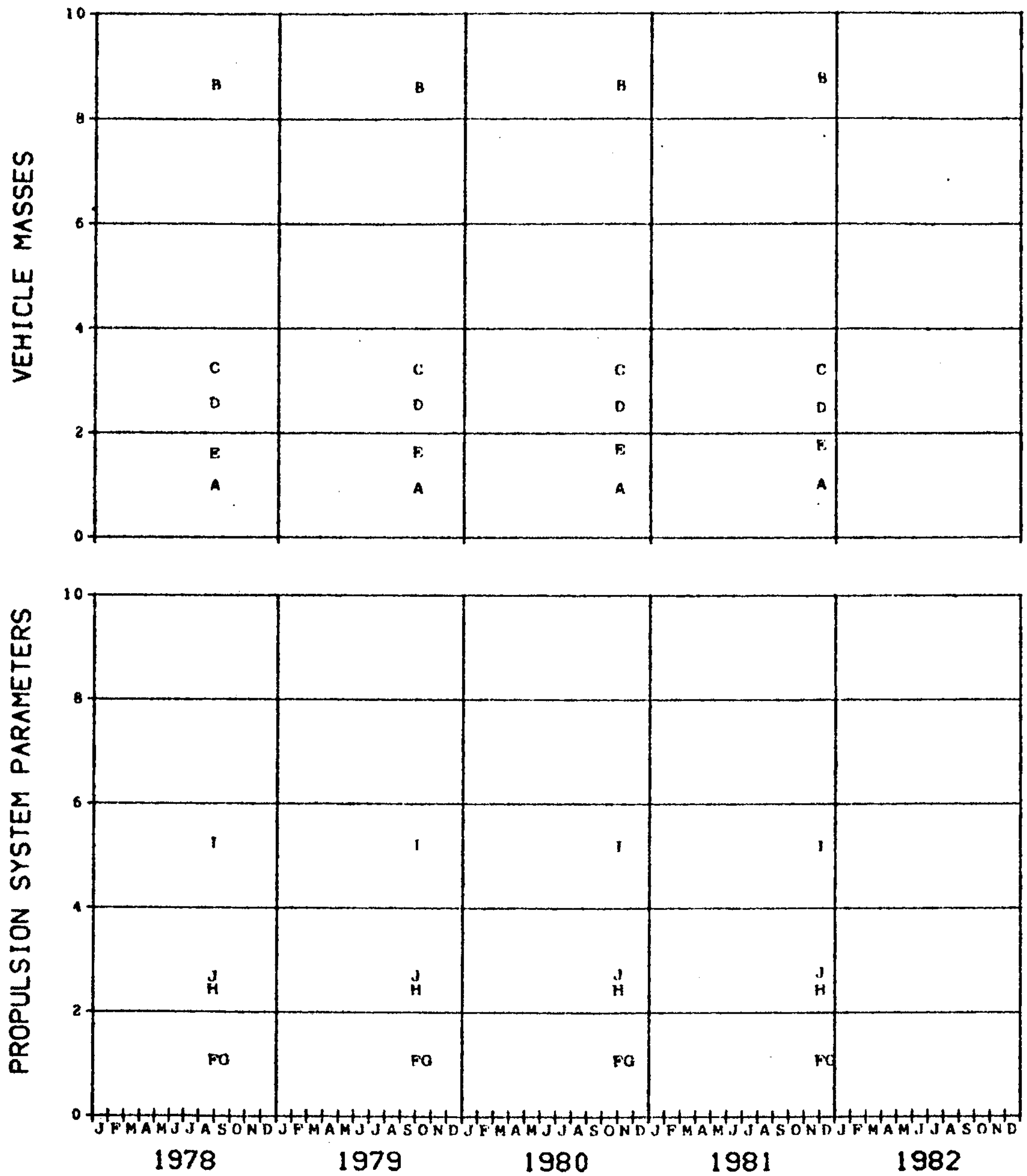

FIG. 13B. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 600 DAYS

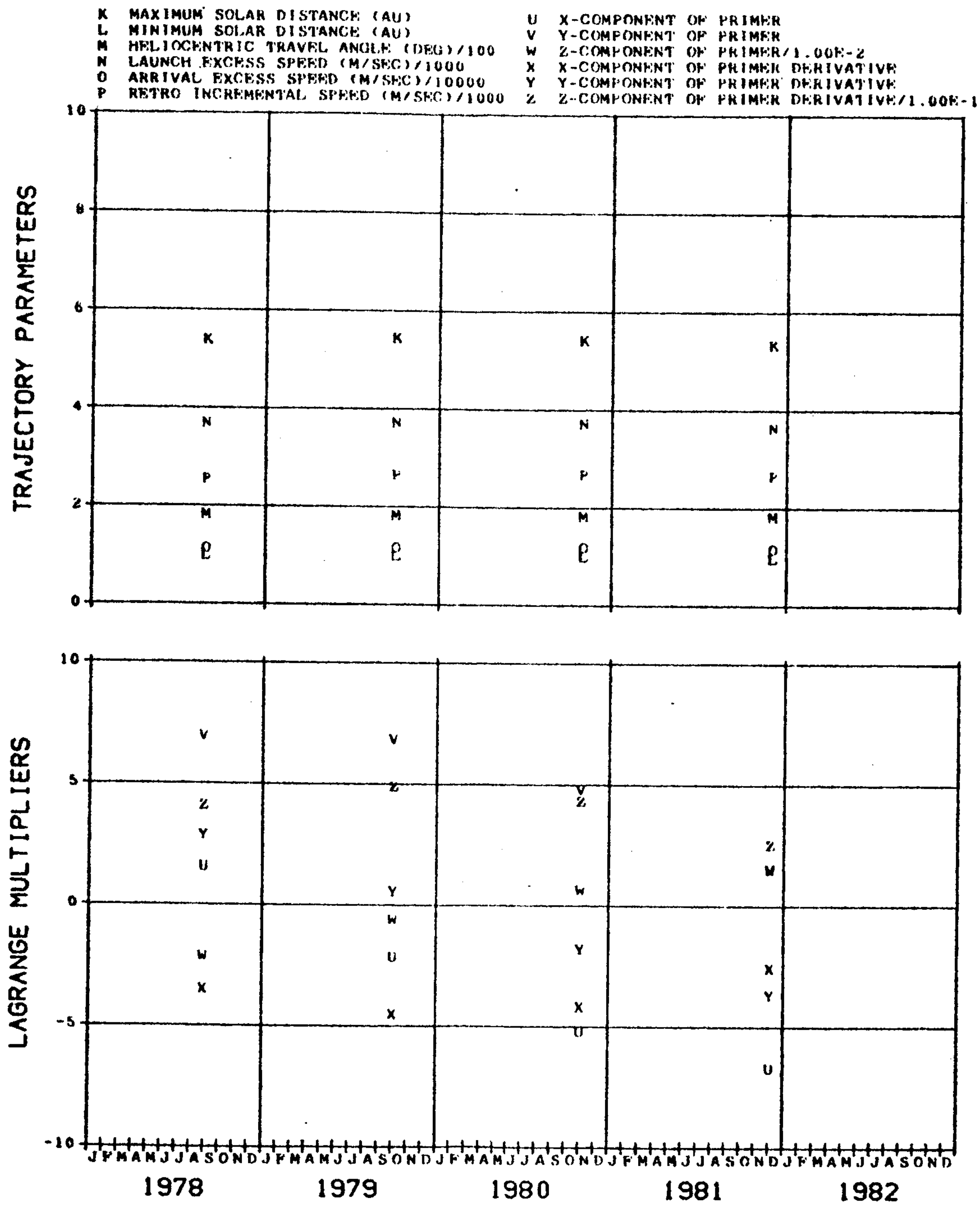

FIG. 13B. (CONCLUDED)

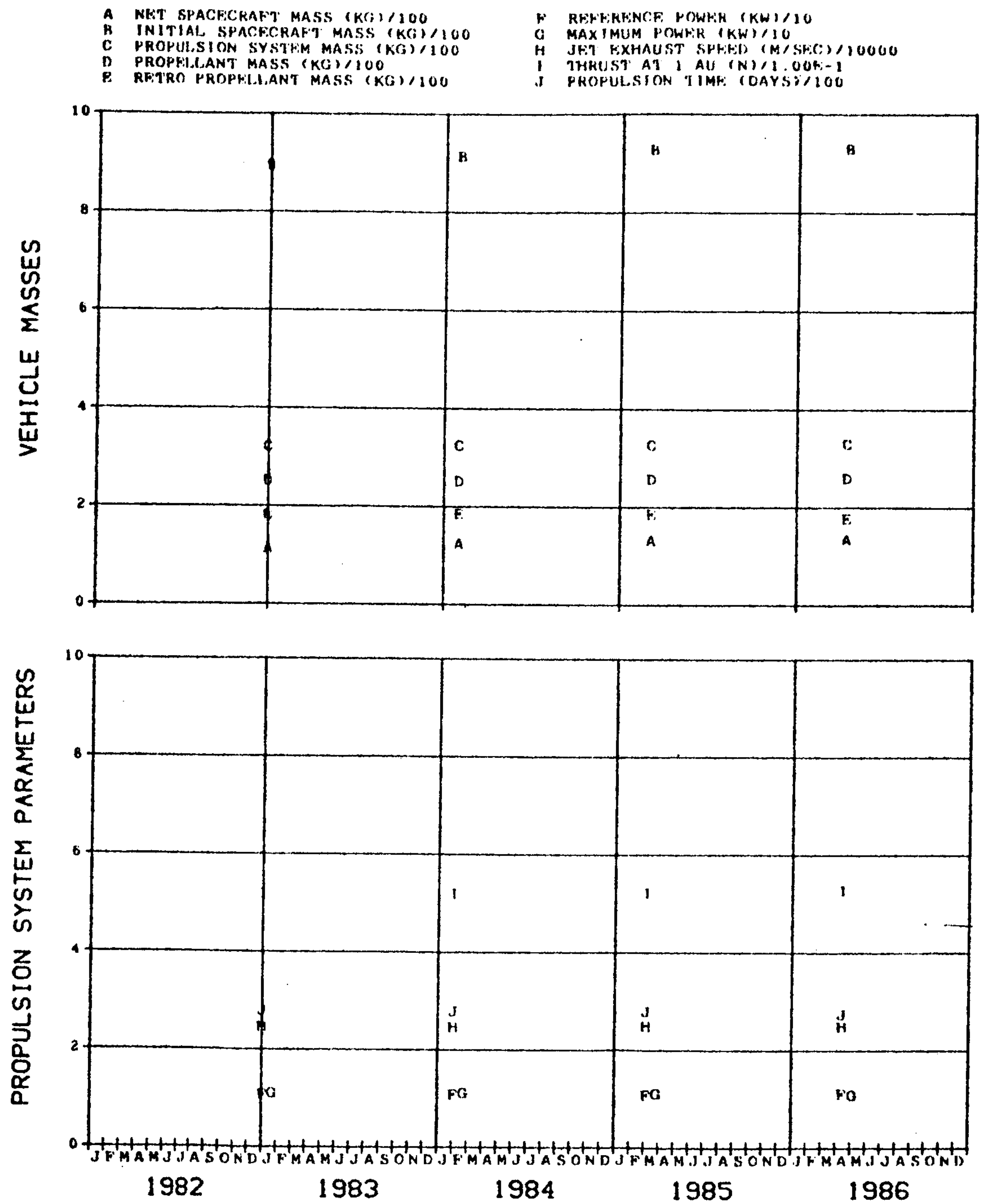

FIG. 13C. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 600 DAYS

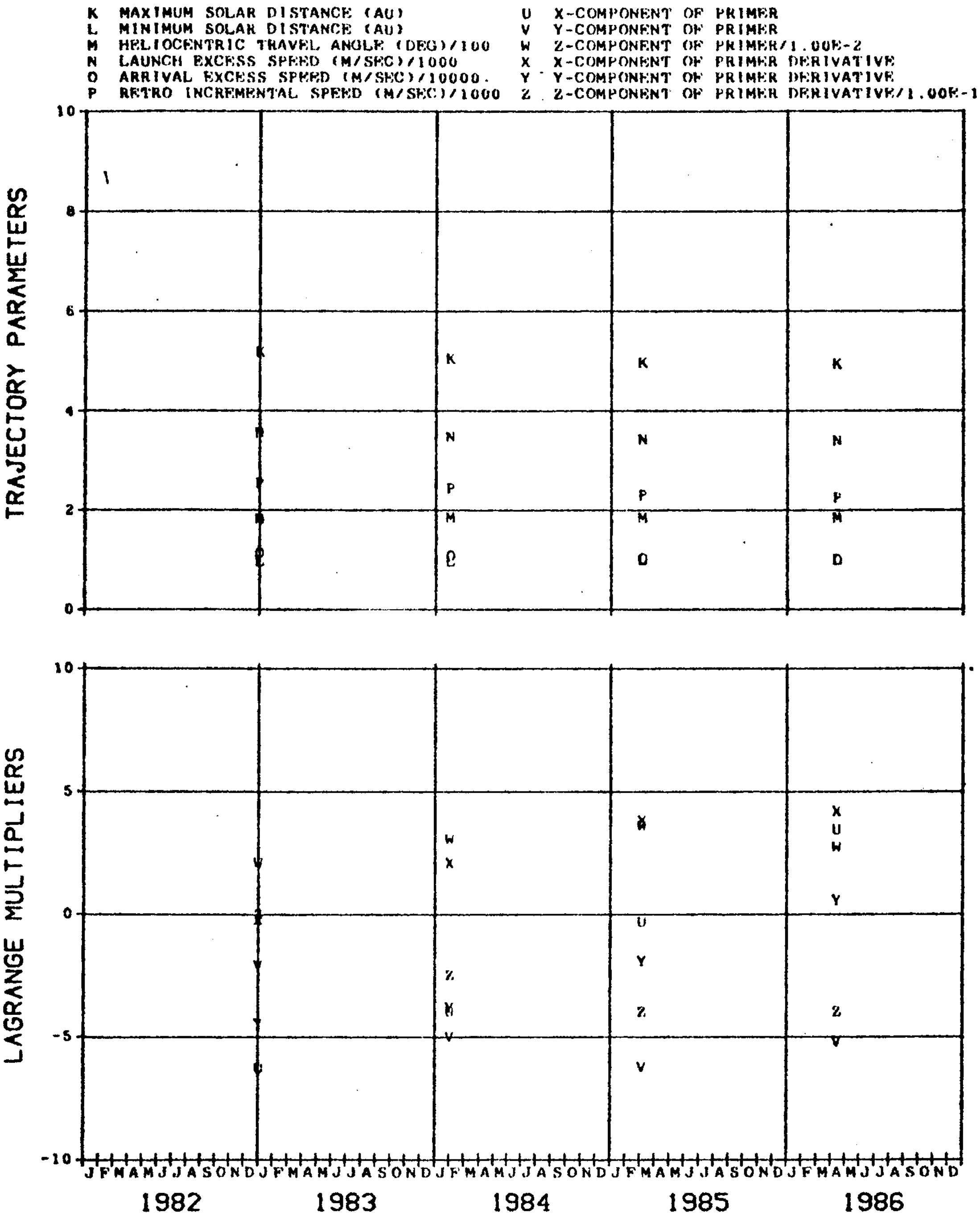

FIG. 13C. (CONCLUDED)

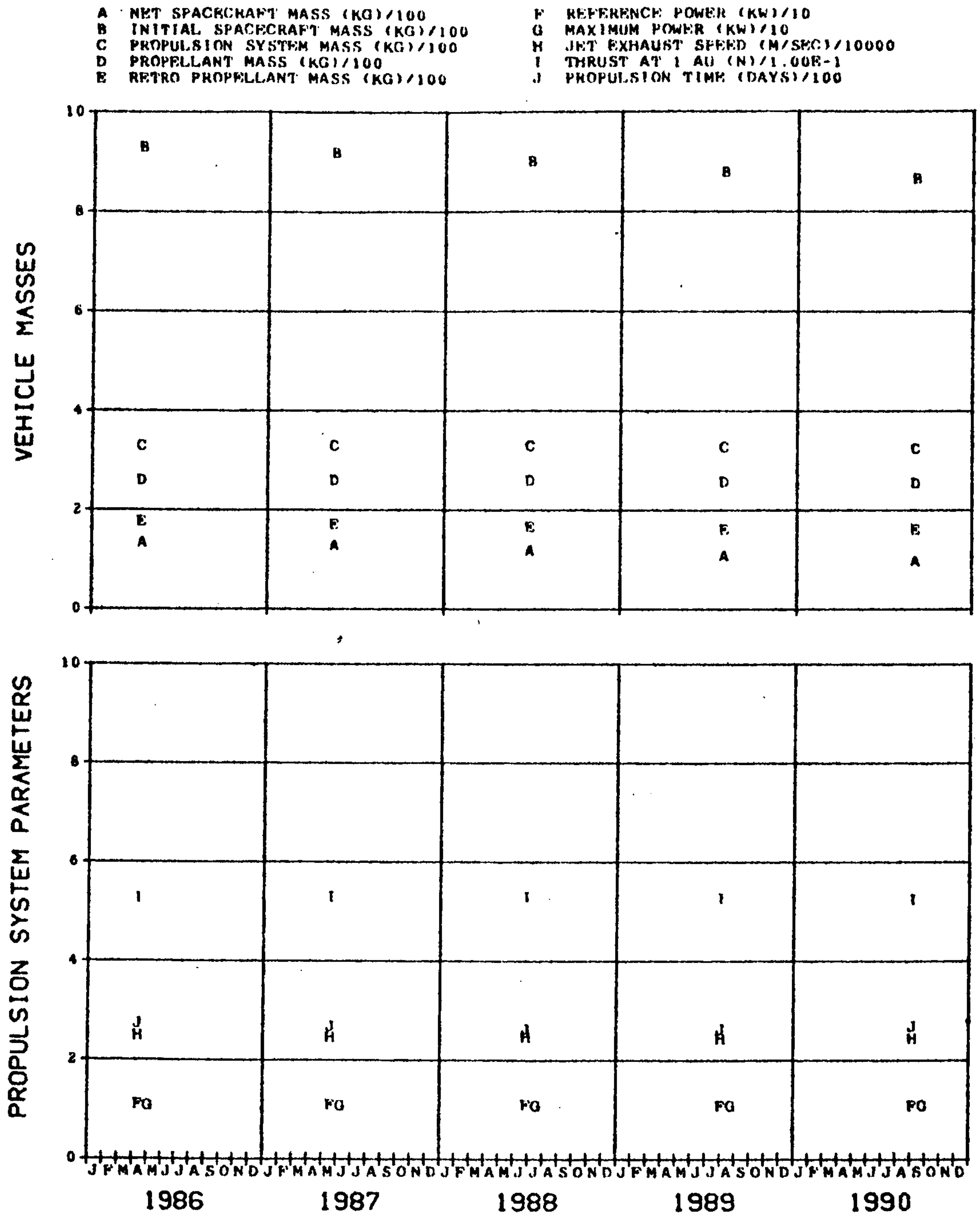

FIG. 13D. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 600 DAYS

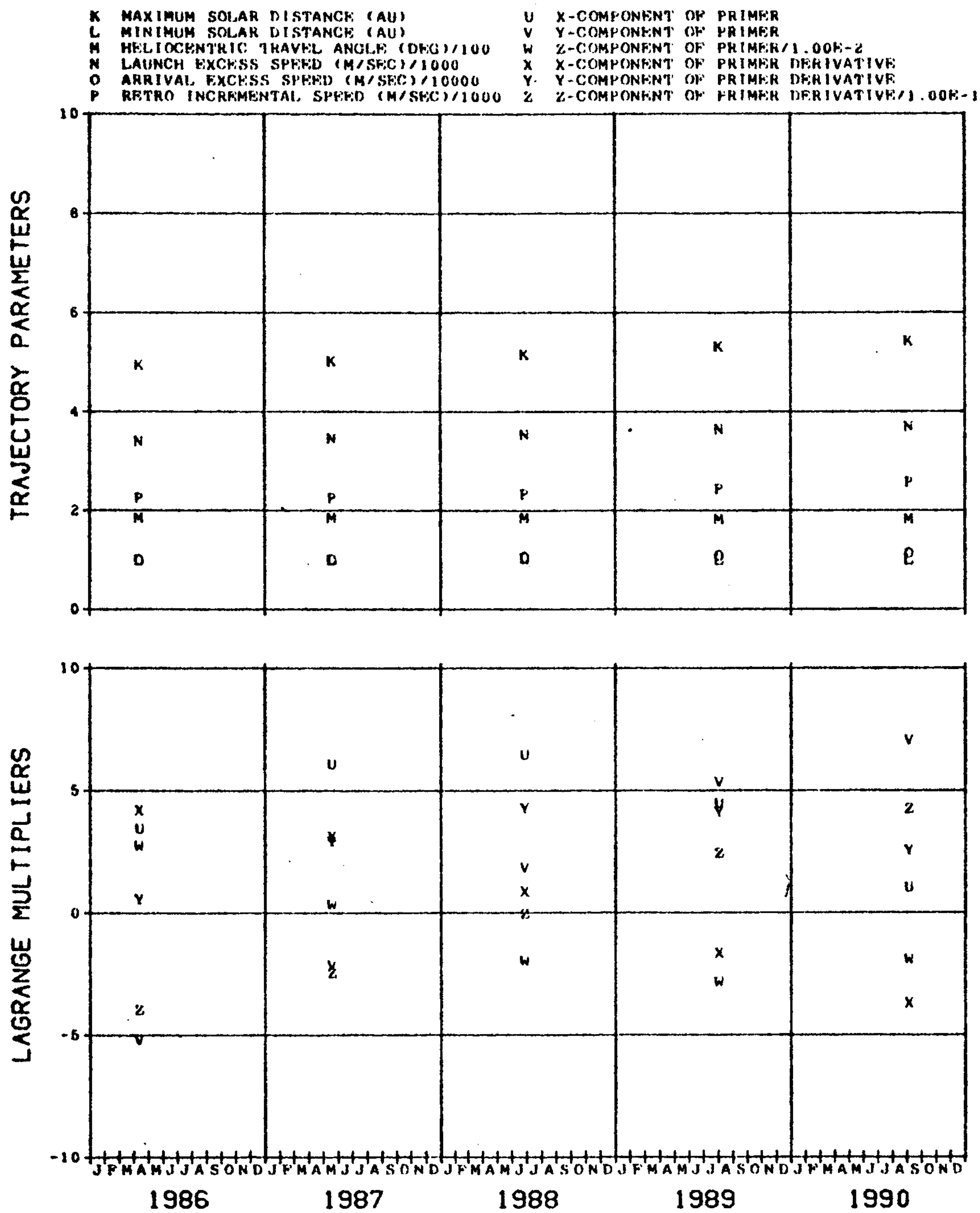

FIG. 13D. (CONCLUDED)

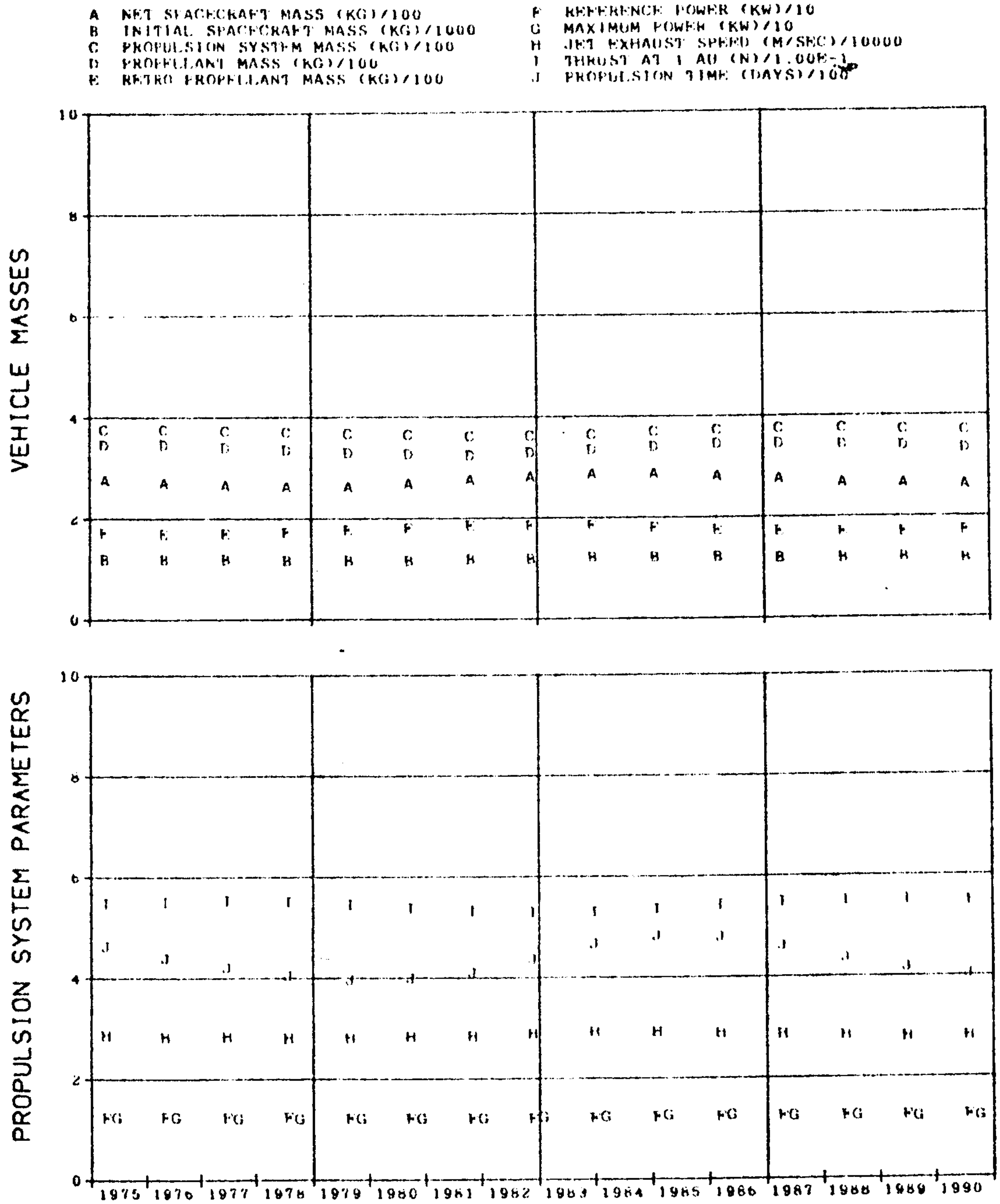

FIG. 14. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1000 DAYS

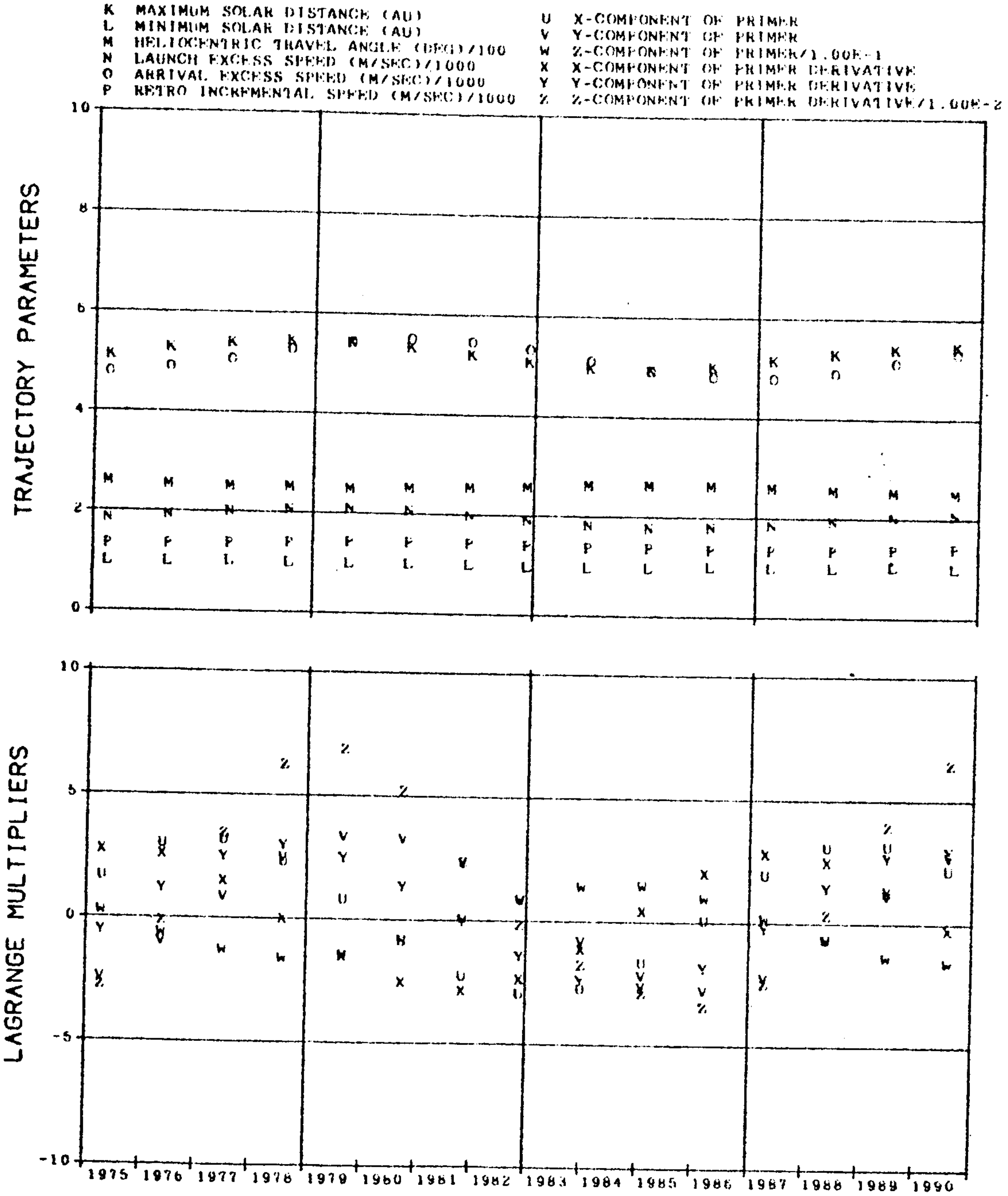

FIG. 14. (CONCLUDED)

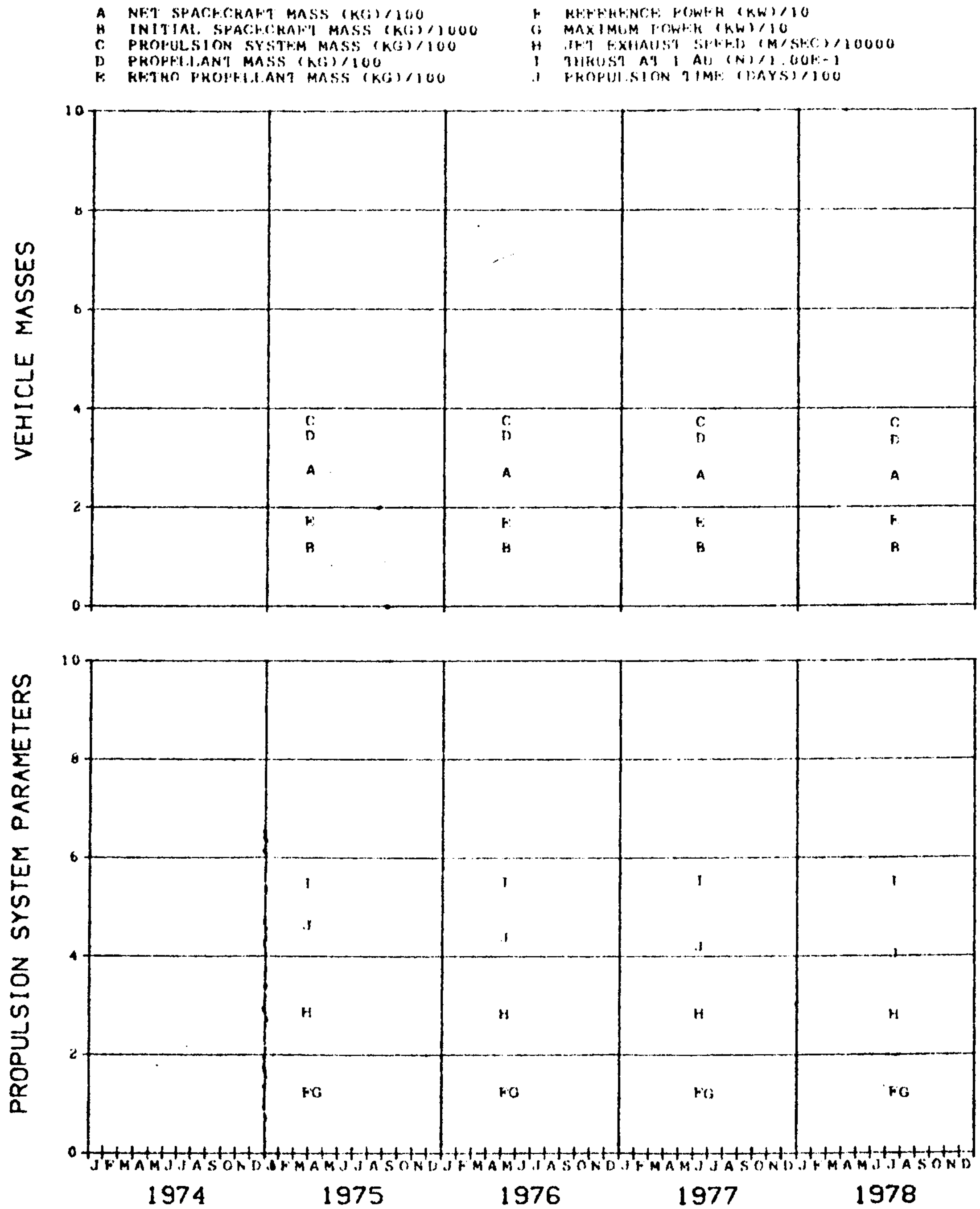

FIG. 14A. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1000 DAYS

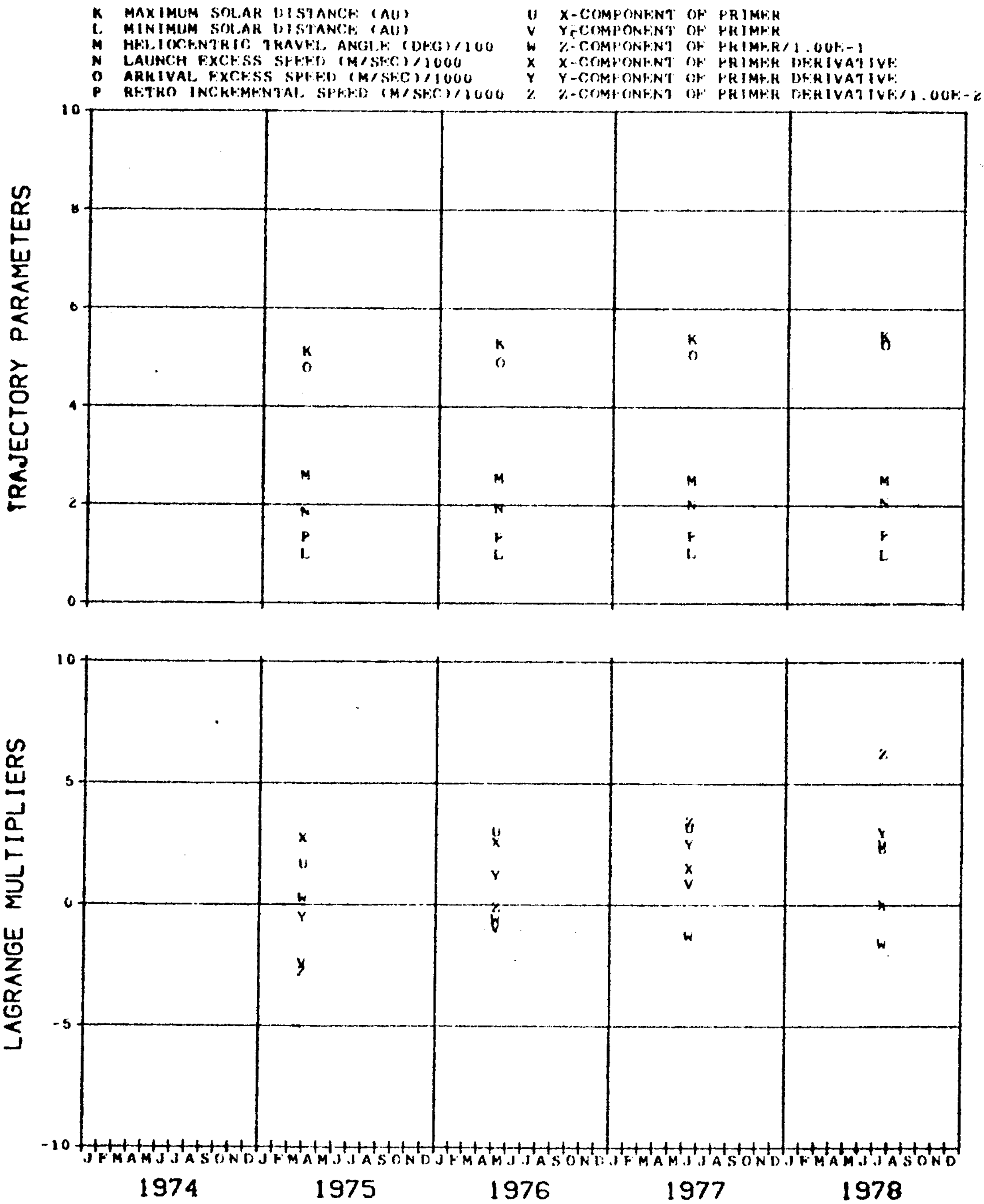

FIG. 14A. (CONCLUDED)

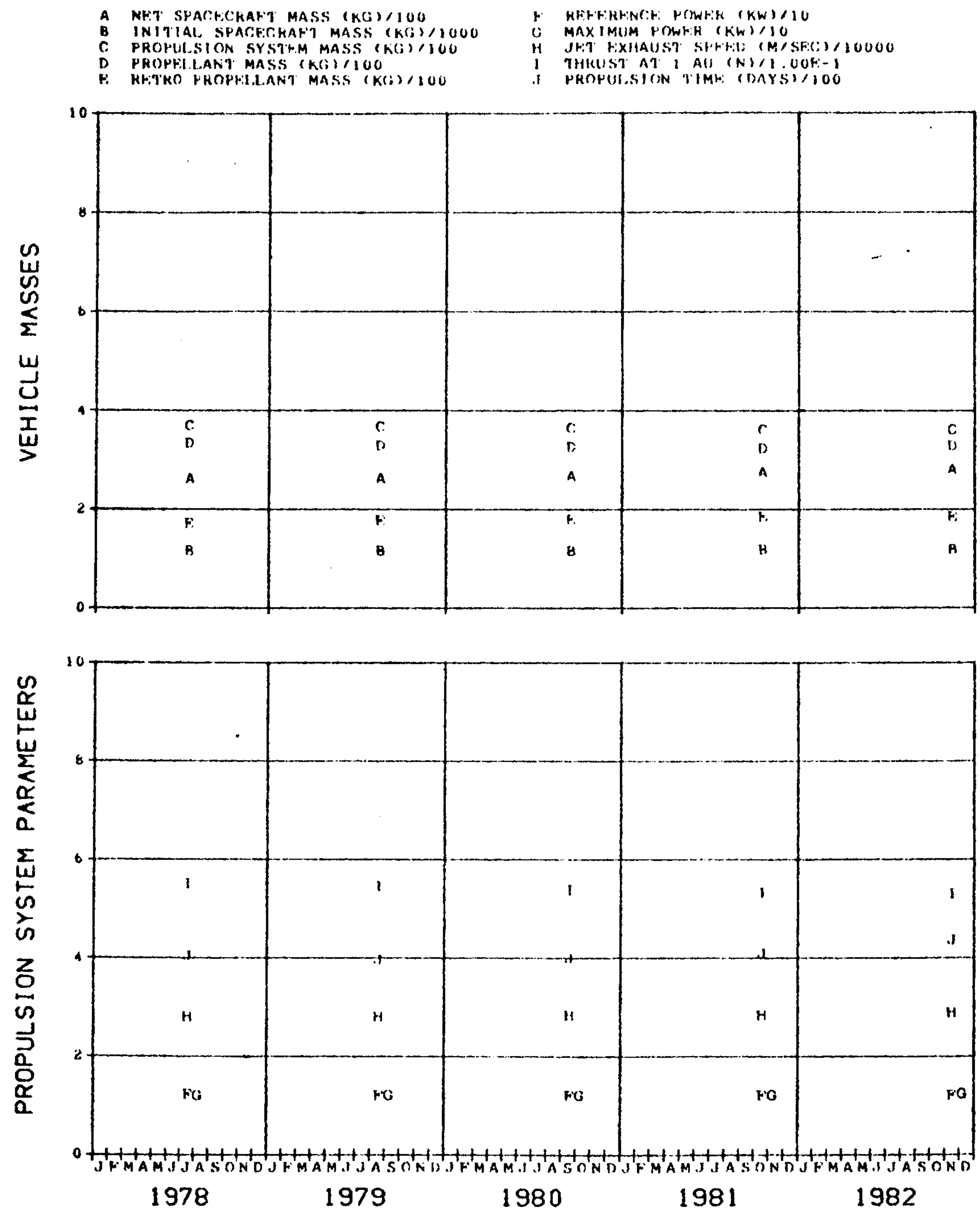

FIG. 14B. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1000 DAYS

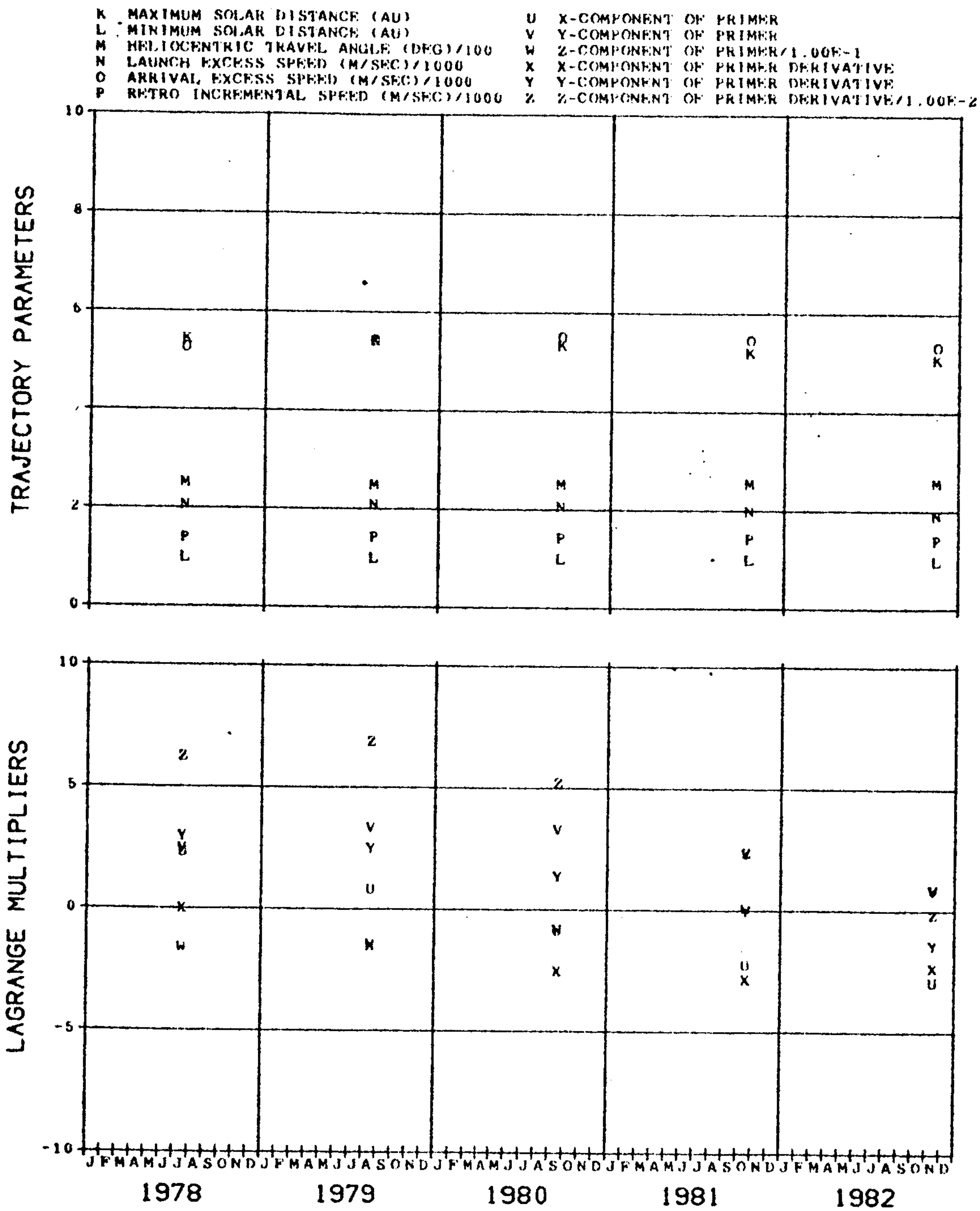

FIG. 14B. (CONCLUDED)

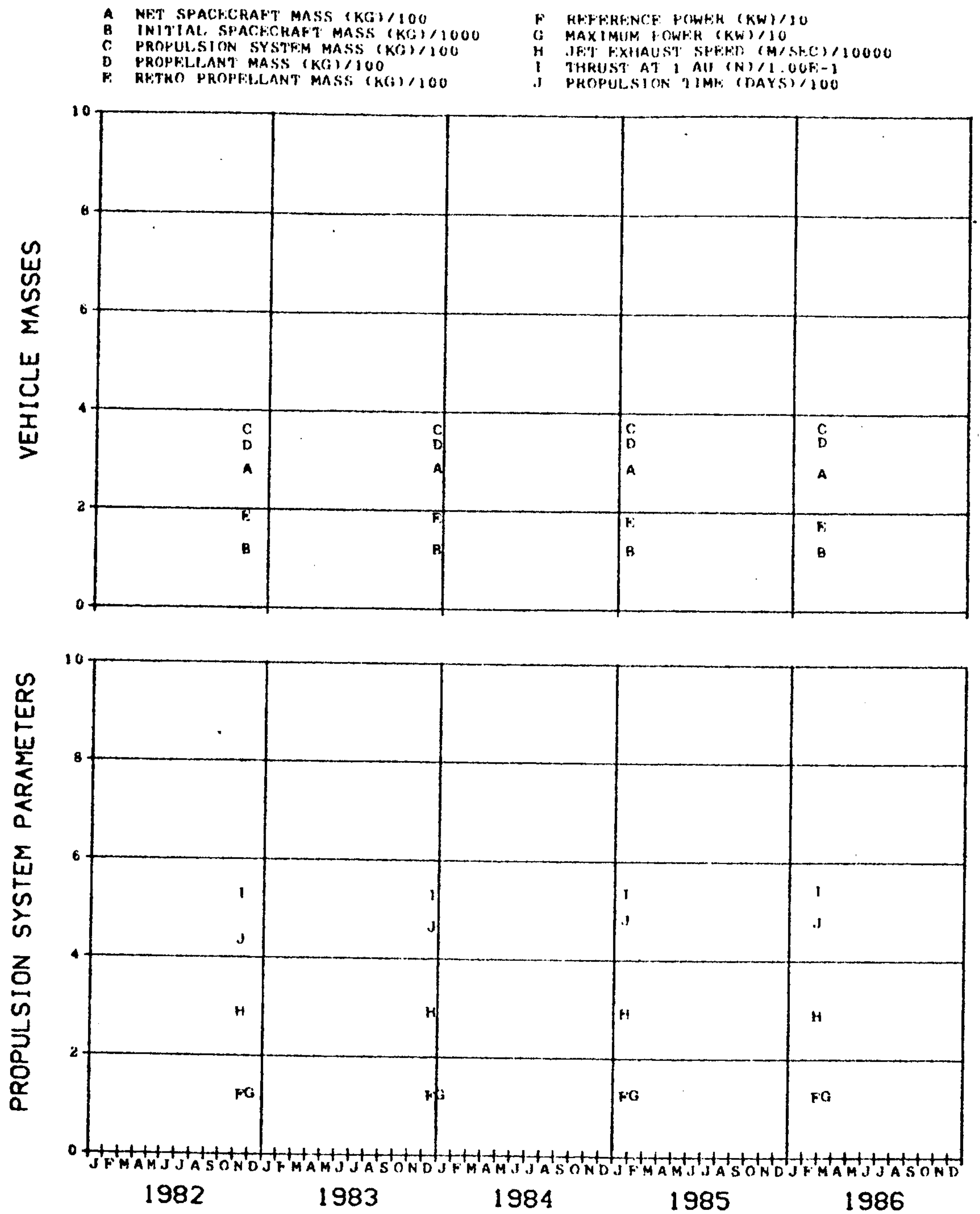

FIG. 14C. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1000 DAYS

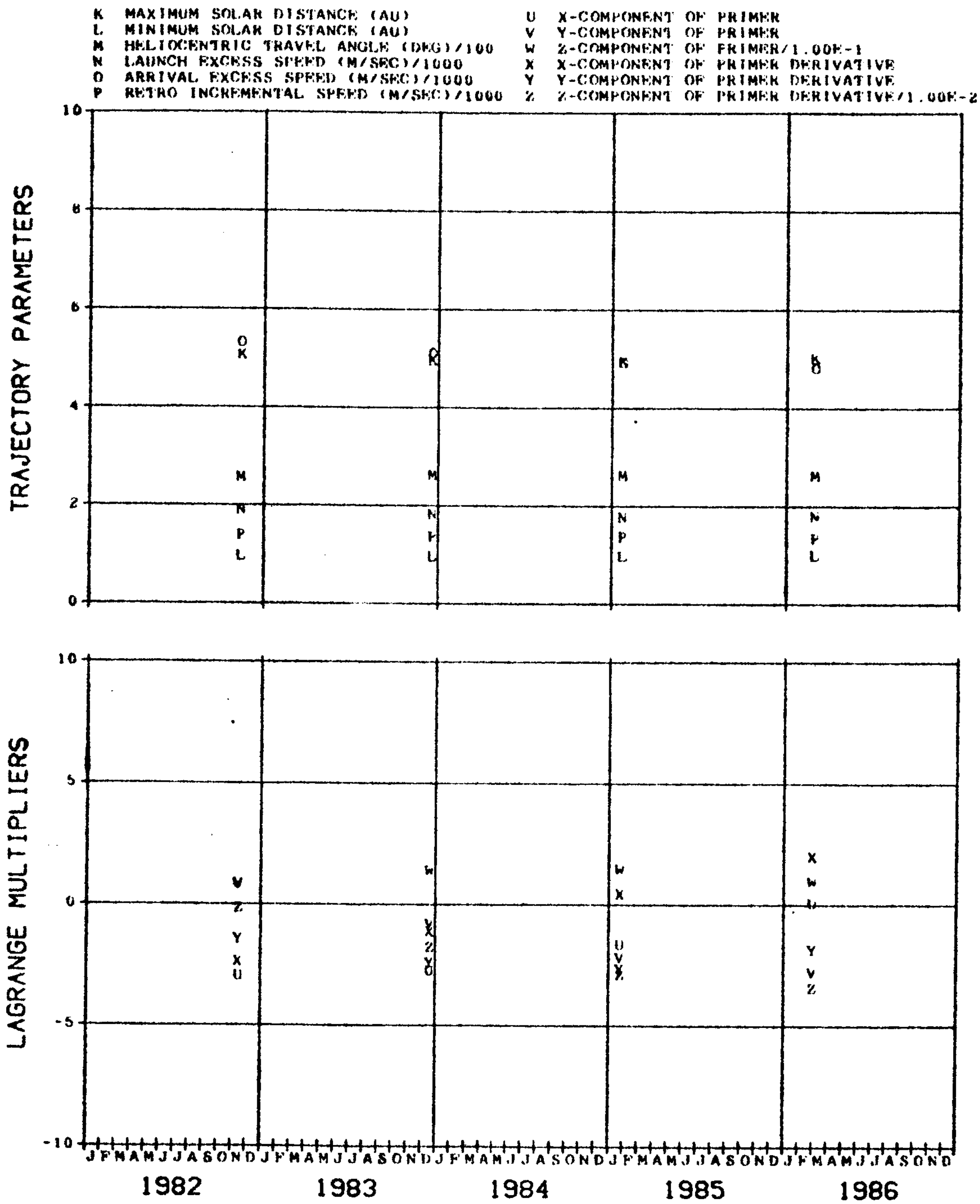

FIG. 14C. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

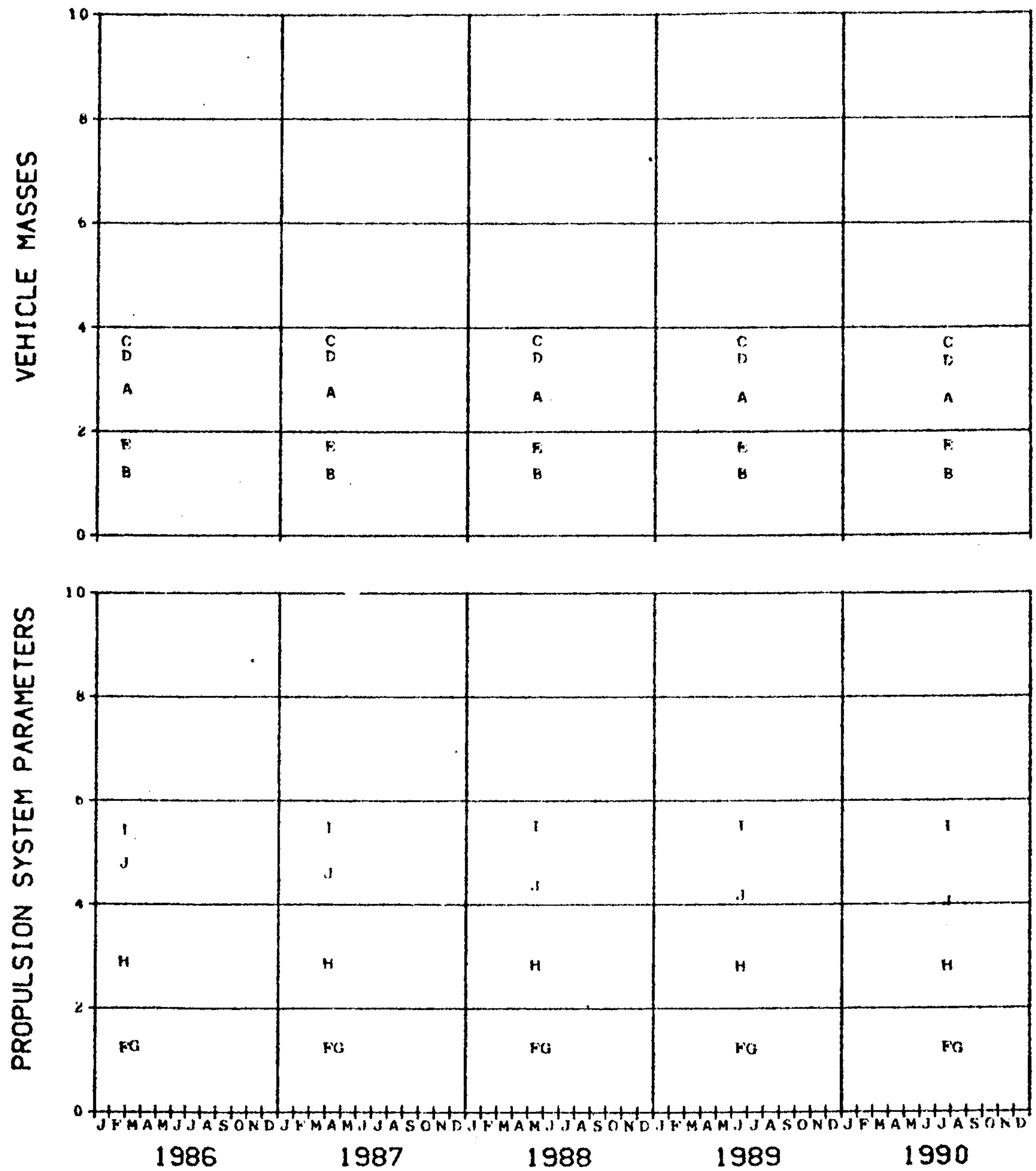

FIG. 14D. JUPITER MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1000 DAYS

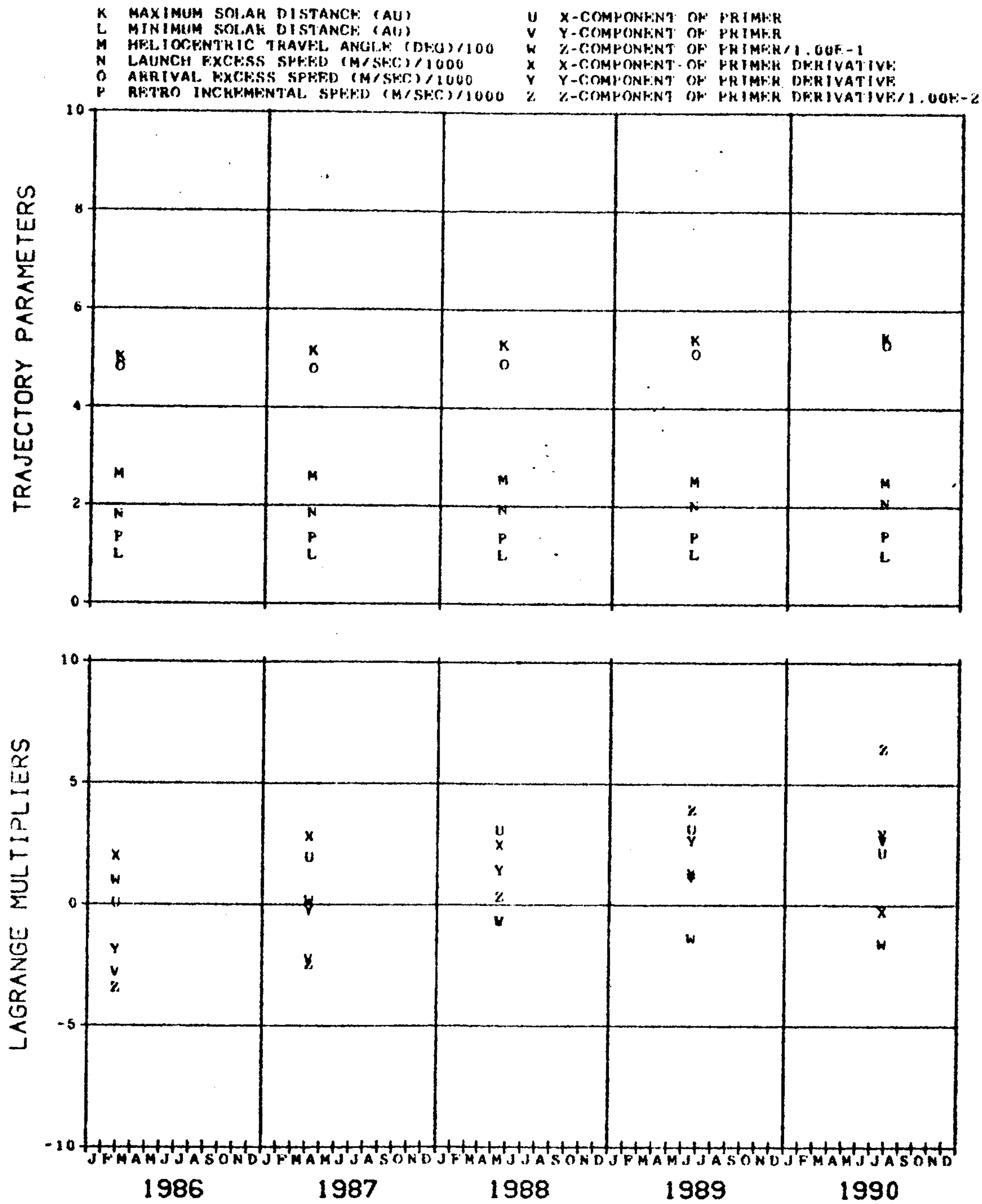

FIG. 14D. (CONCLUDED)

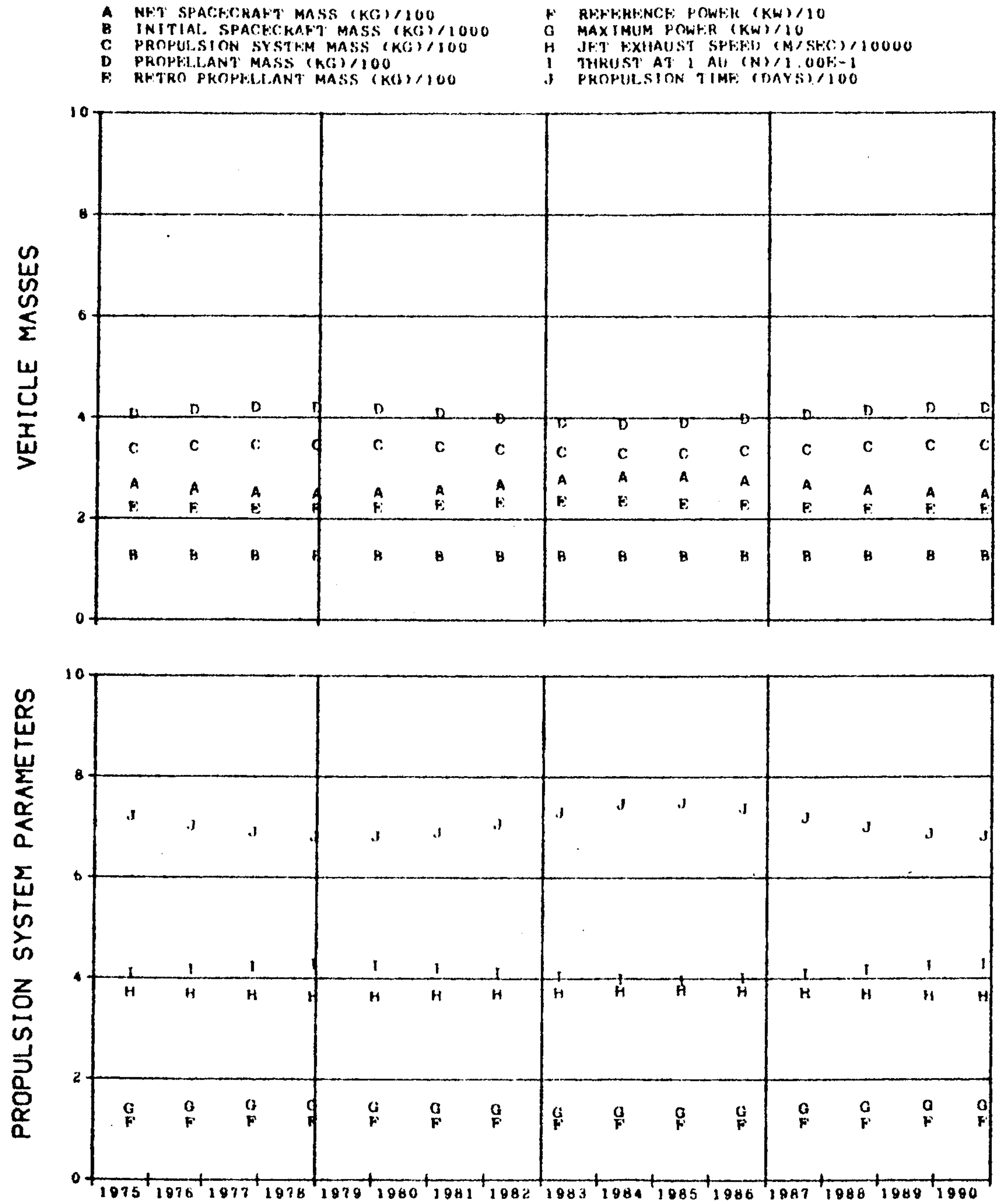

FIG. 15. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1100 DAYS

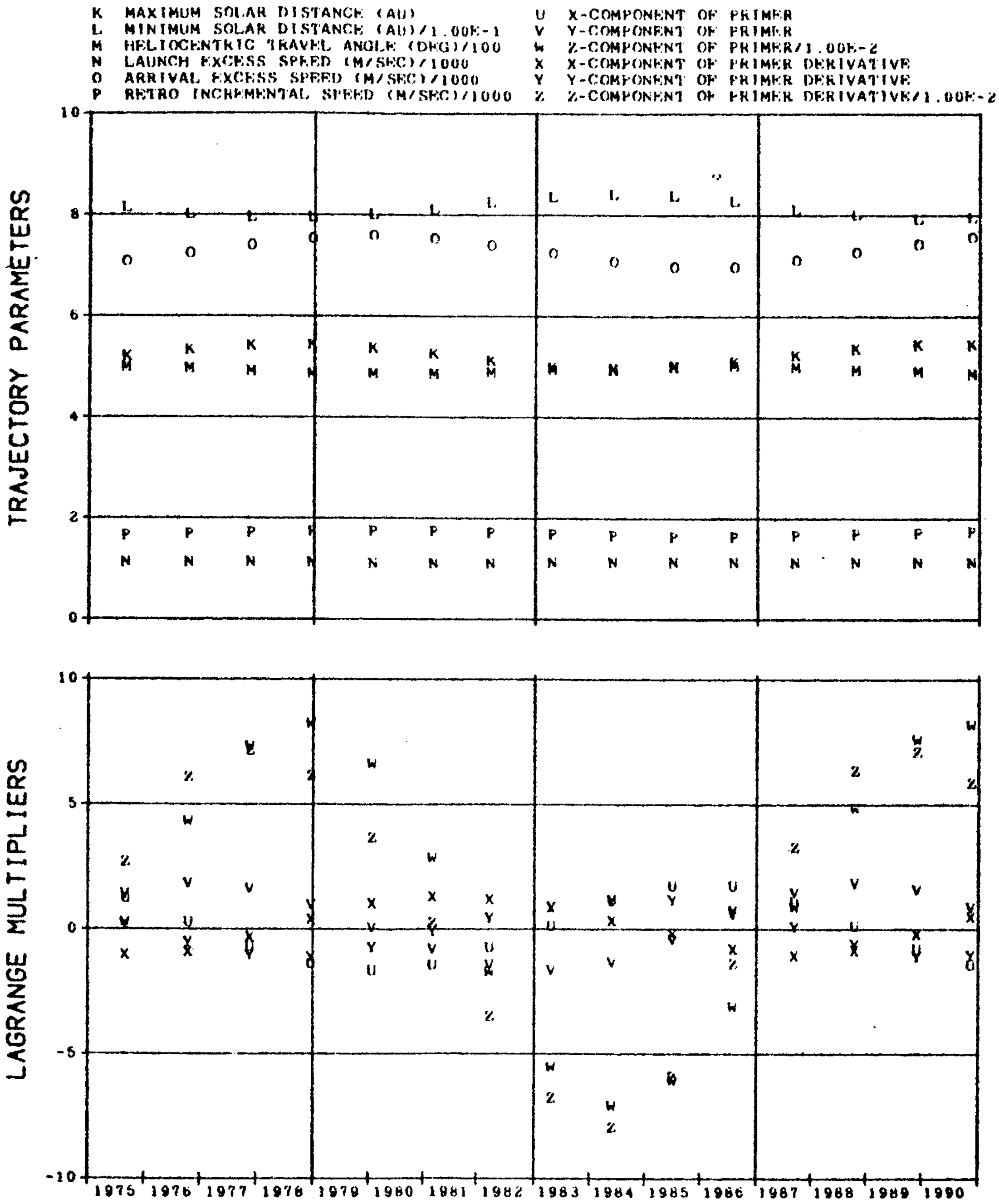

FIG. 15. (CONCLUDED)

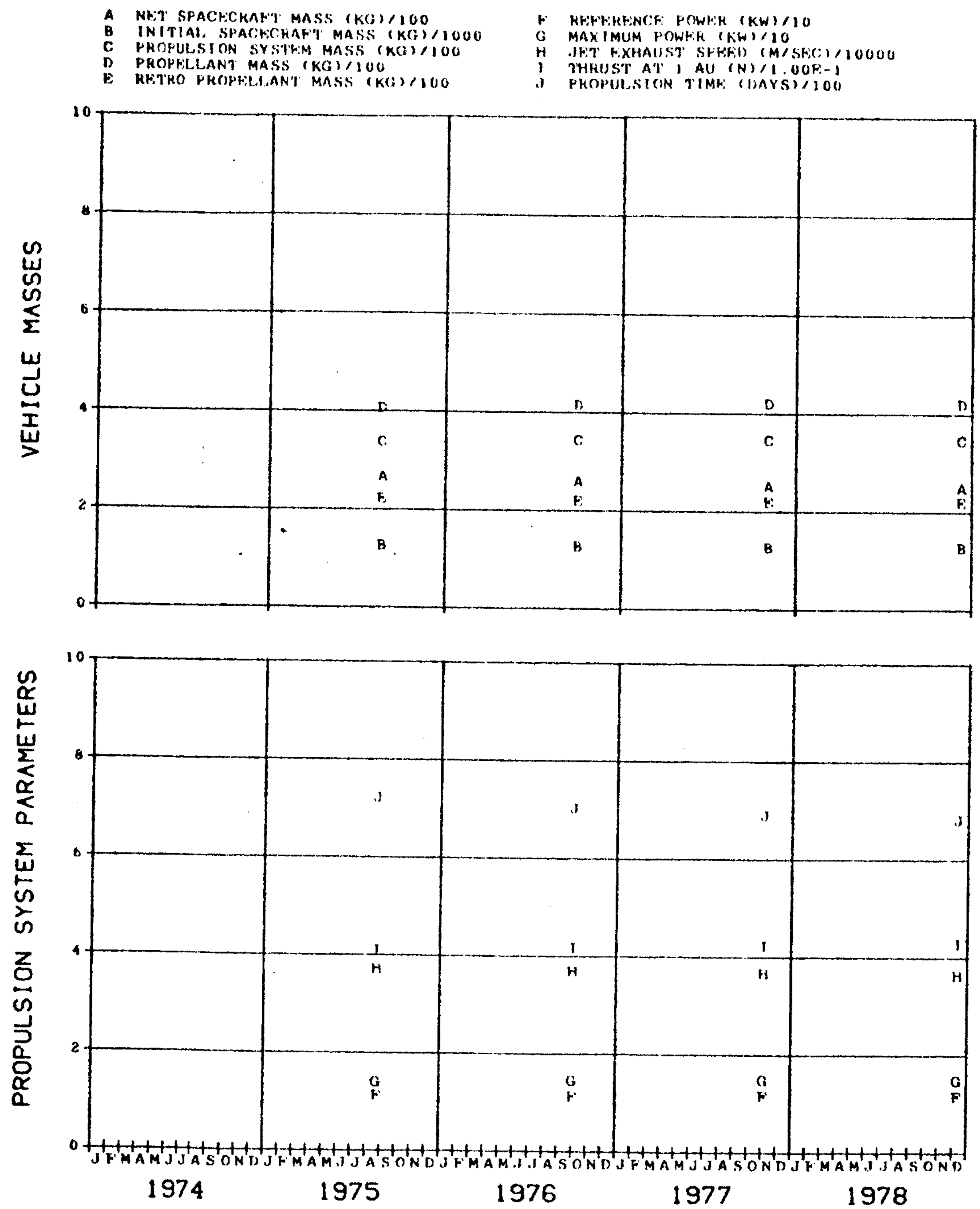

FIG. 15A. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1100 DAYS

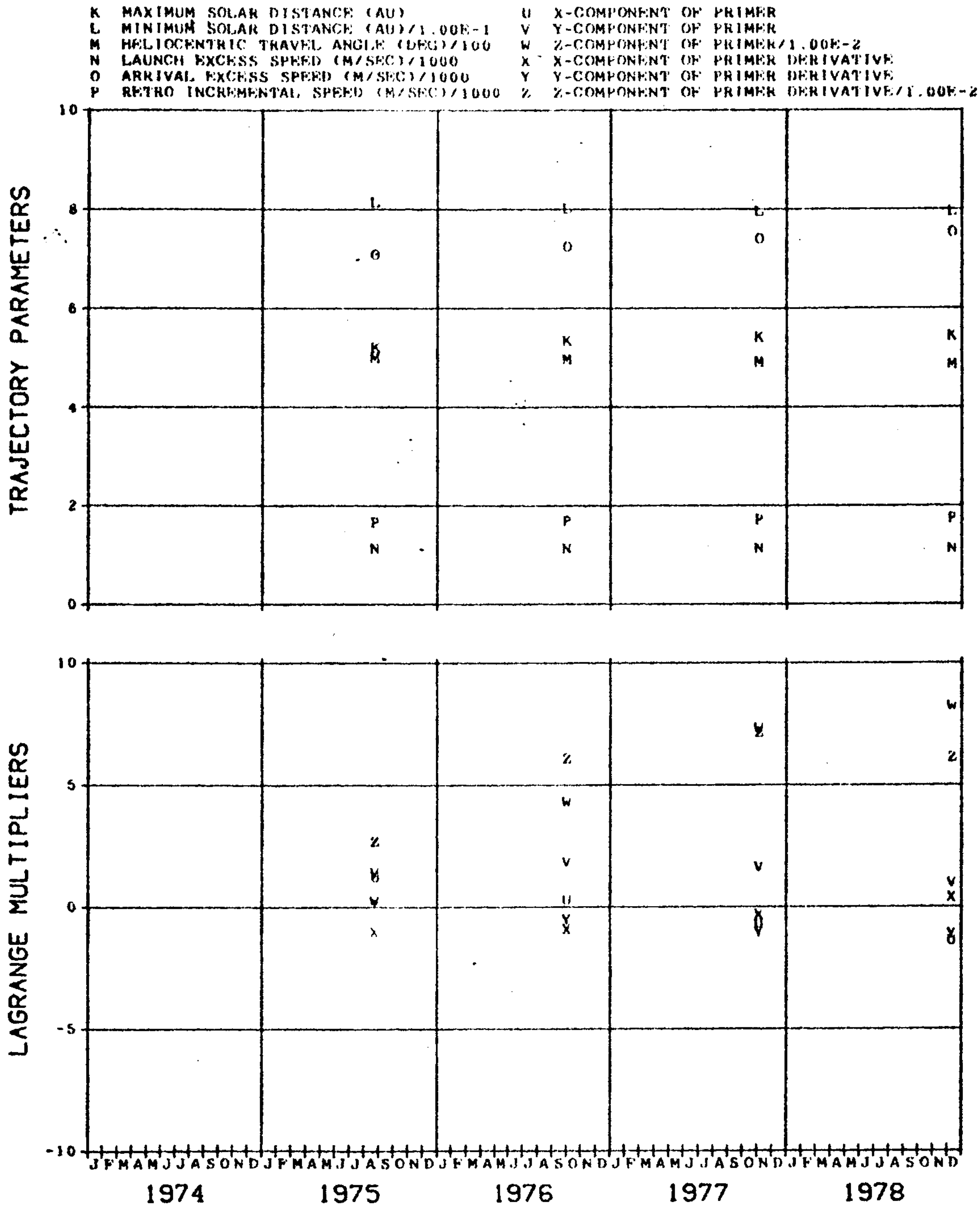

FIG. 15A. (CONCLUDED)

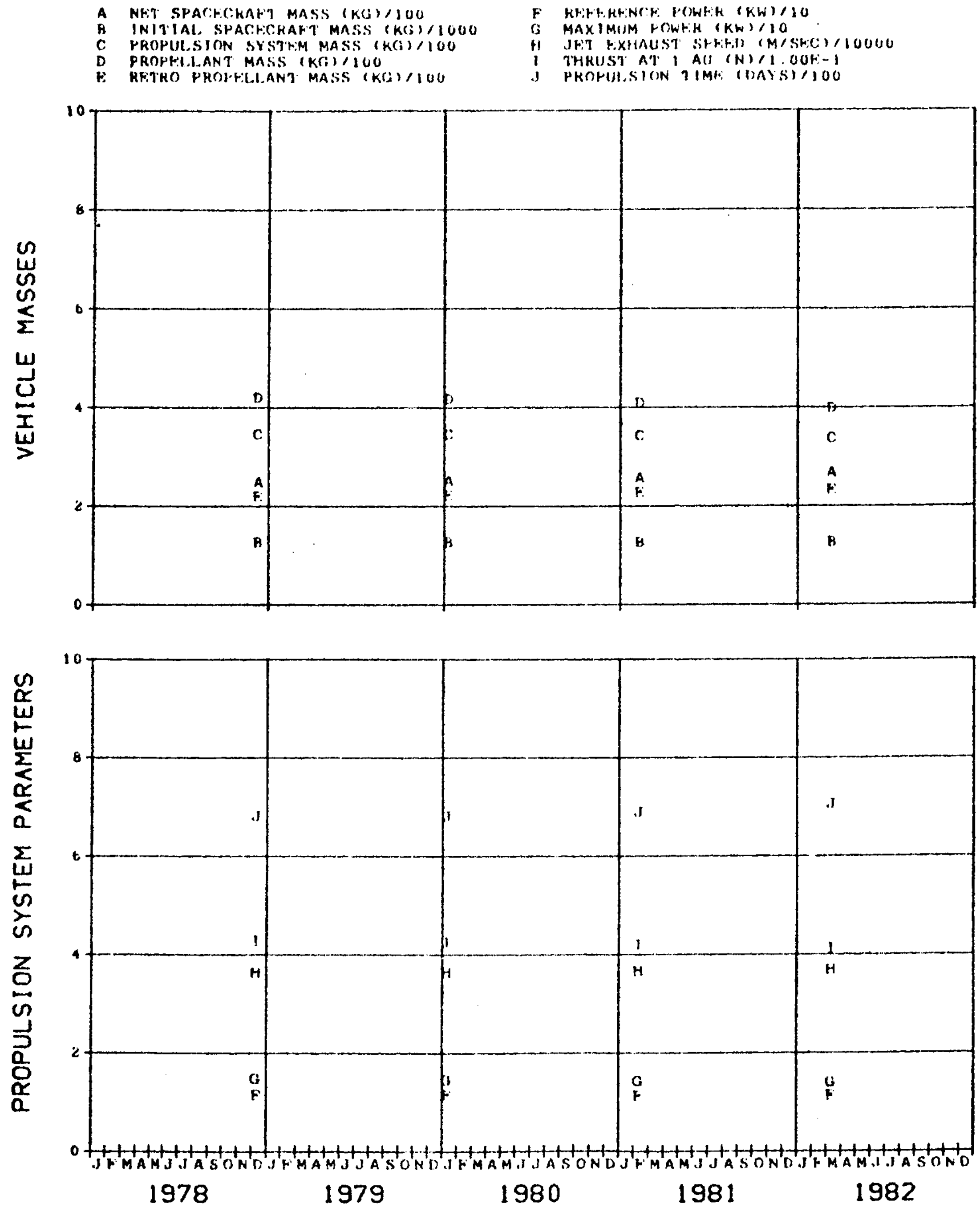

FIG. 15B. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1100 DAYS

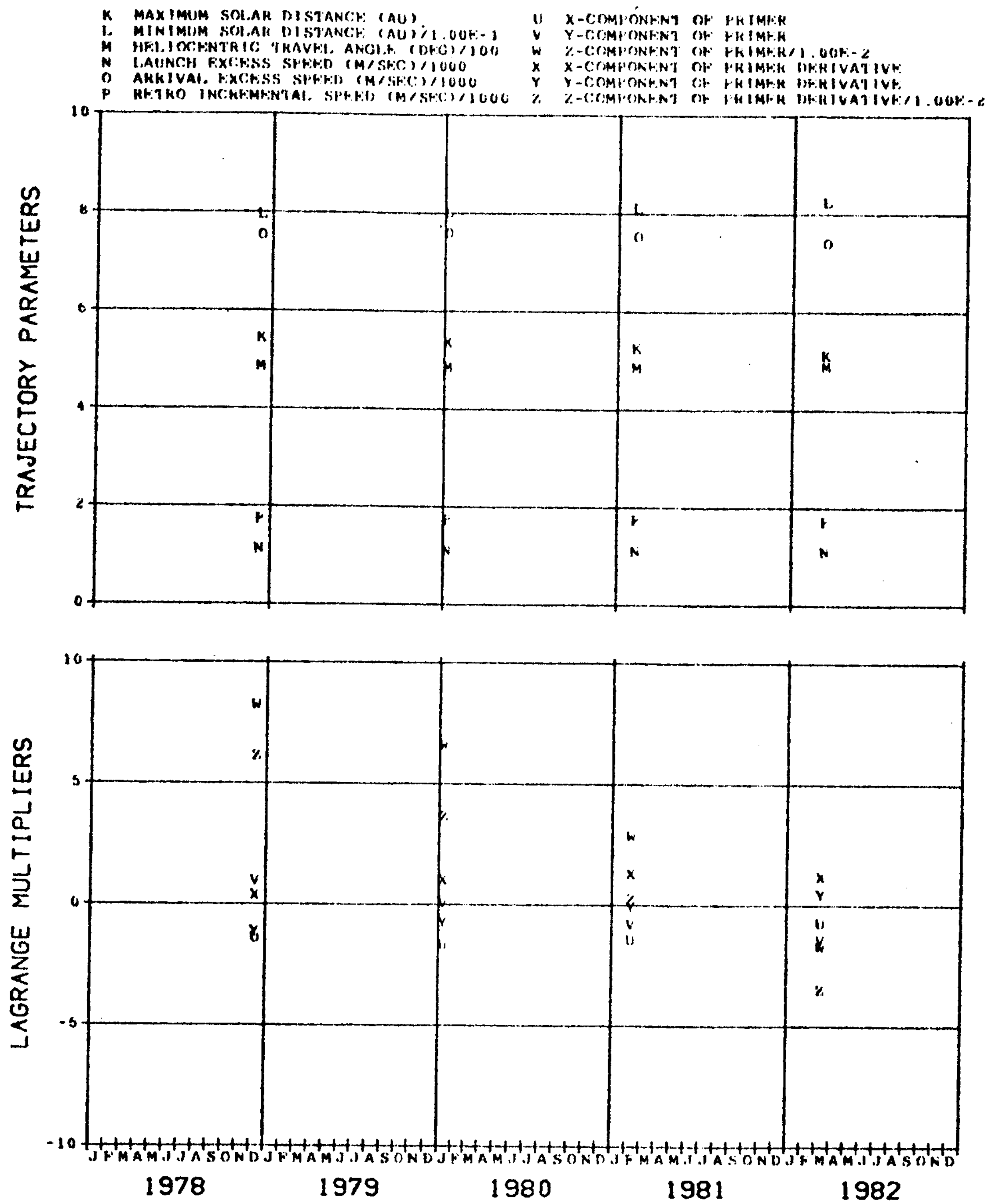

FIG. 158. (CONCLUDED)

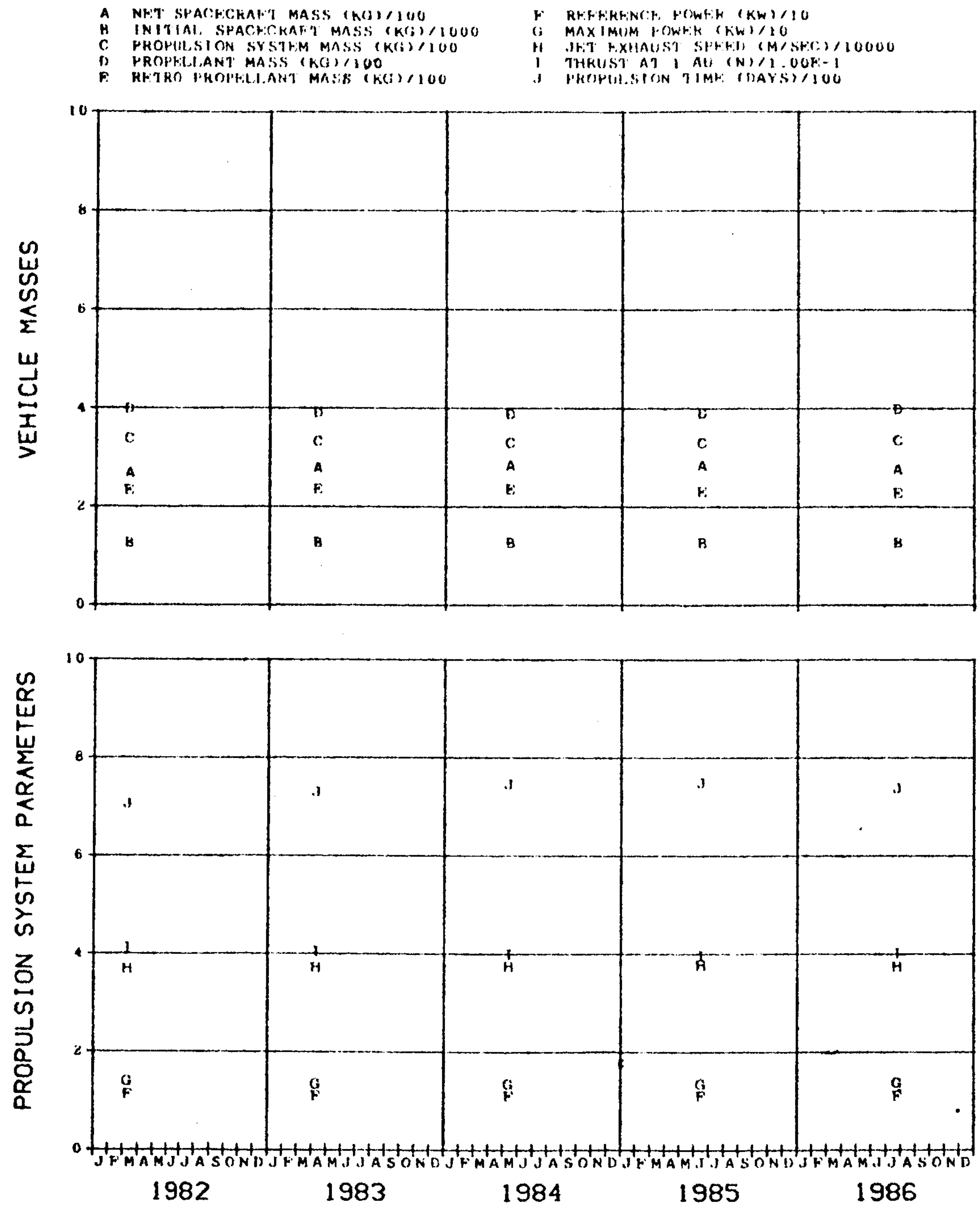

FIG. 15C. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1100 DAYS

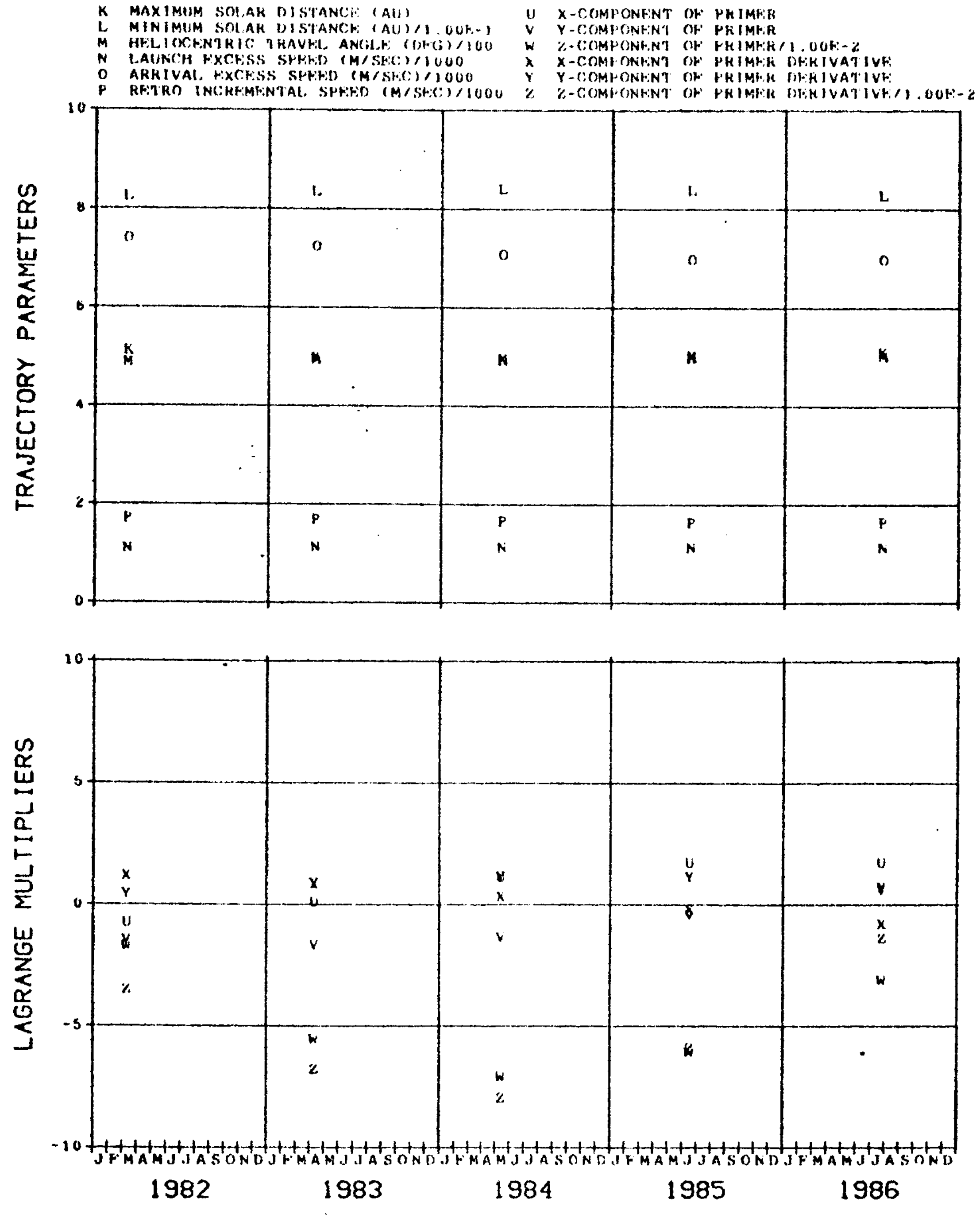

FIG. 15C. (CONCLUDED)

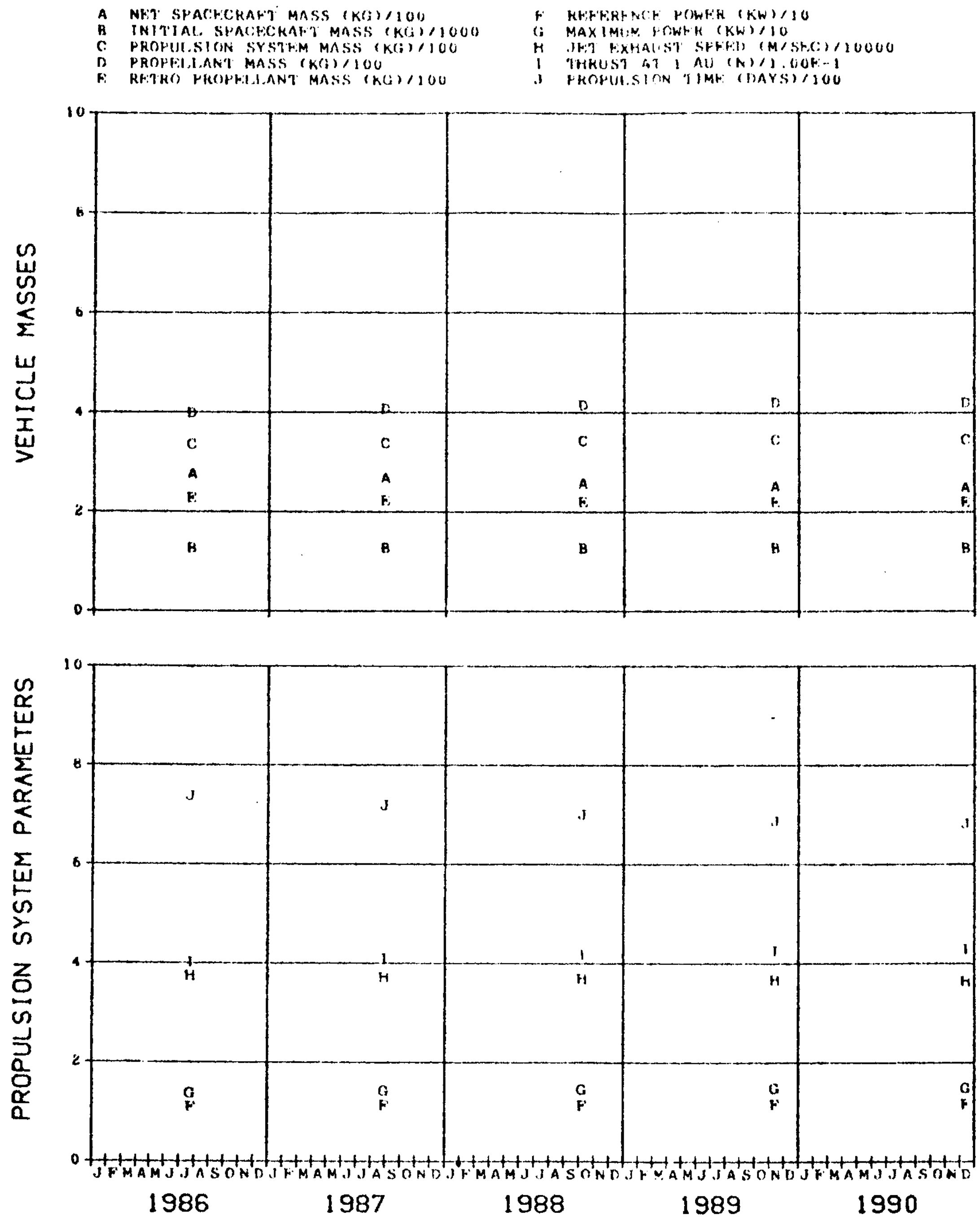

FIG. 15D. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1100 DAYS

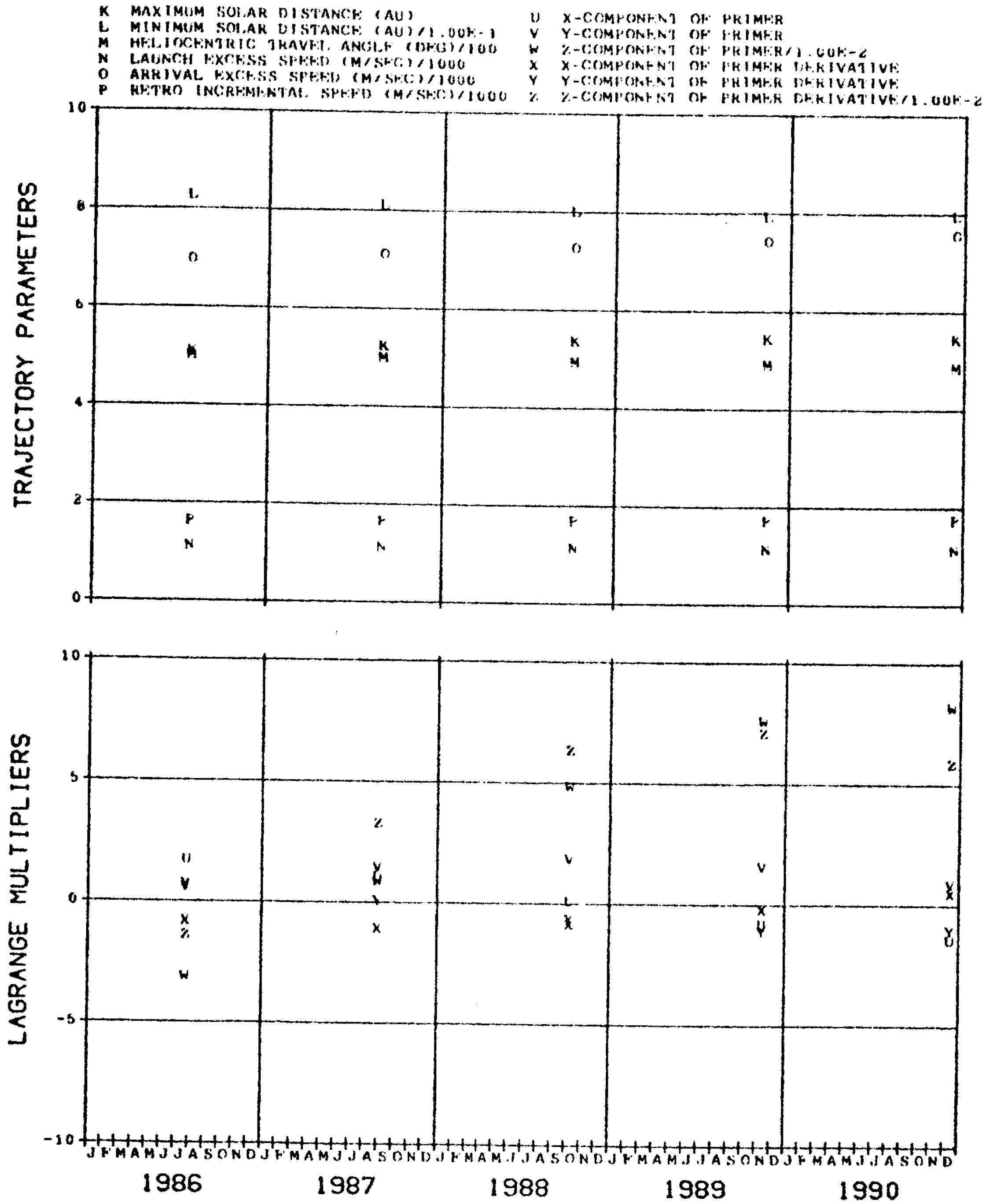

FIG. 15D. (CONCLUDED)

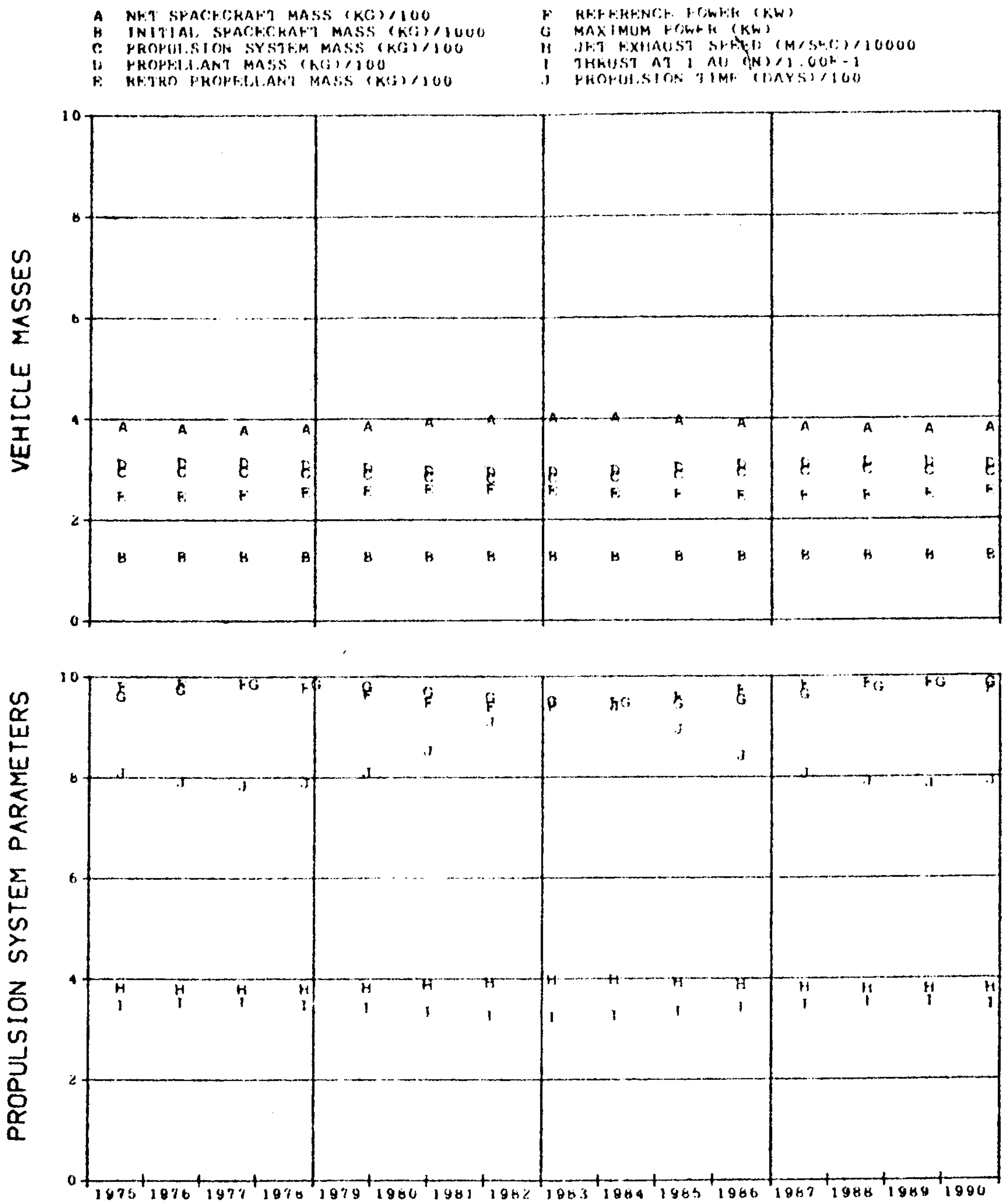

FIG. 16. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1500 DAYS

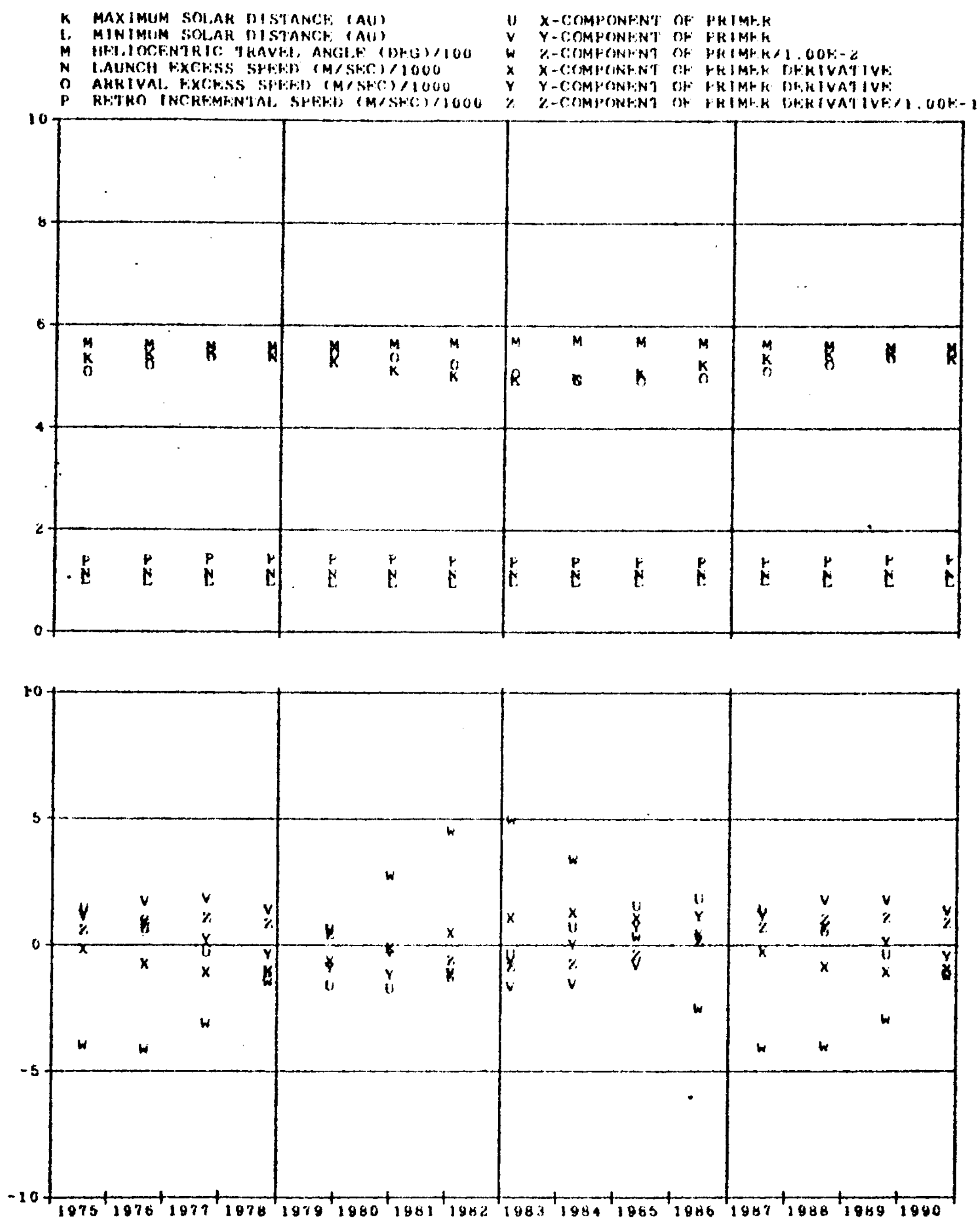

FIG. 16. (CONCLUDED)

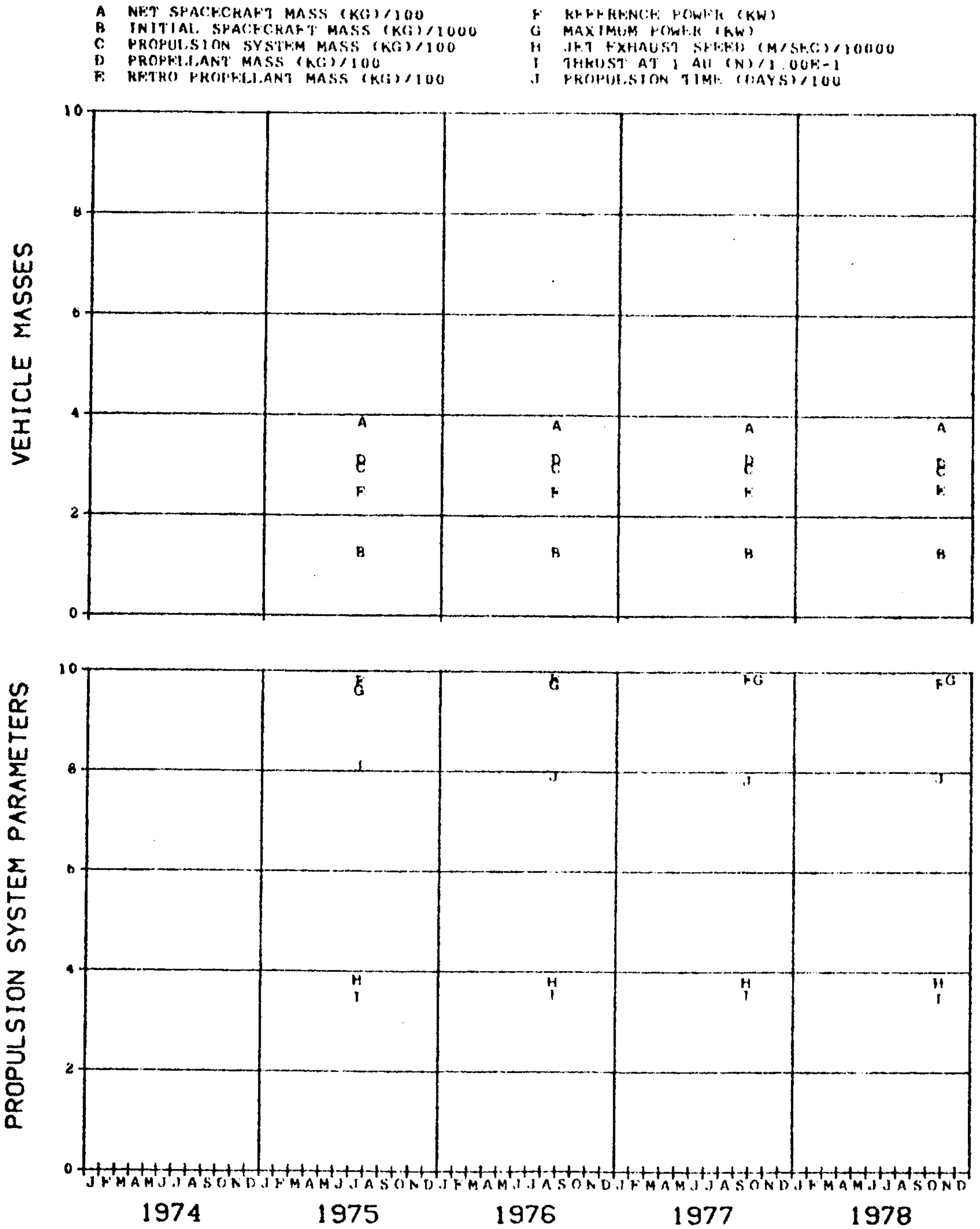

FIG. 16A. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1500 DAYS

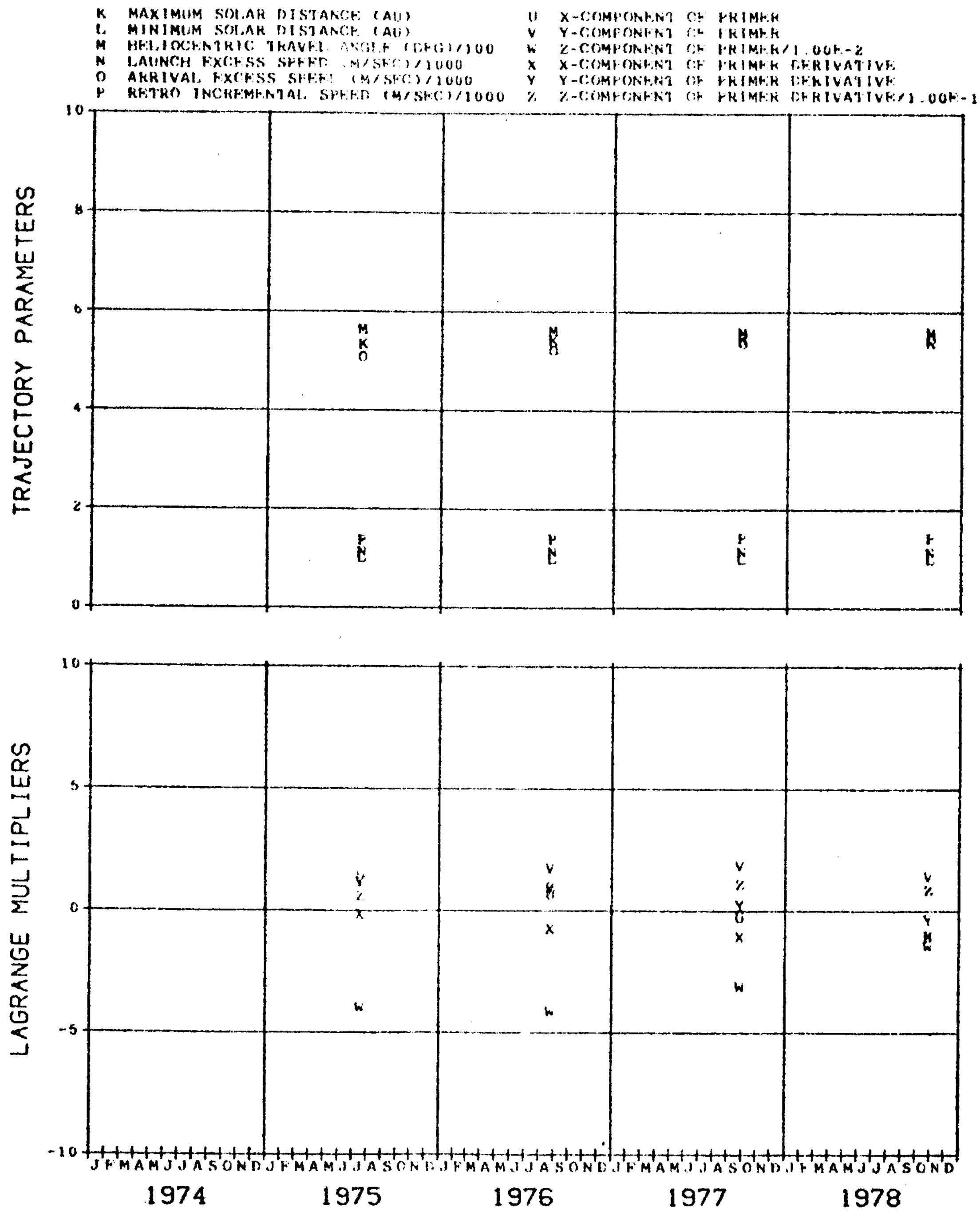

FIG. 16A. (CONCLUDED)

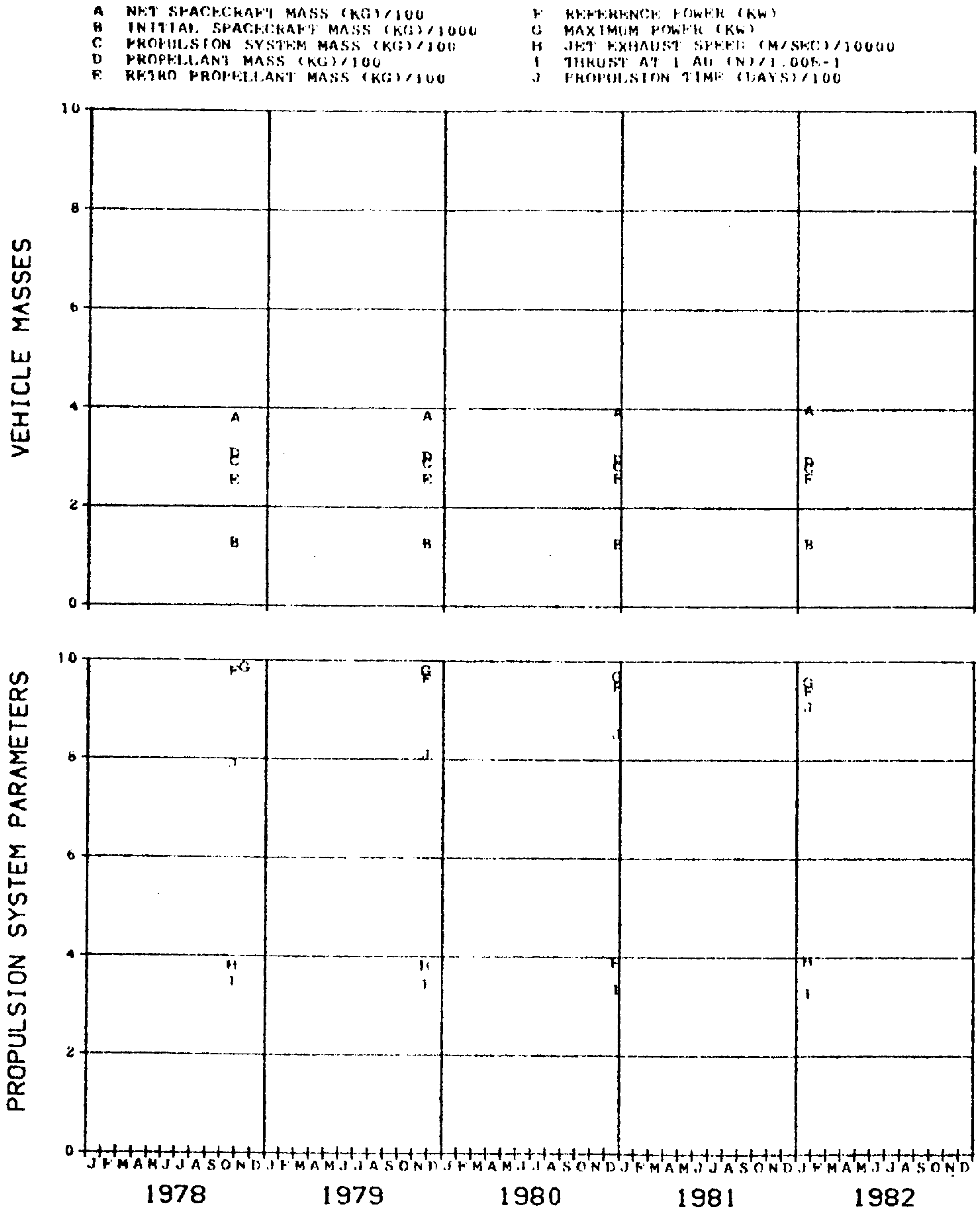

FIG. 16B. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1500 DAYS

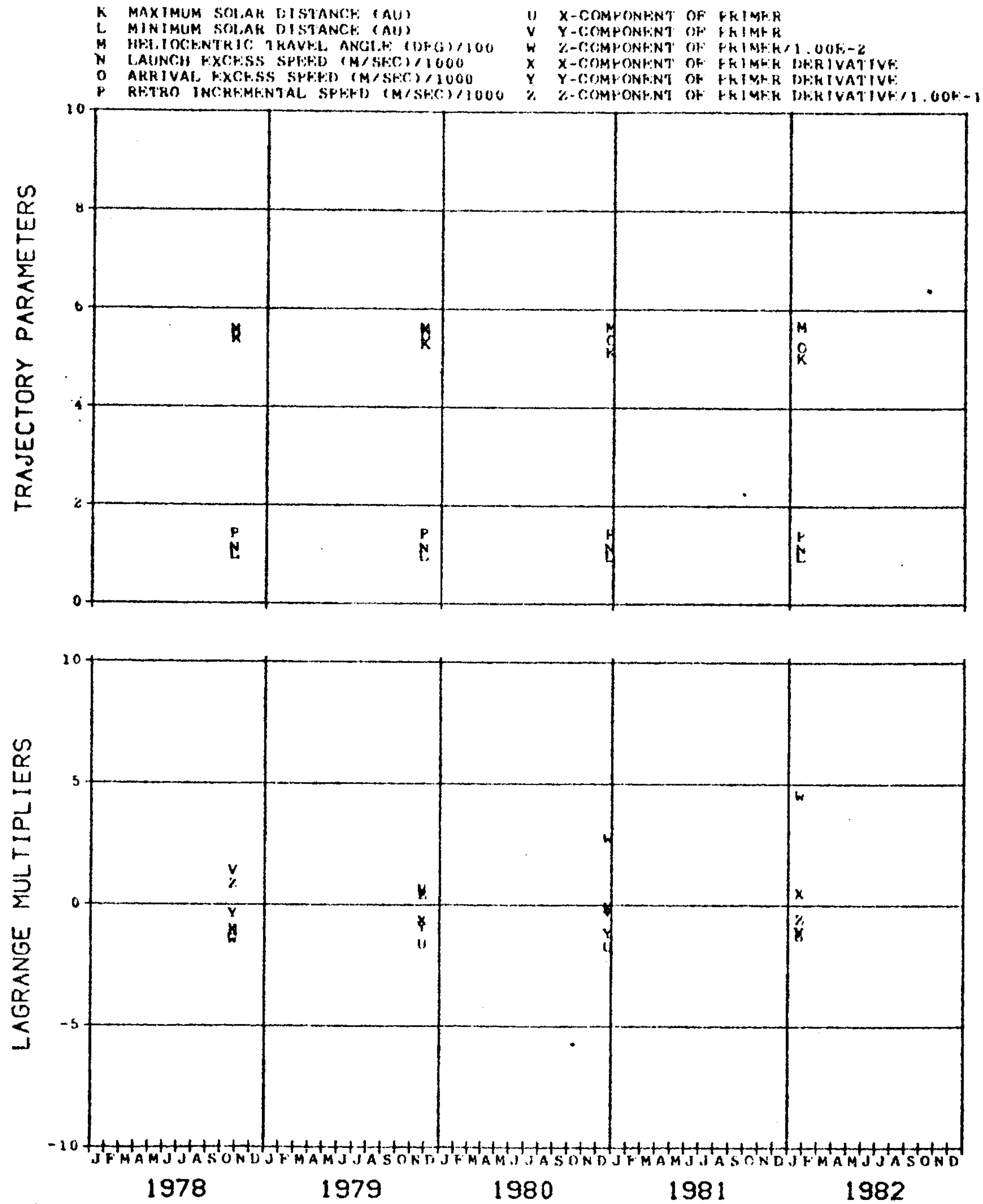

FIG. 16B. (CONCLUDED)

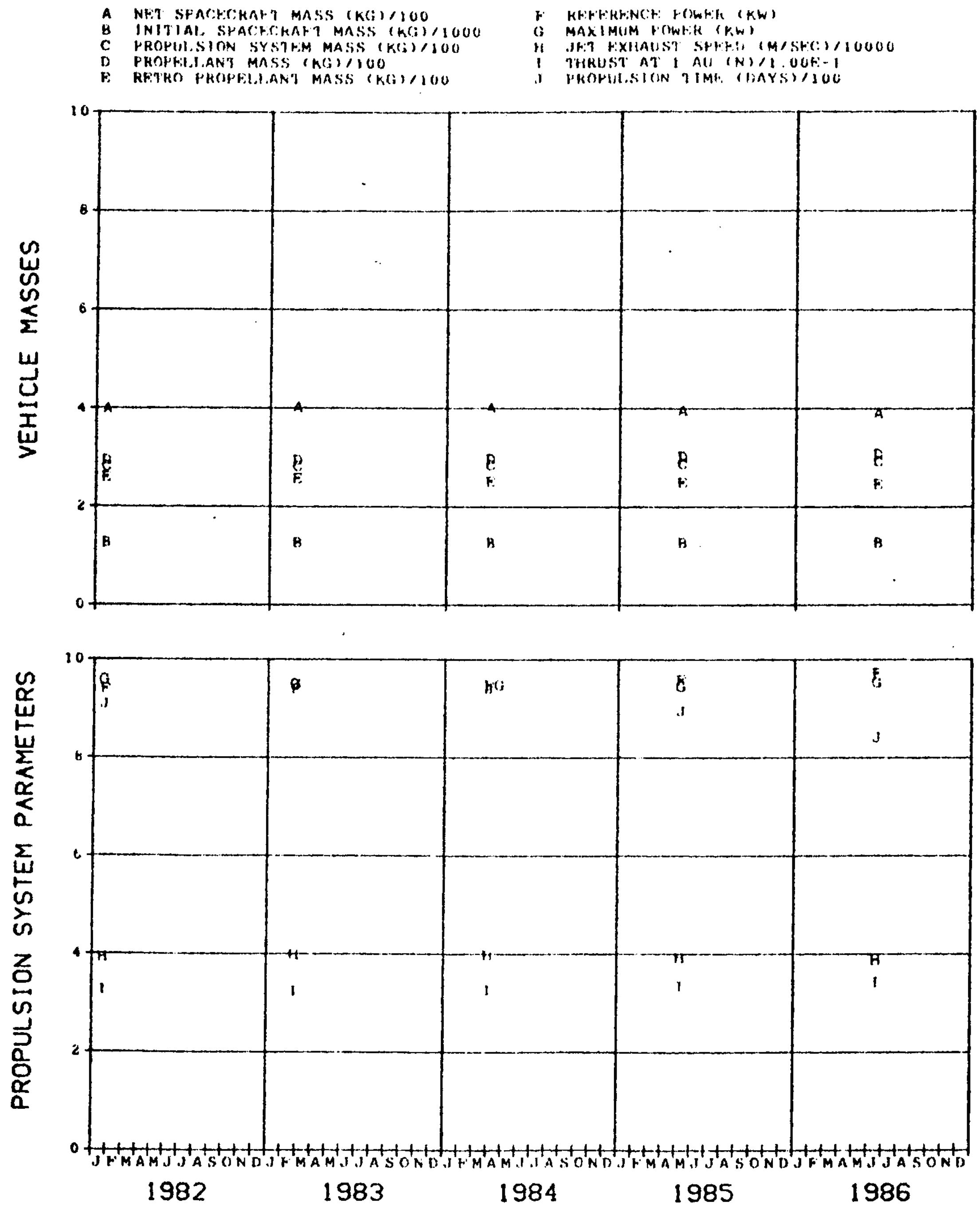

FIG. 16C. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1500 DAYS

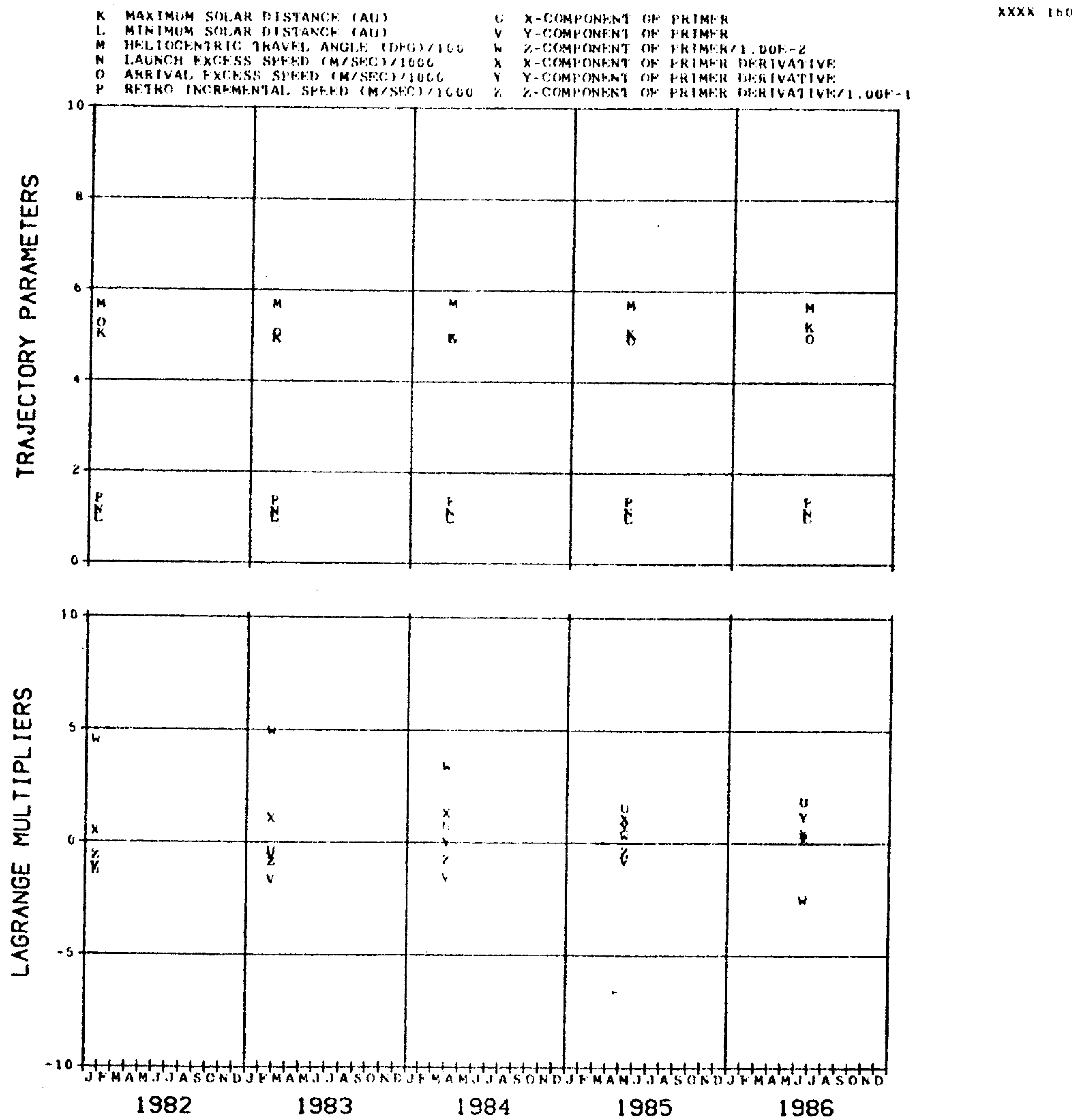

FIG. 16C. (CONCLUDED)

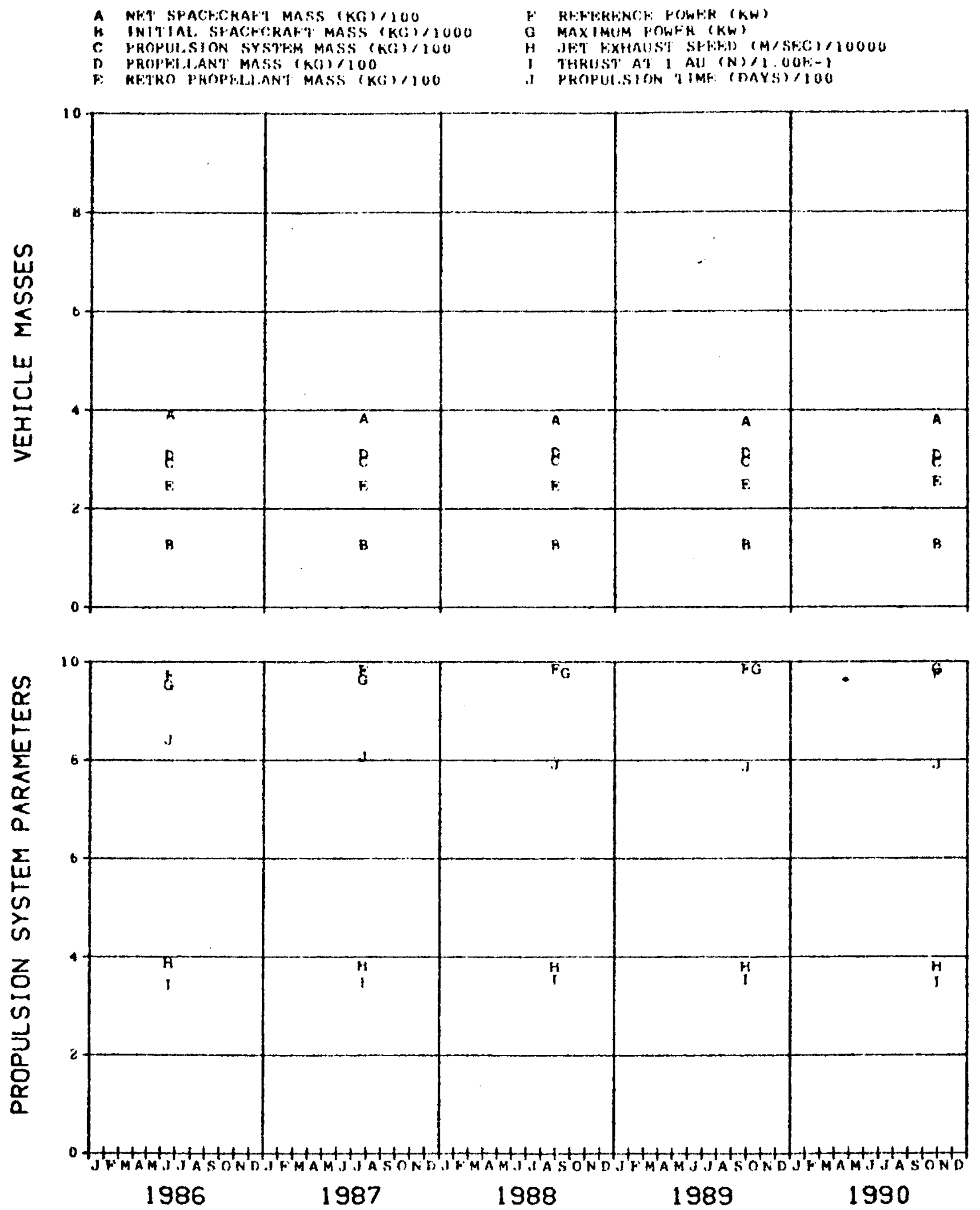

FIG. 16D. JUPITER MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 1500 DAYS

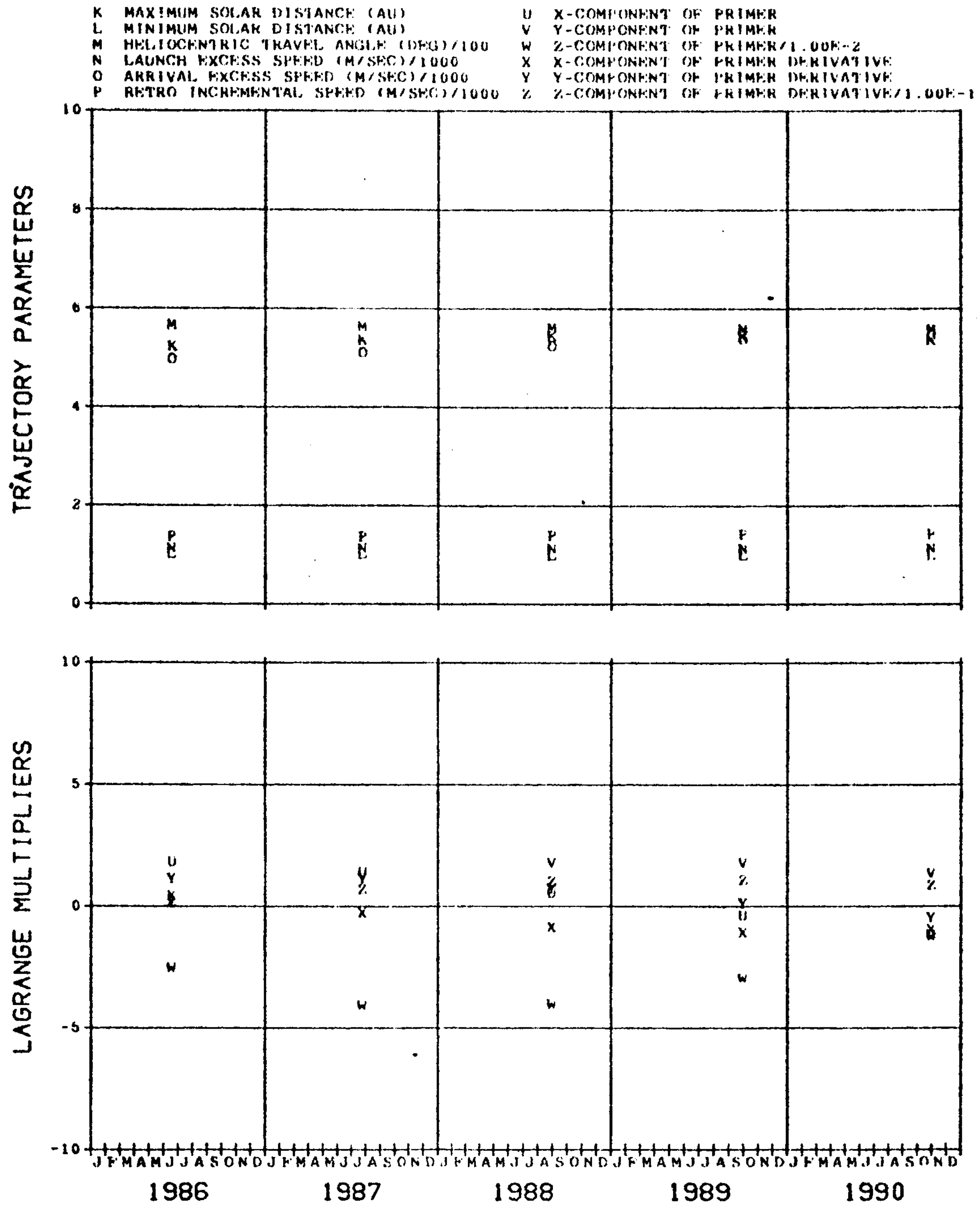

FIG. 16D. (CONCLUDED)

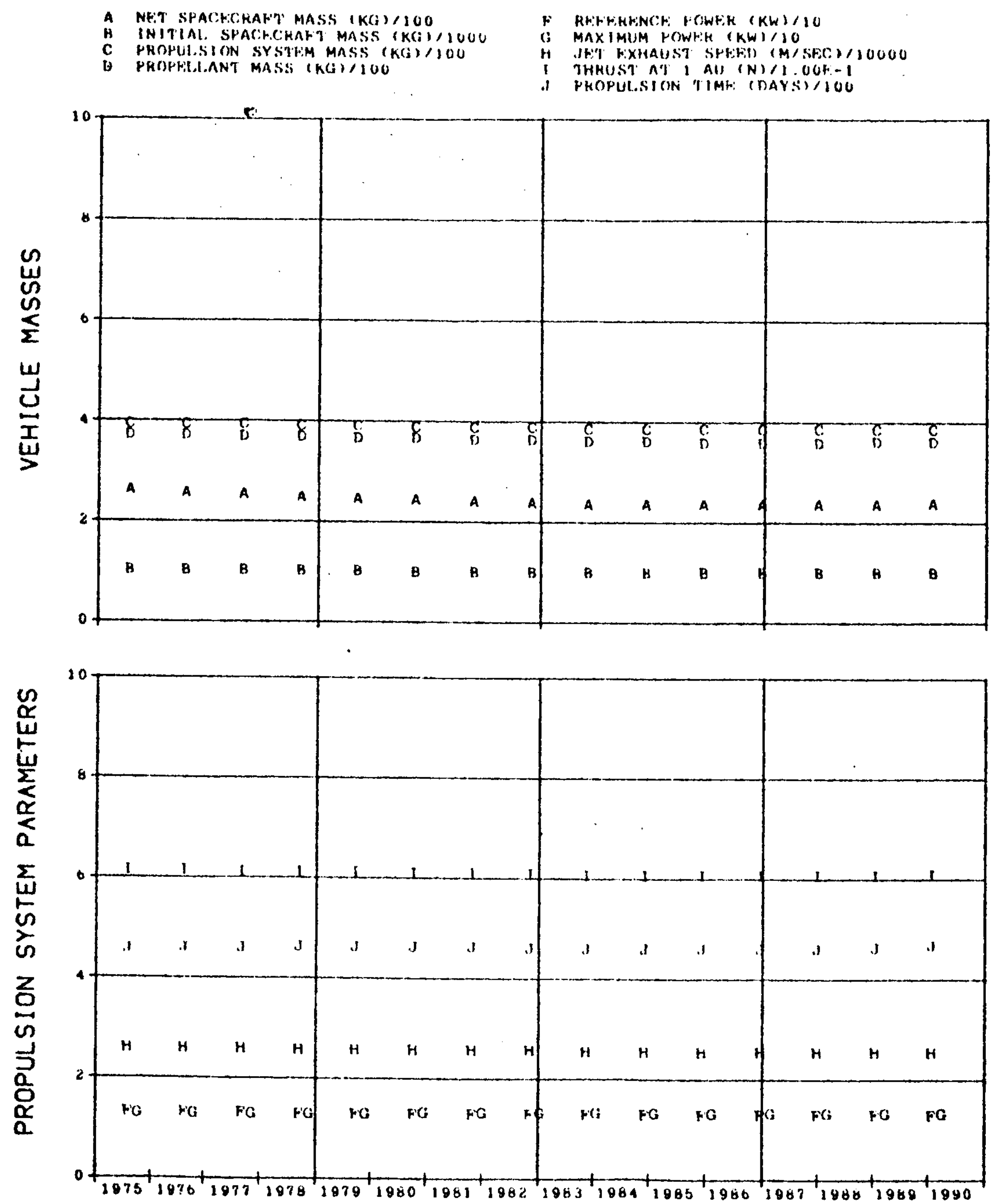

FIG. 17. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

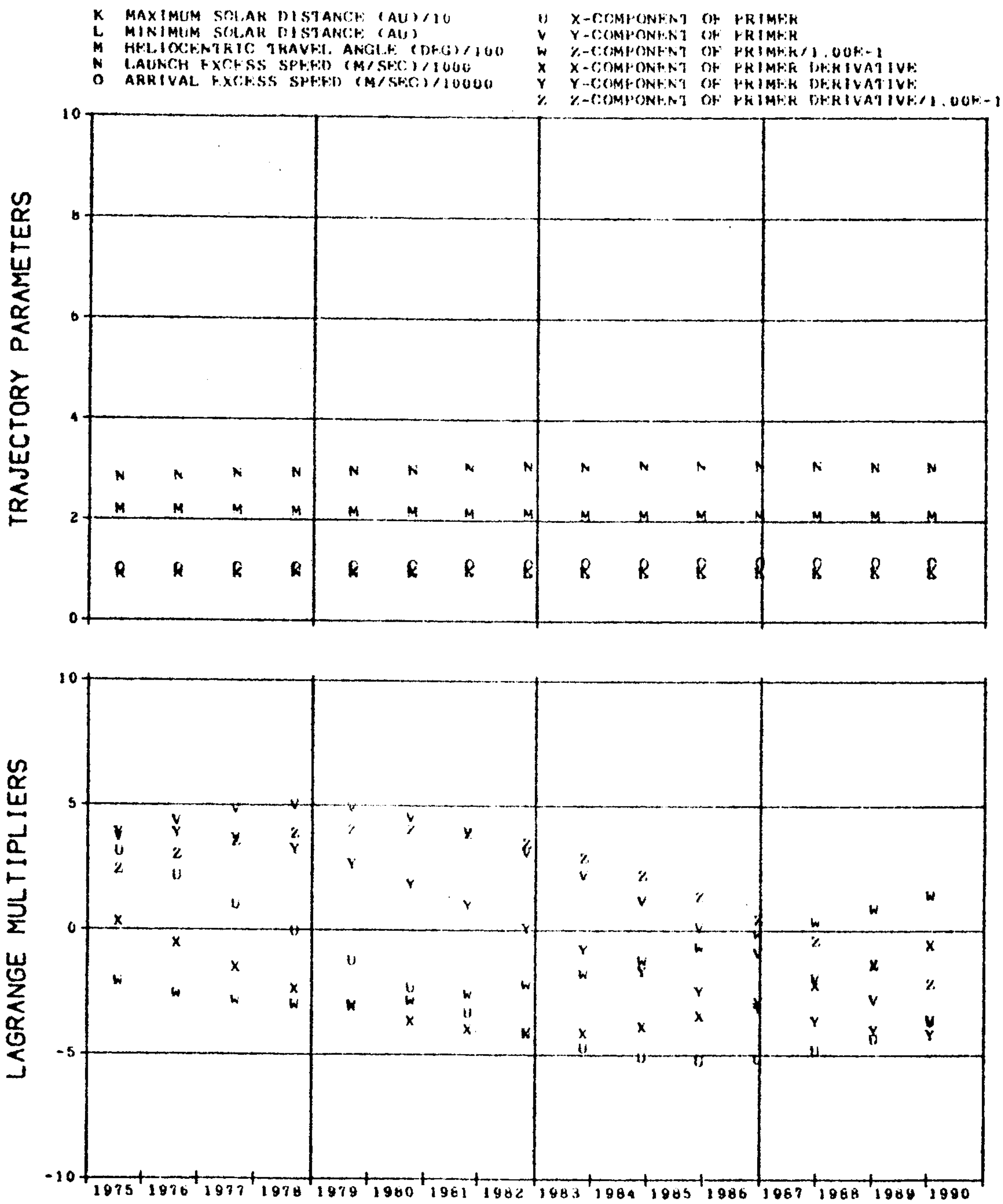

FIG. 17. (CONCLUDED)

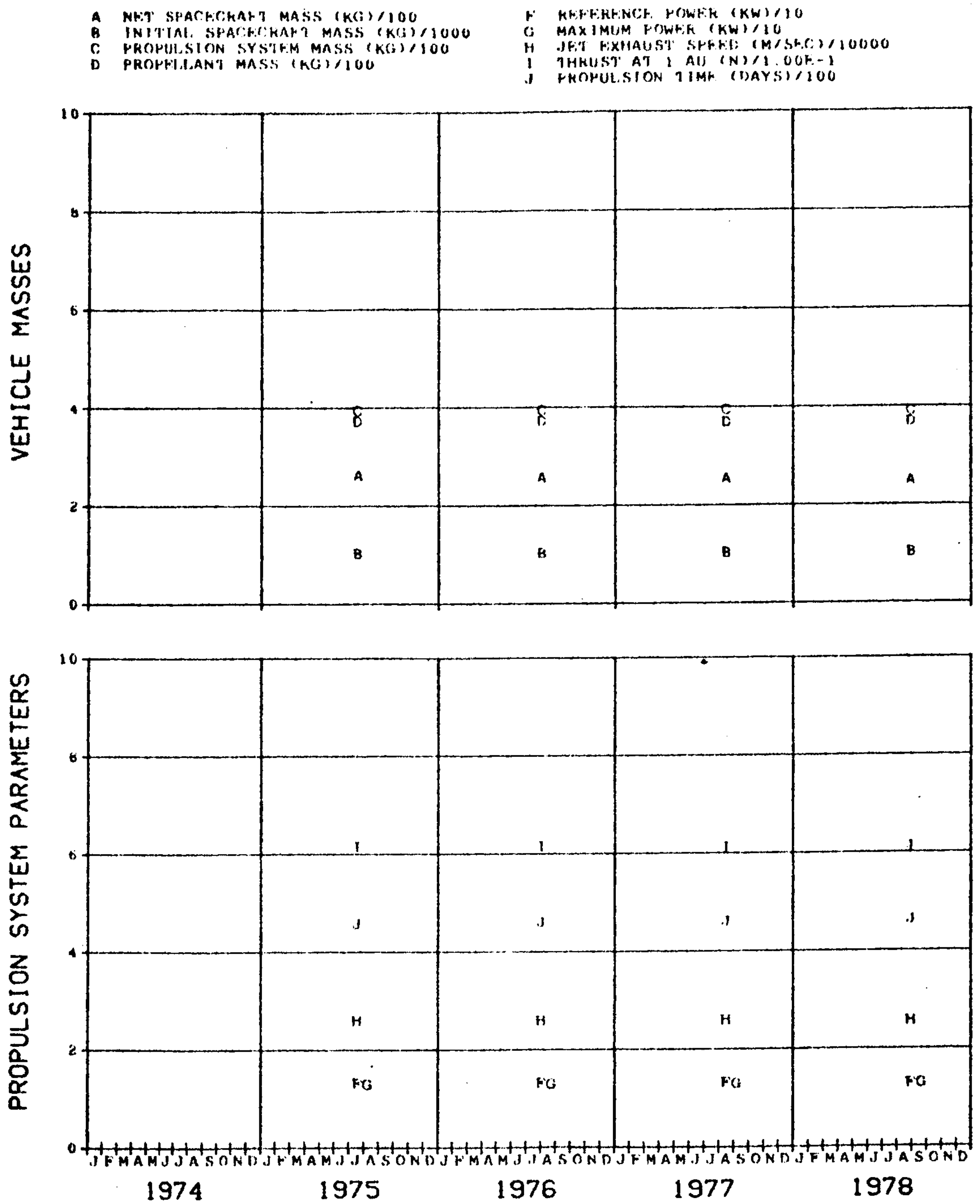

FIG. 17A. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

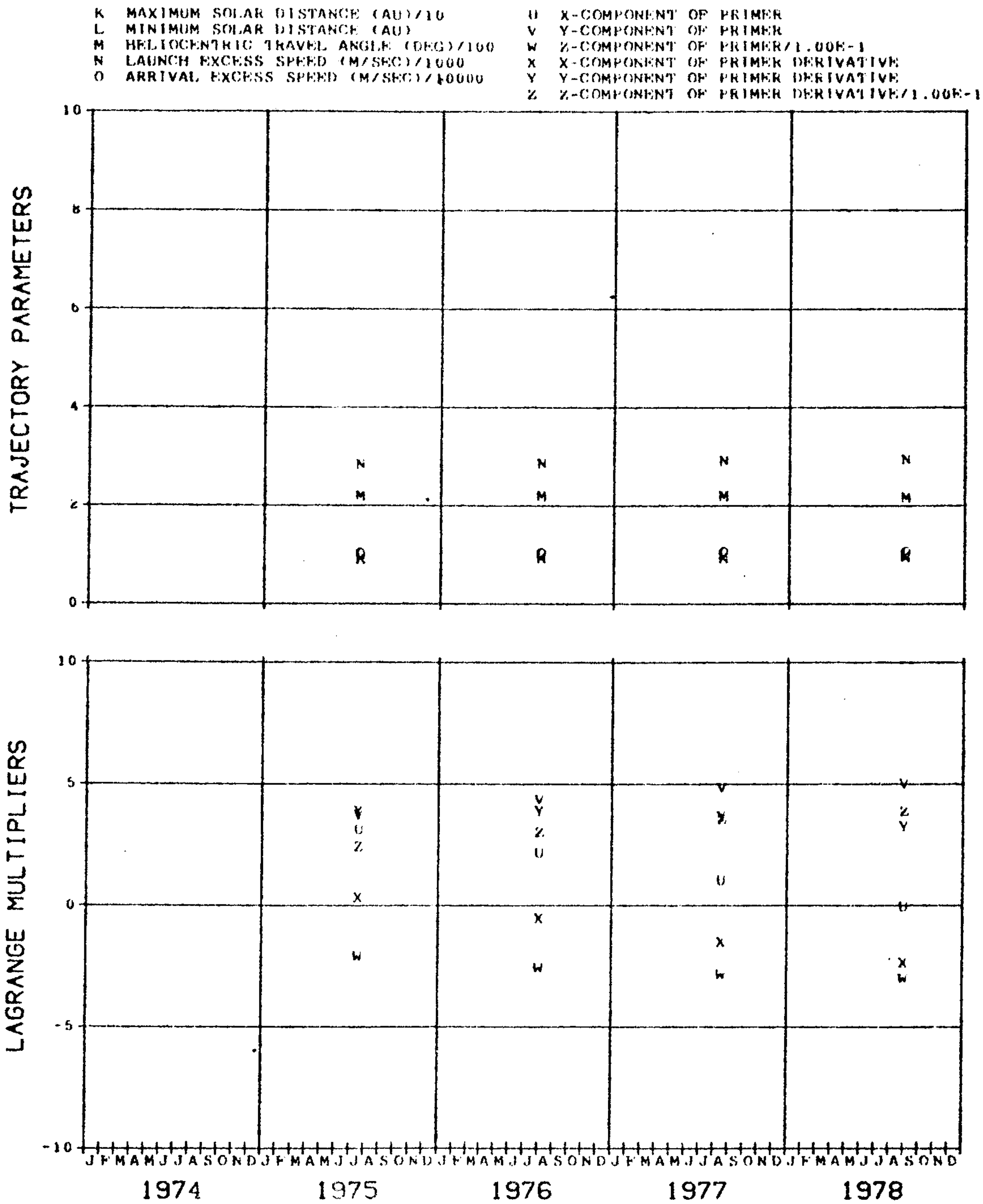

FIG. 17A. (CONCLUDED)

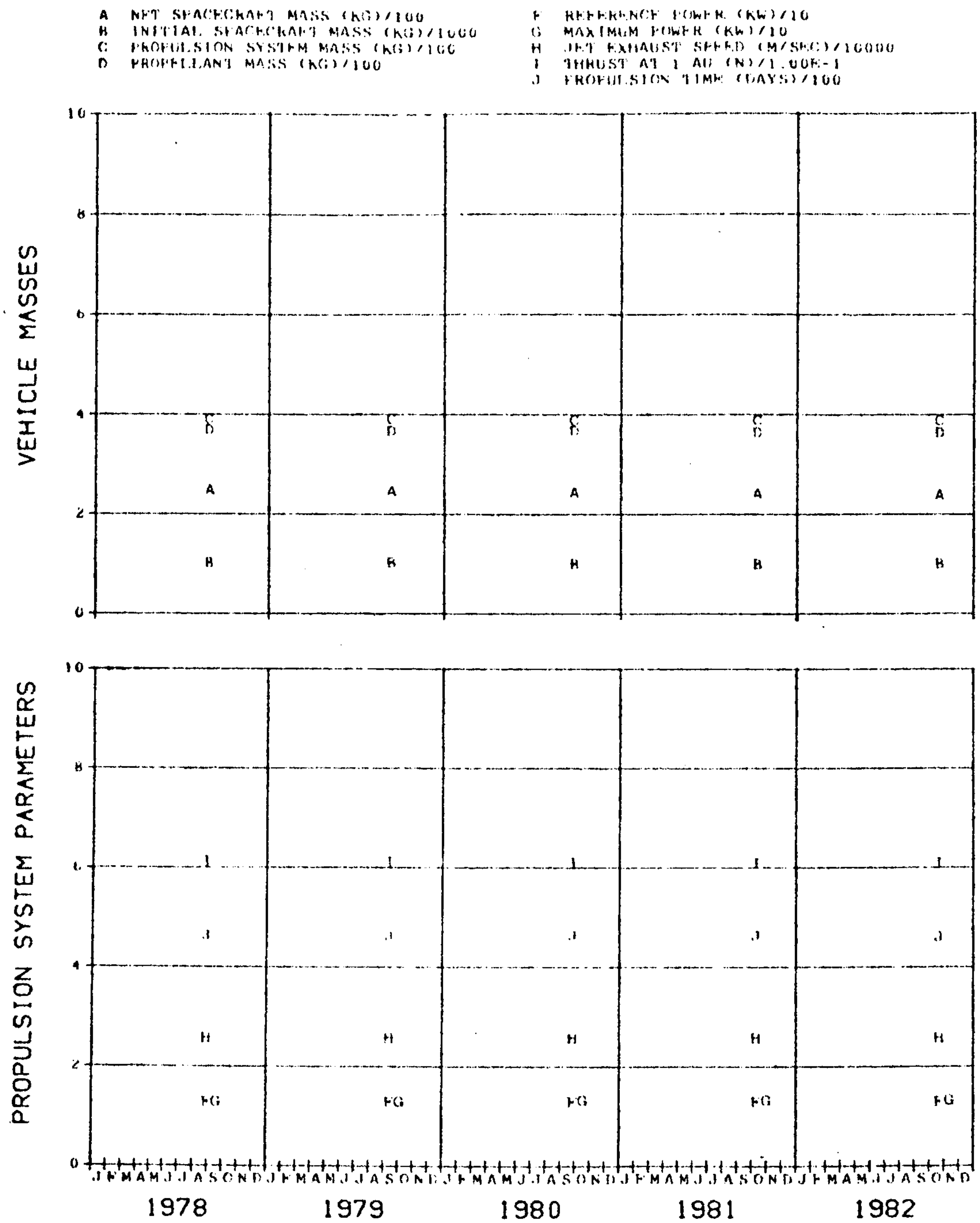

FIG. 17B. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

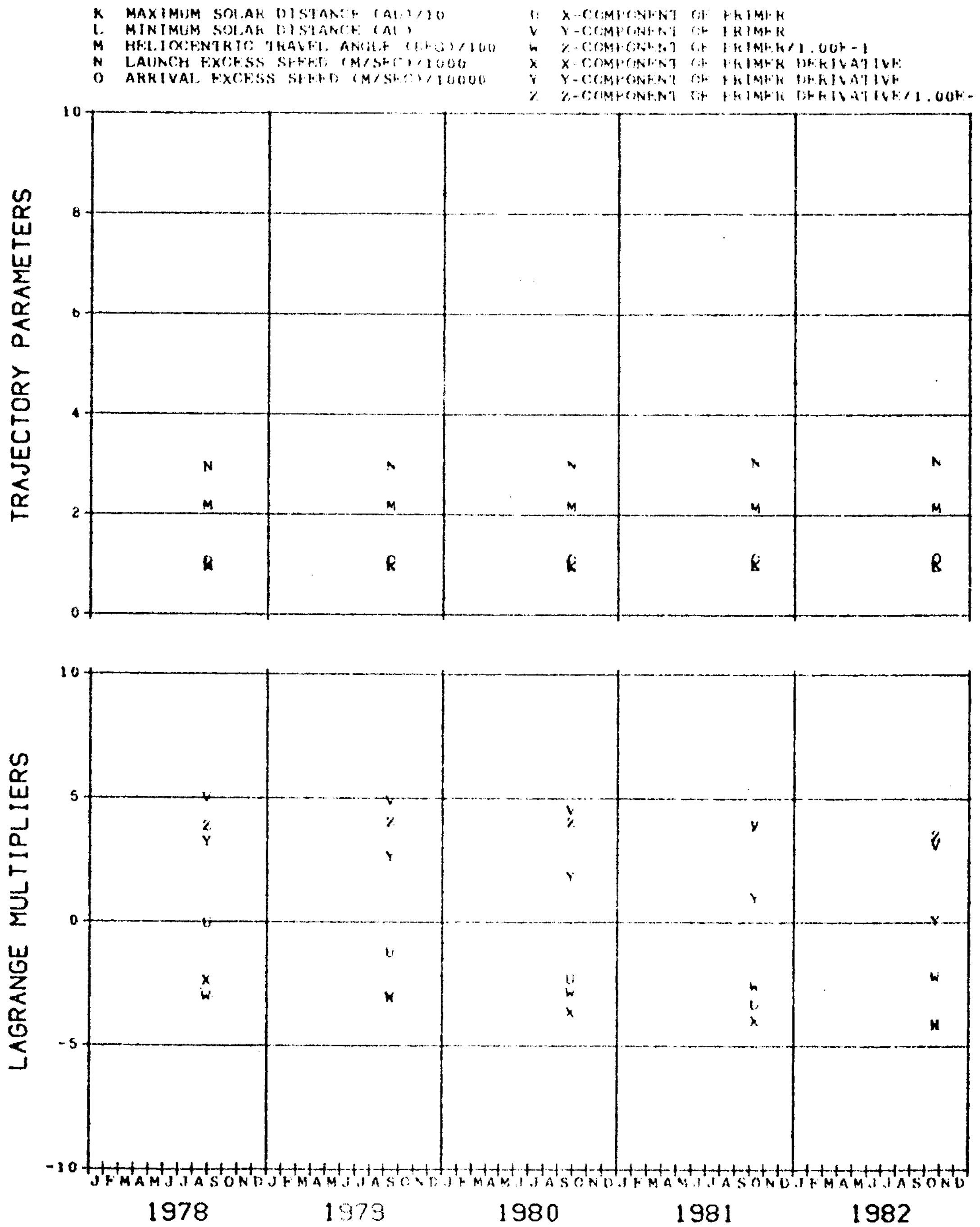

FIG. 17B. (CONCLUDED)

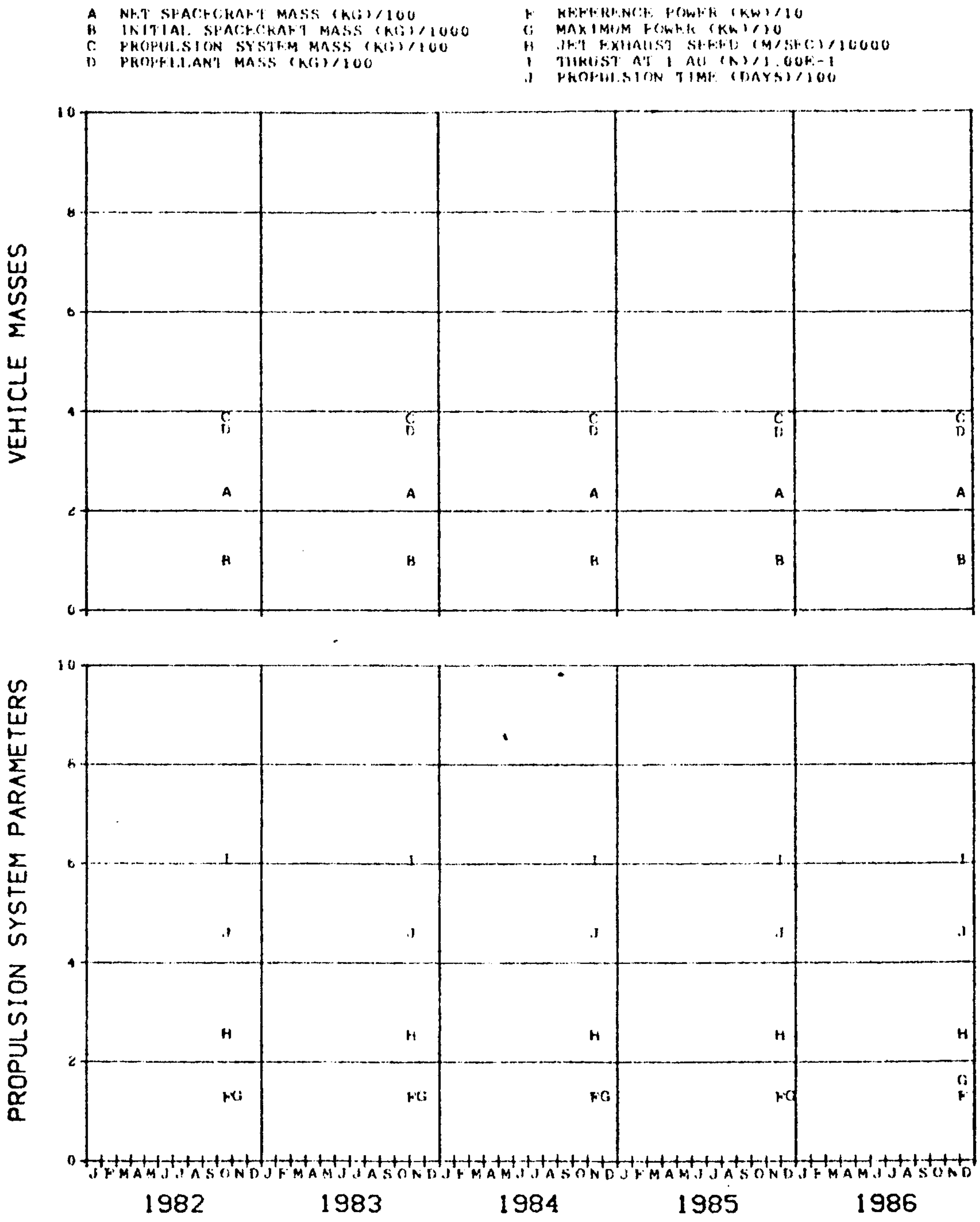

FIG. 17C. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

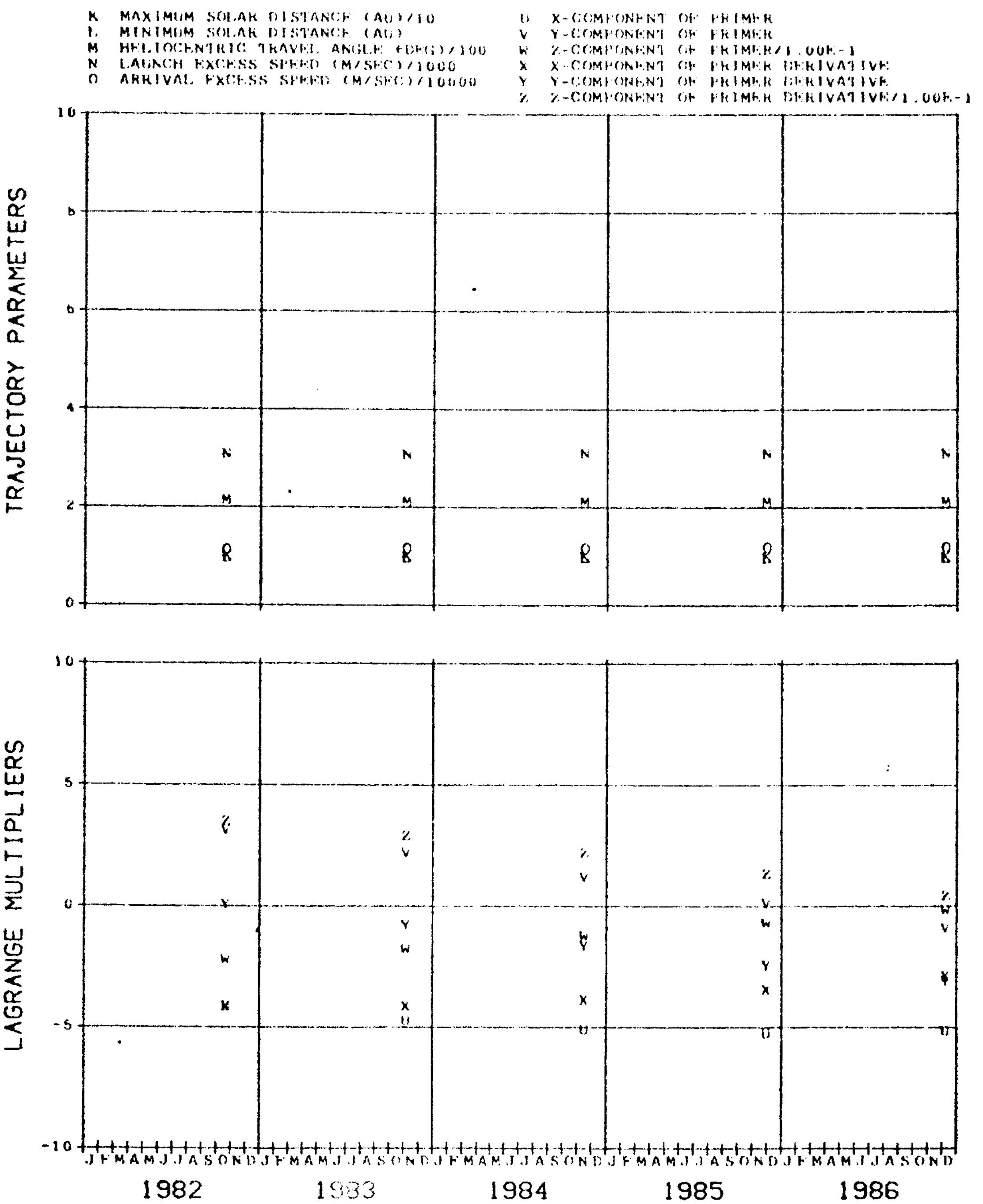

FIG. 17C. (CONCLUDED)

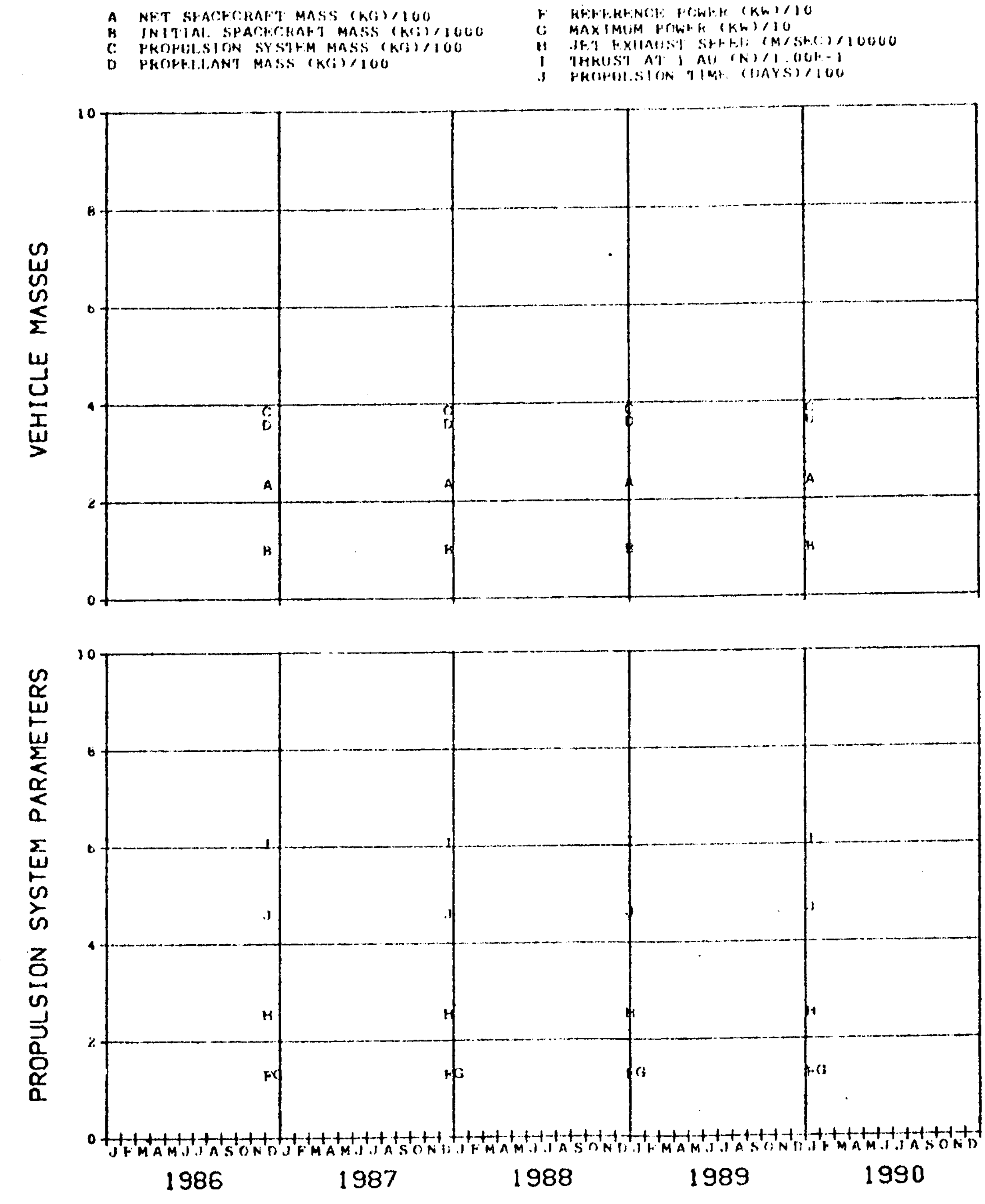

FIG. 17D. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

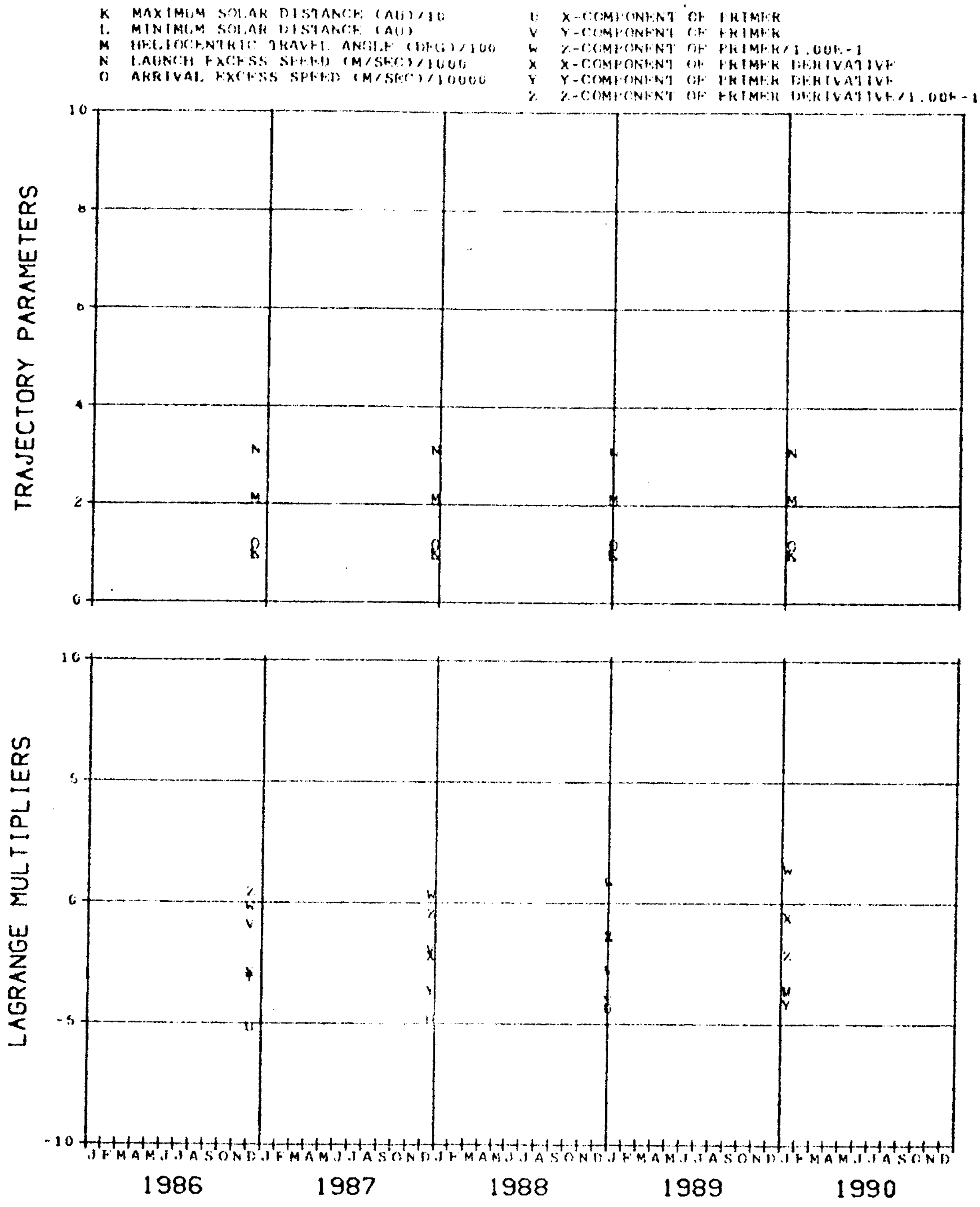

FIG. 17D. (CONCLUDED)

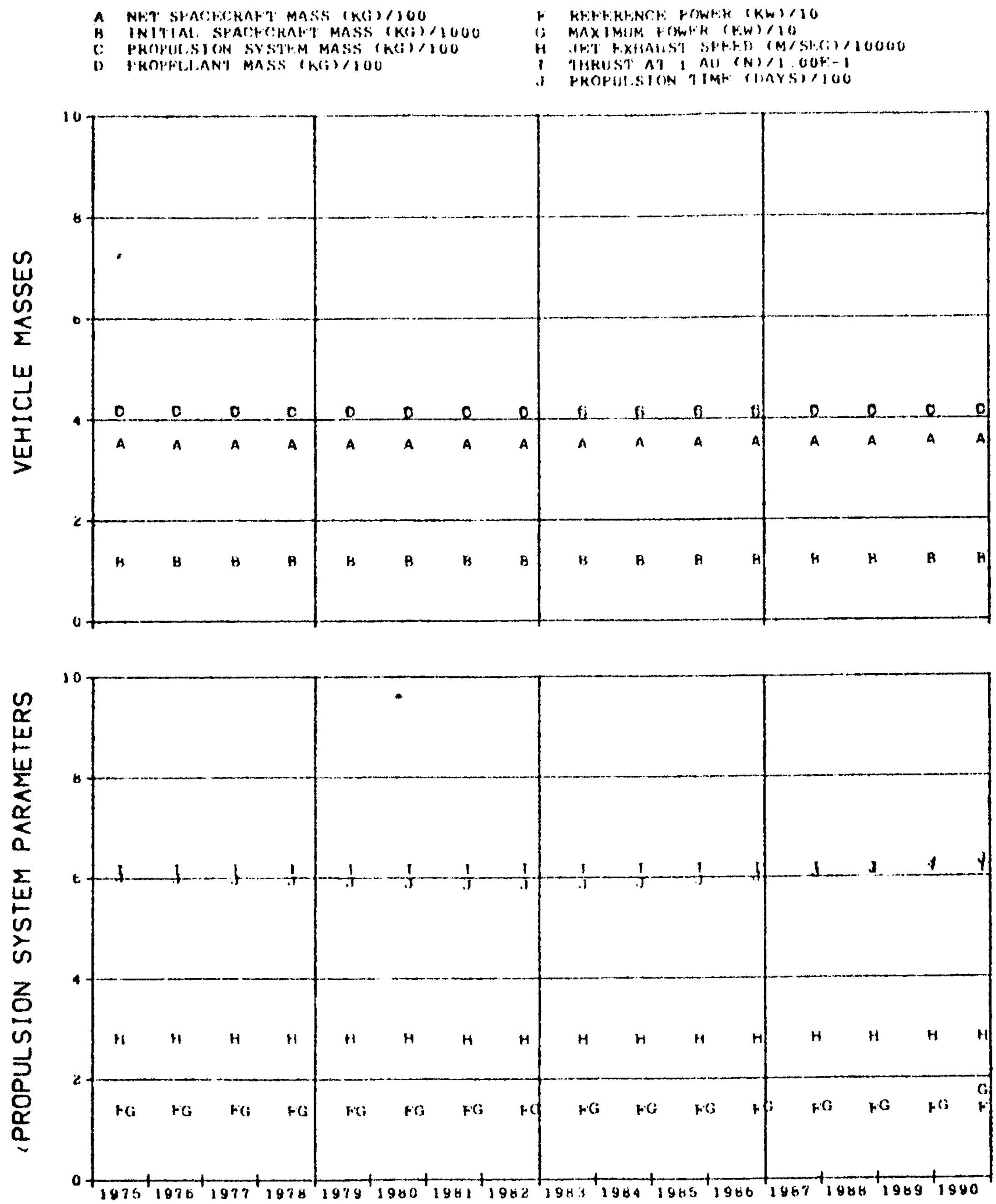

FIG. 18. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

XXXX 174

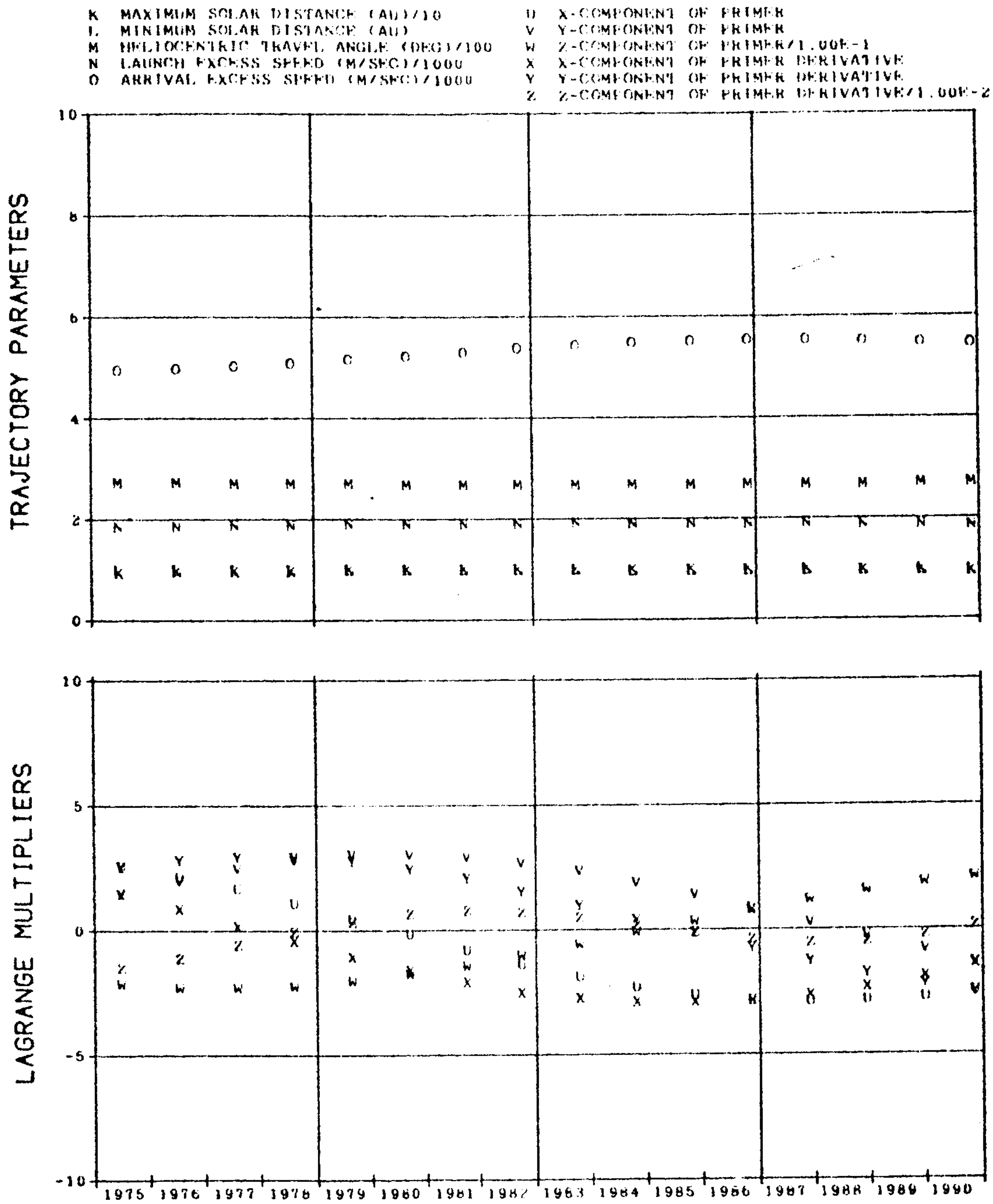

FIG. 18. (CONCLUDED)

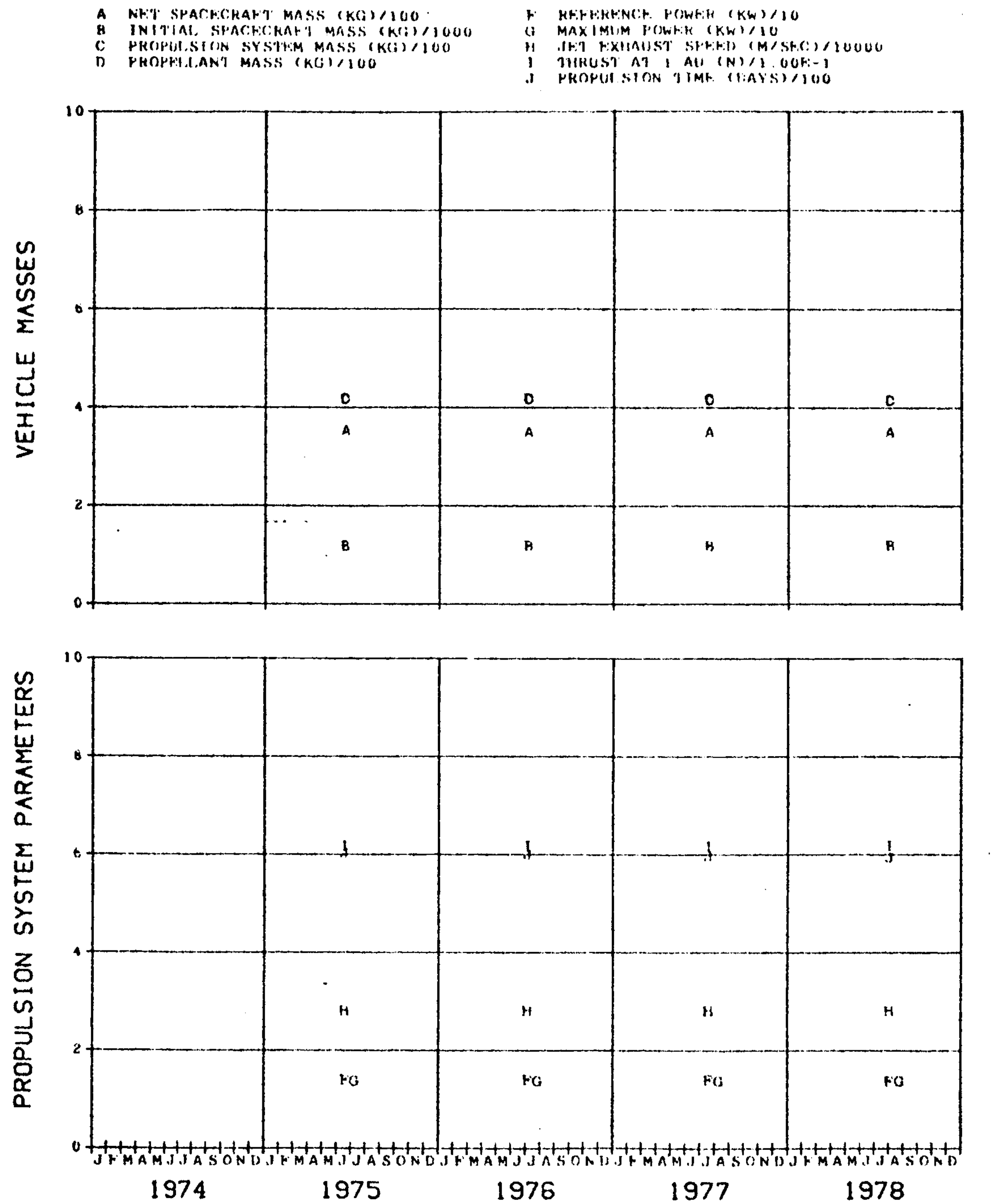

FIG. 18A. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

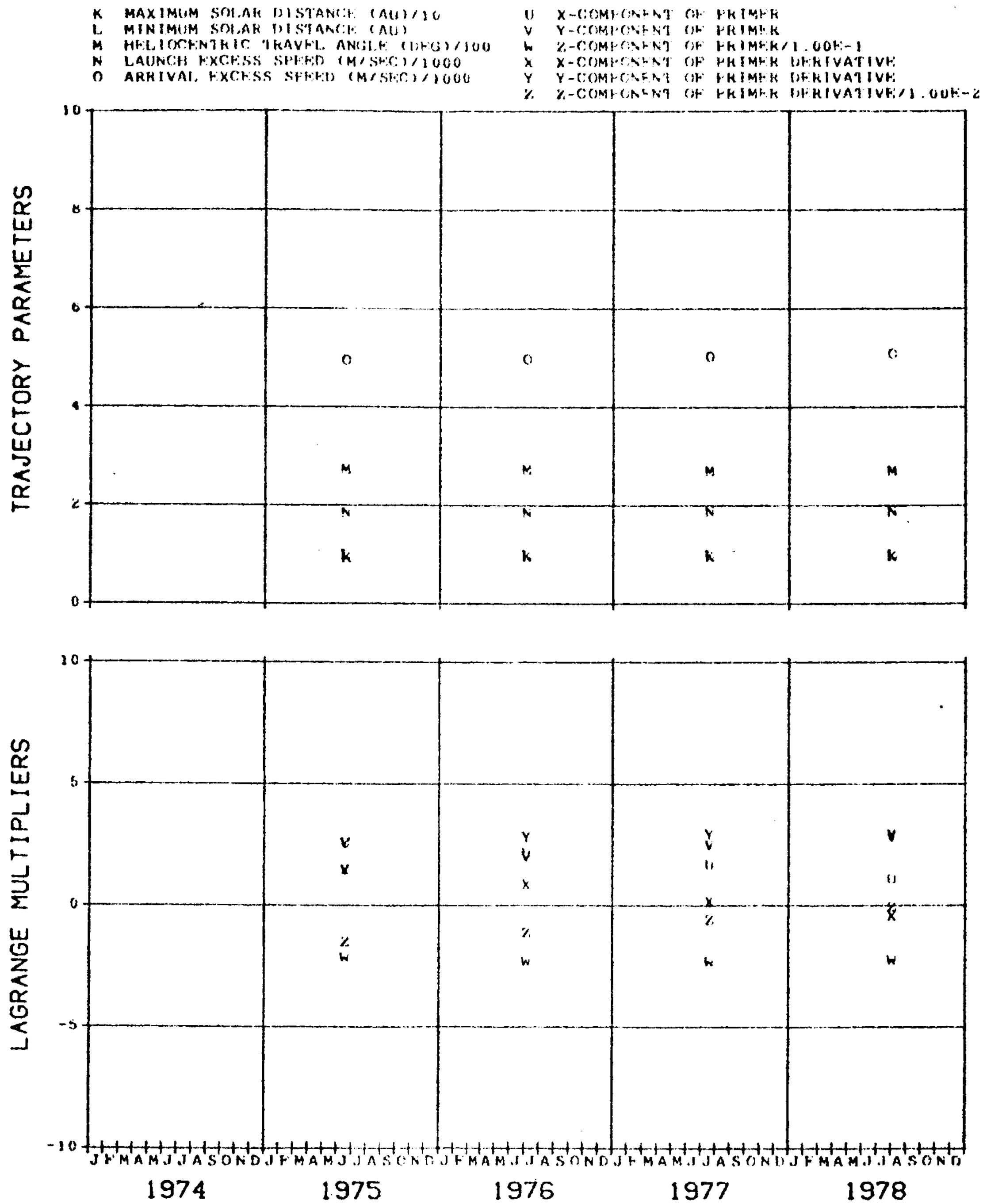

FIG. 18A. (CONCLUDED)

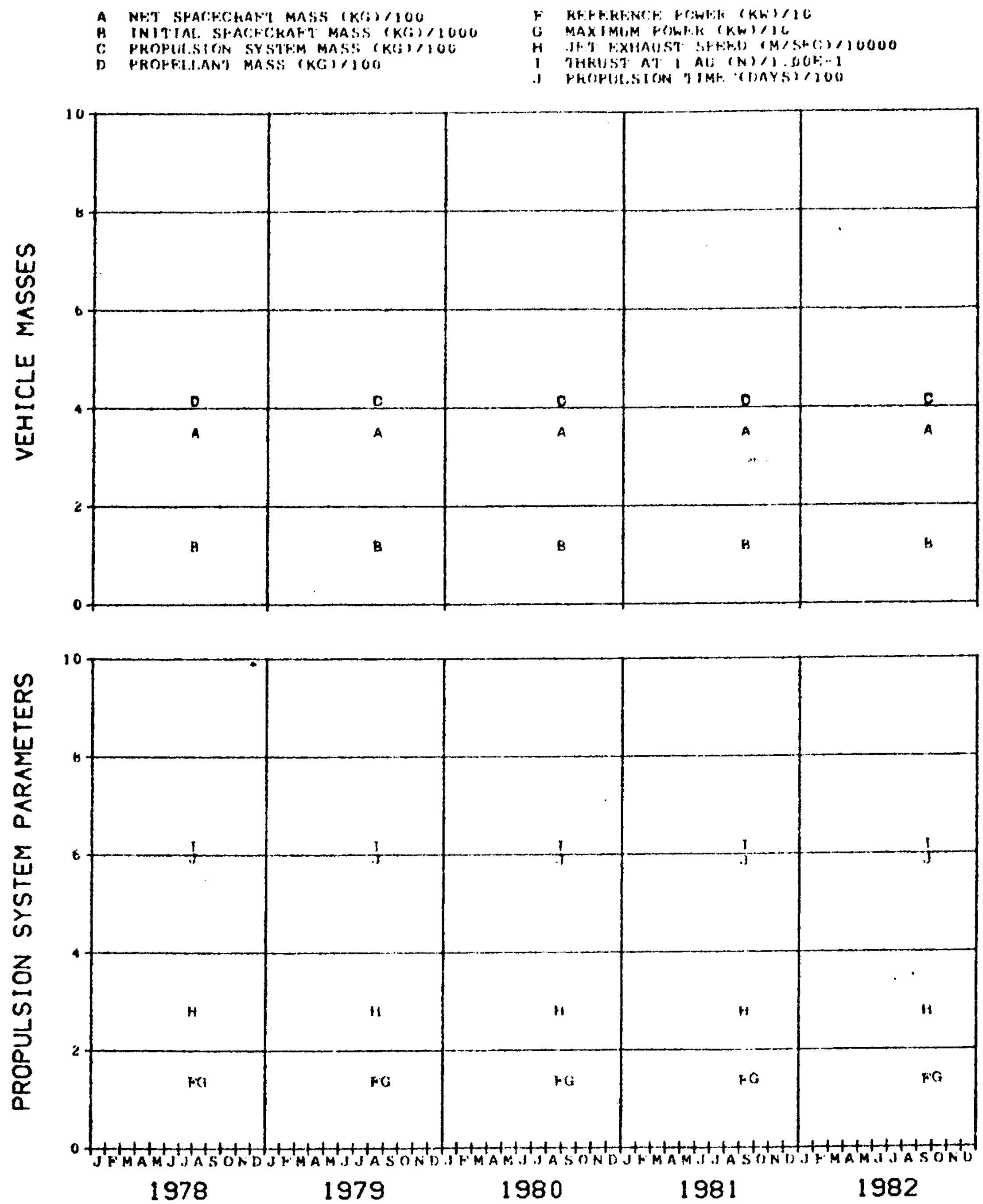

FIG. 18B. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

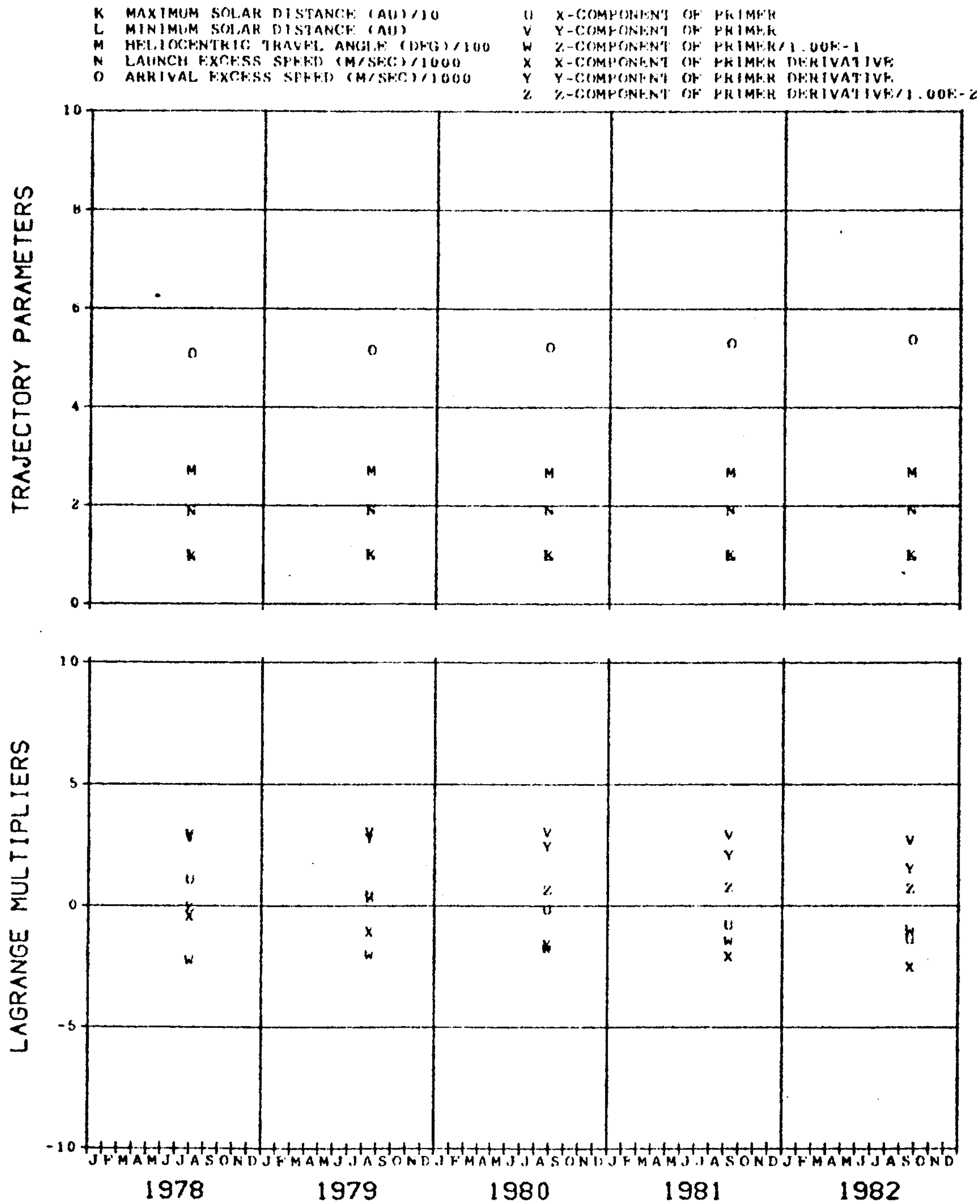

FIG. 18B. (CONCLUDED)

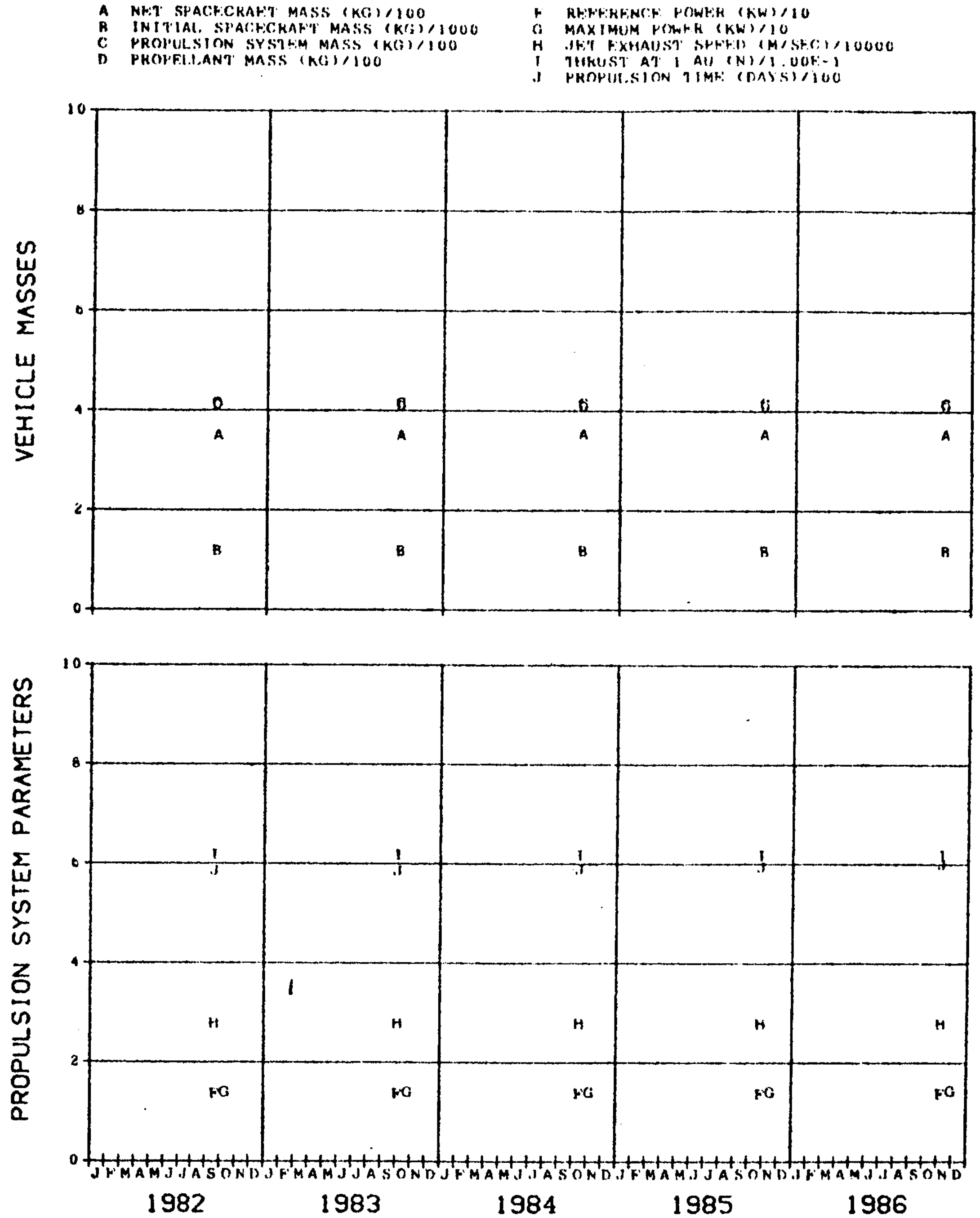

FIG. 18C. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

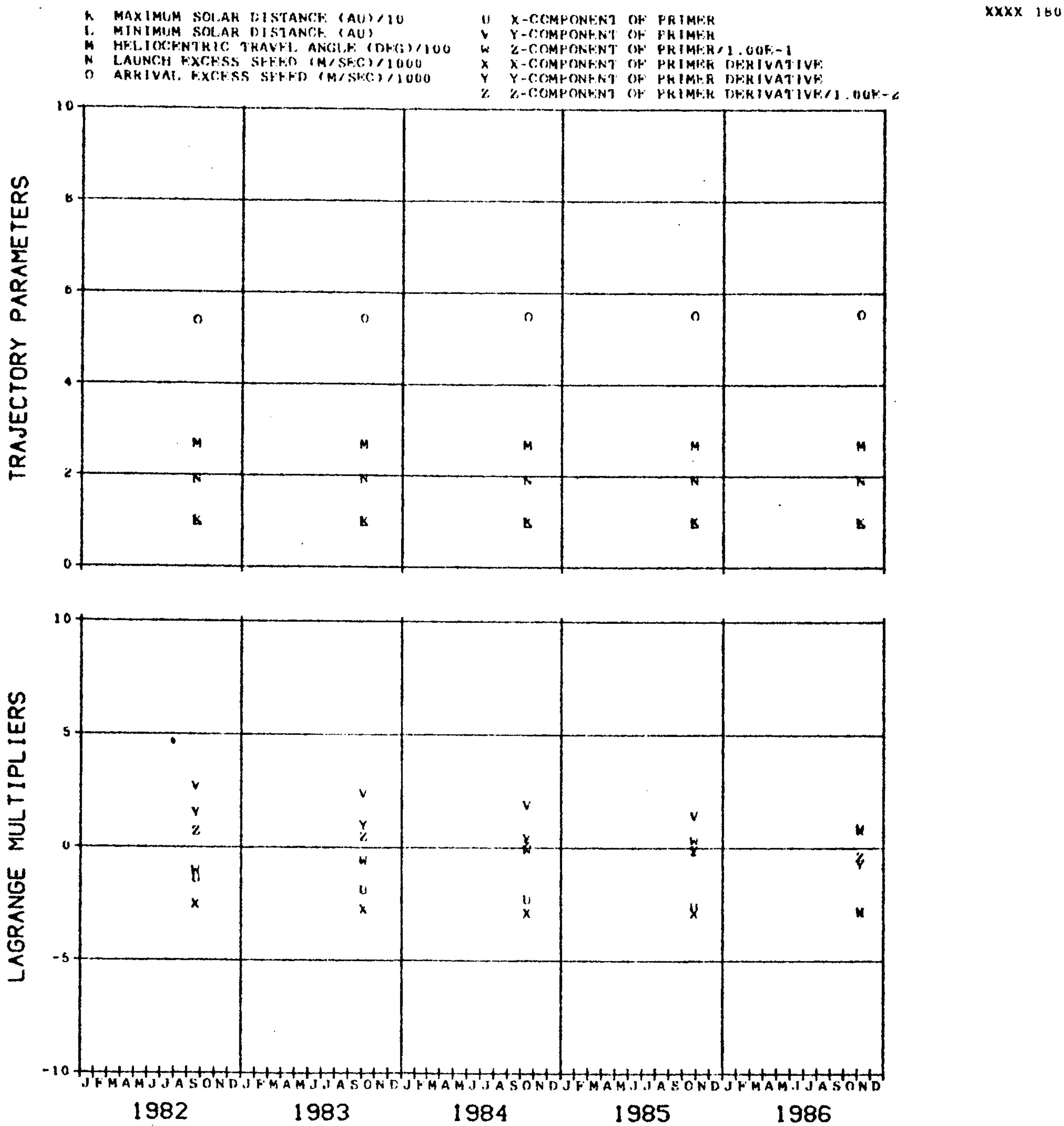

FIG. 18C. (CONCLUDED)

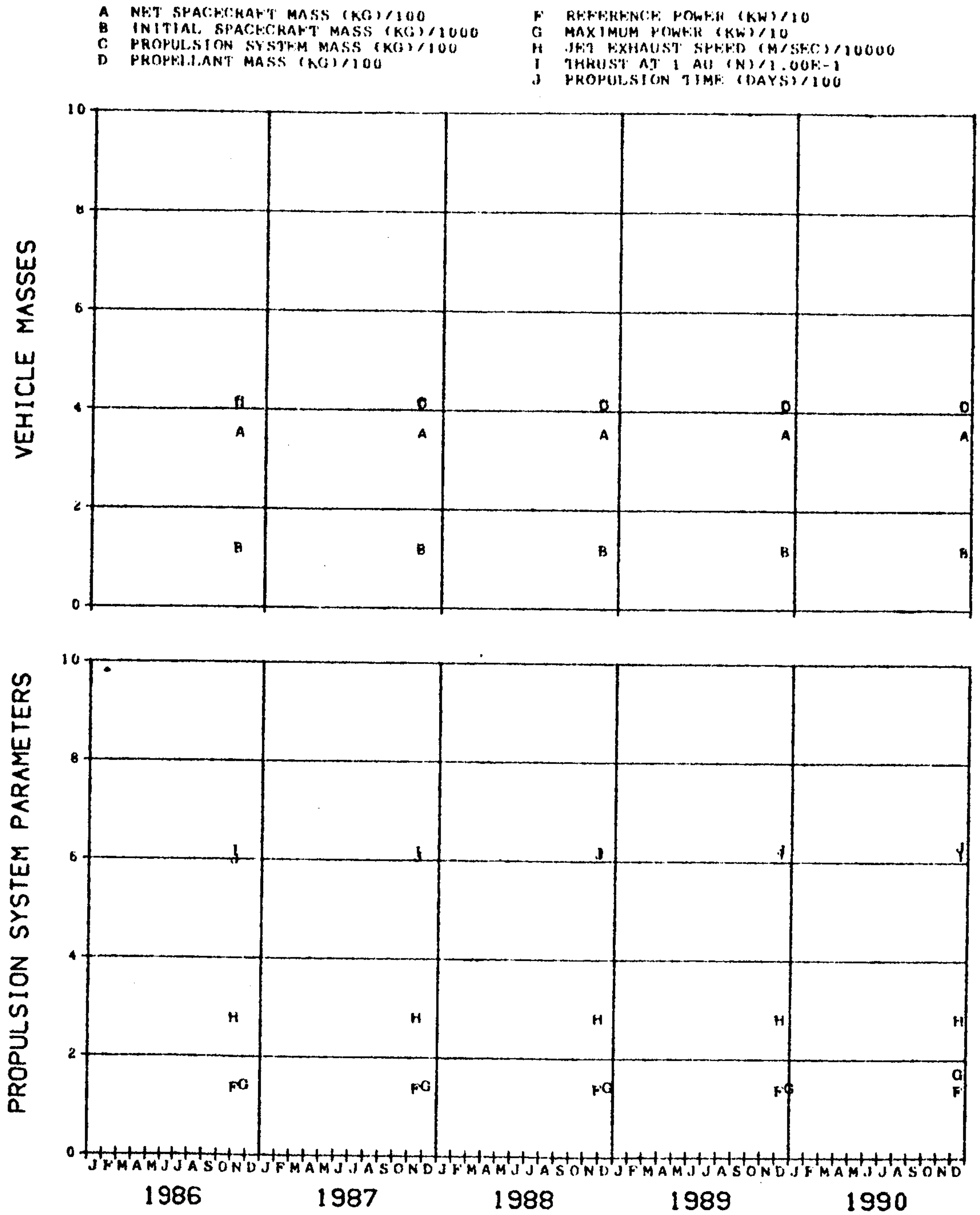

FIG. 18D. SATURN MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

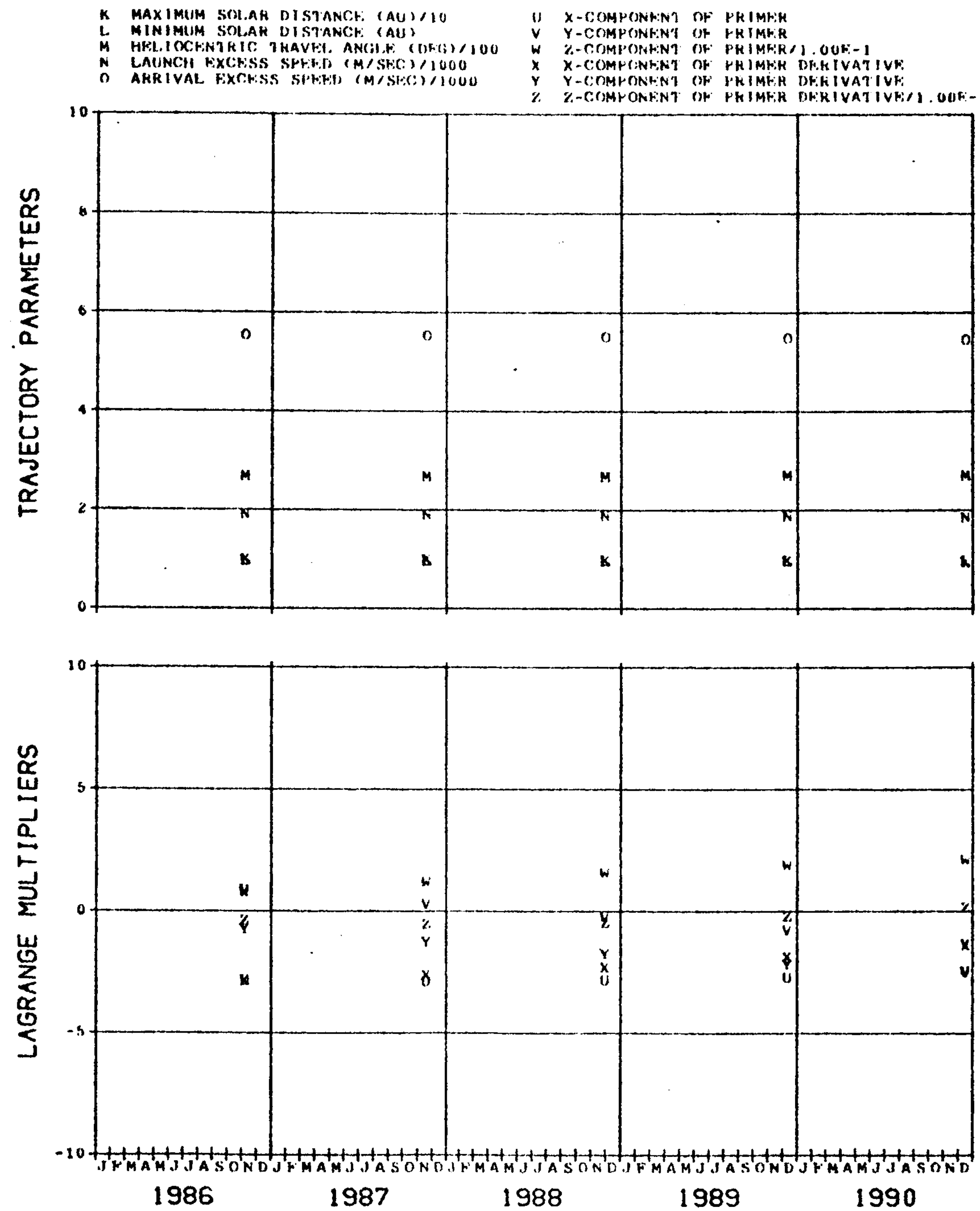

FIG. 18D. (CONCLUDED)

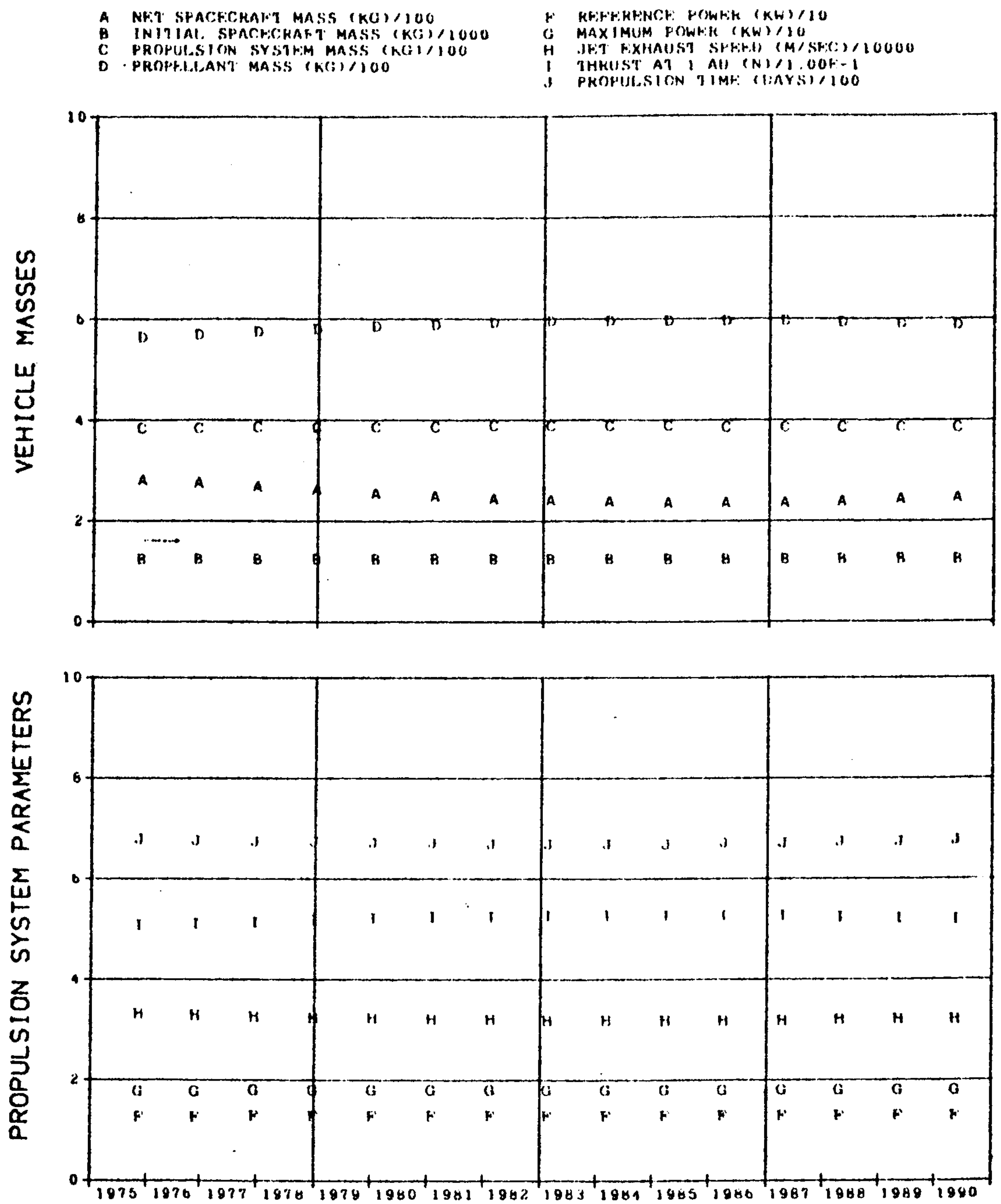

FIG. 19. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

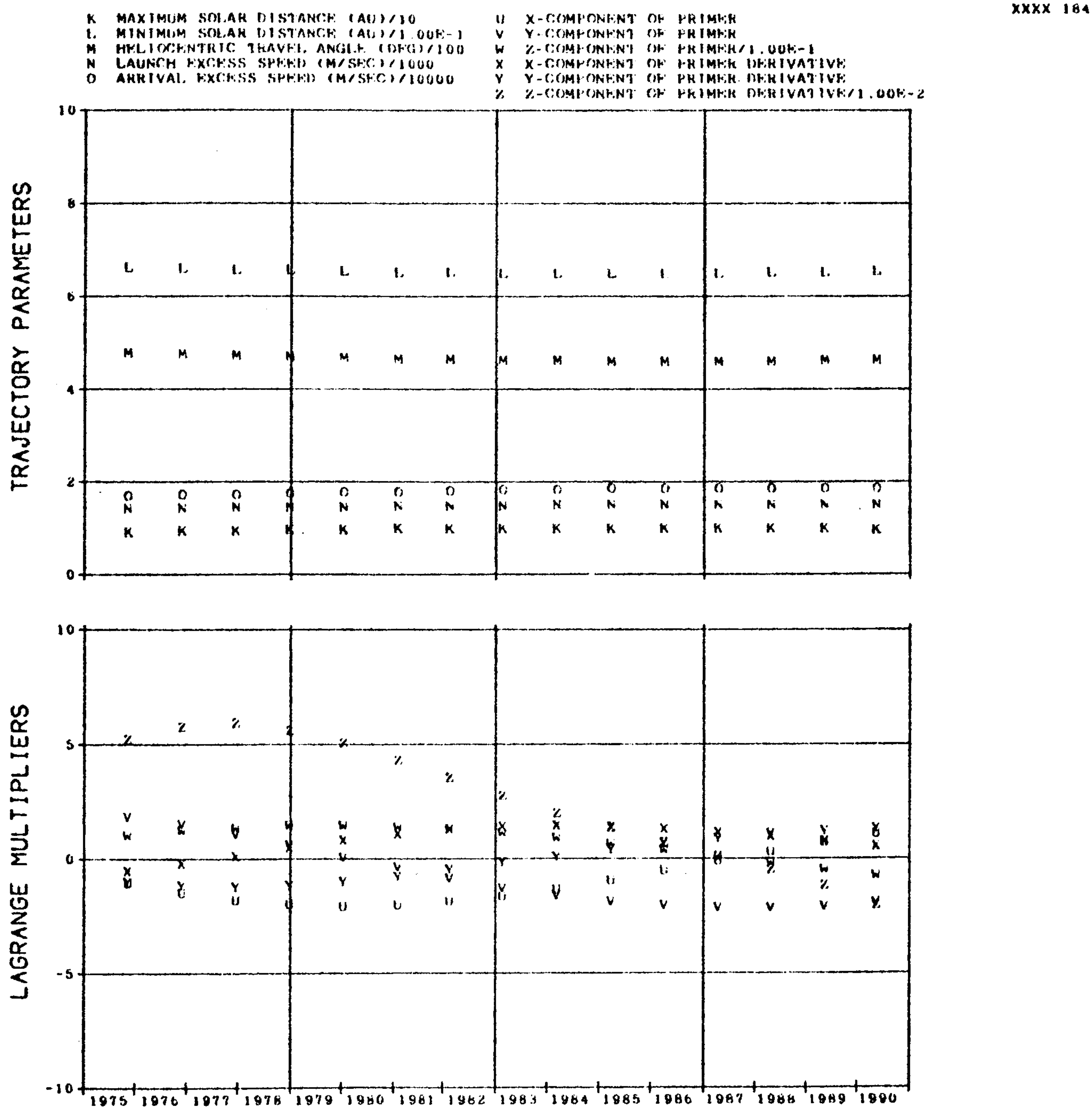

FIG. 19. (CONCLUDED)

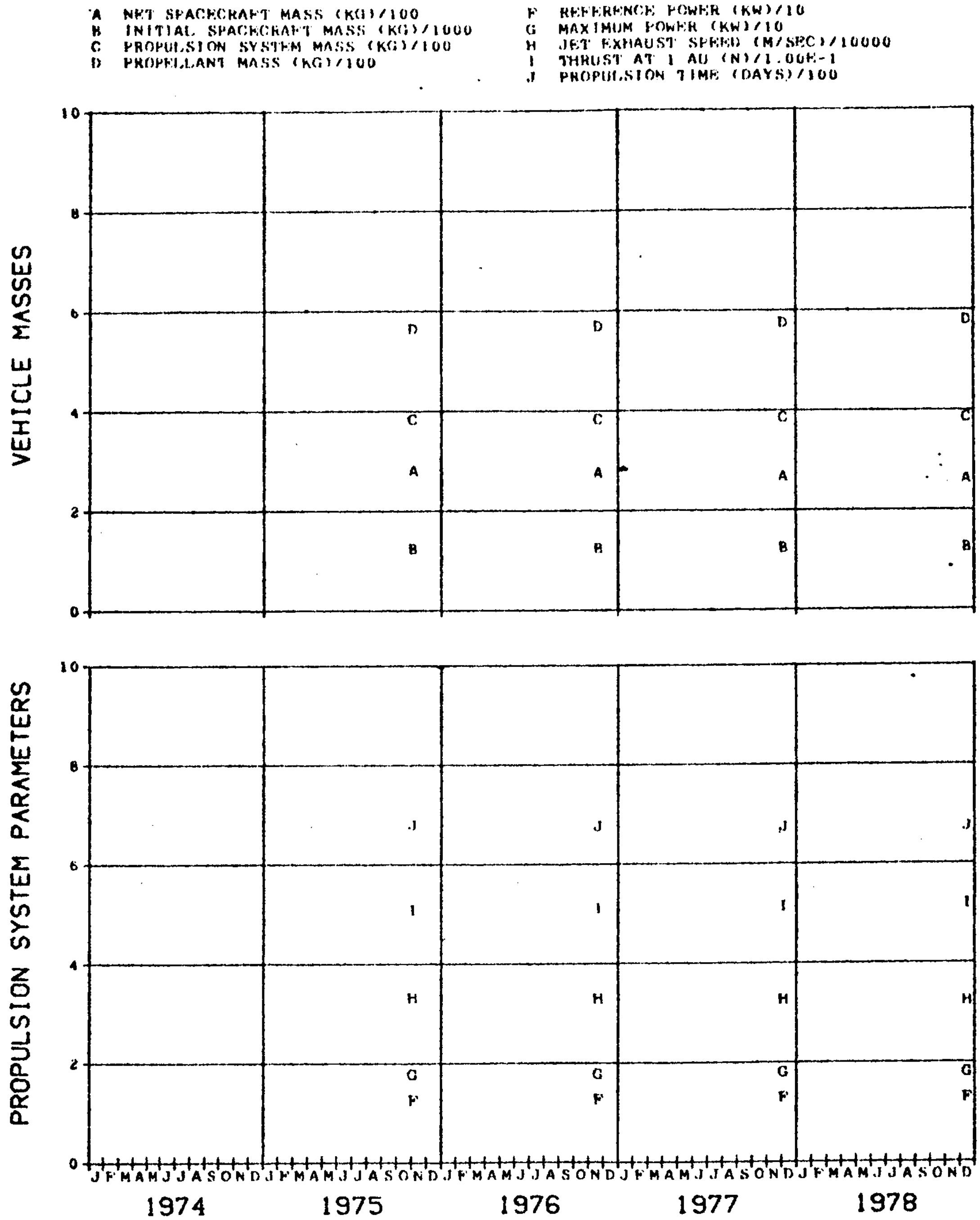

FIG. 19A. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

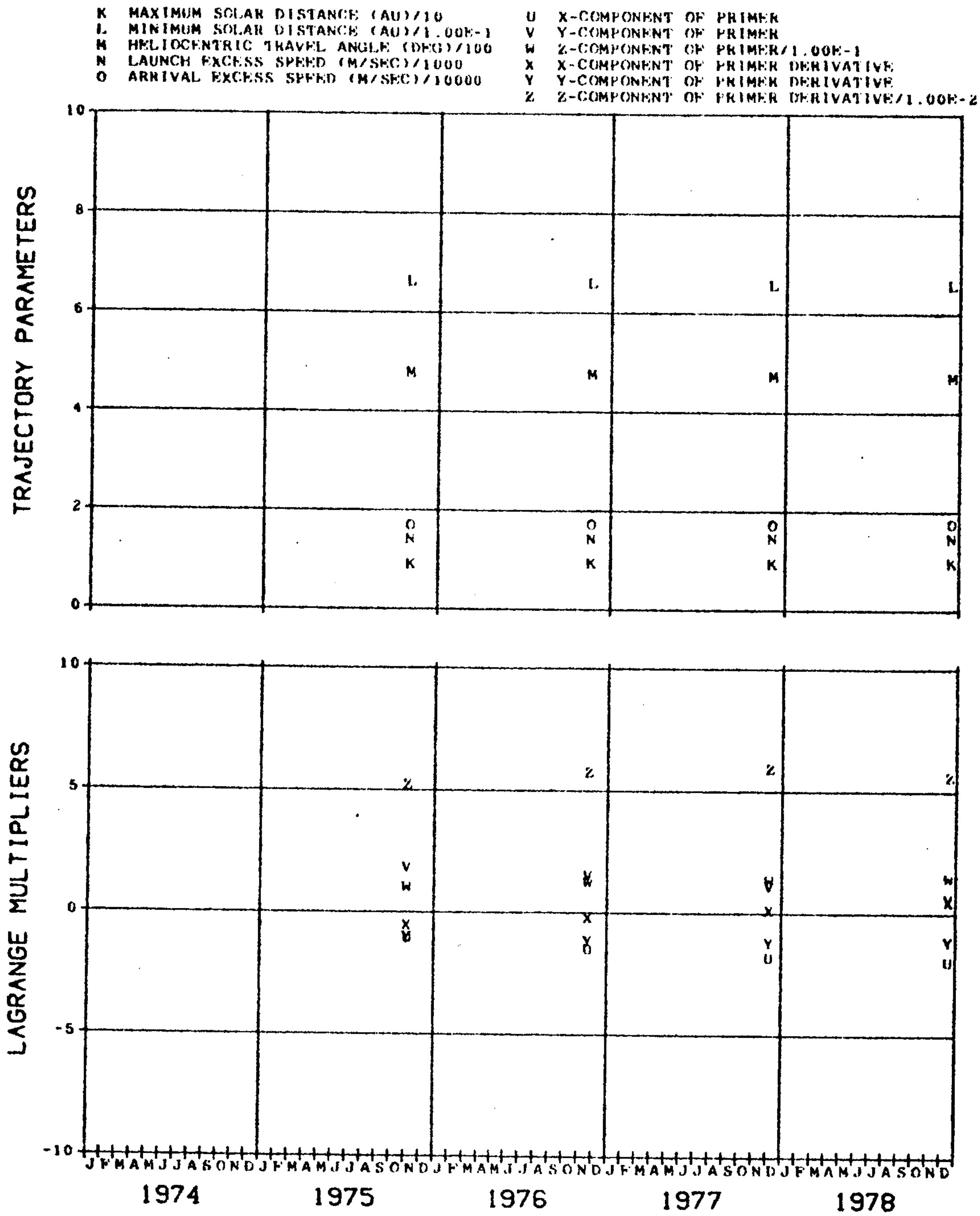

FIG. 19A. (CONCLUDED)

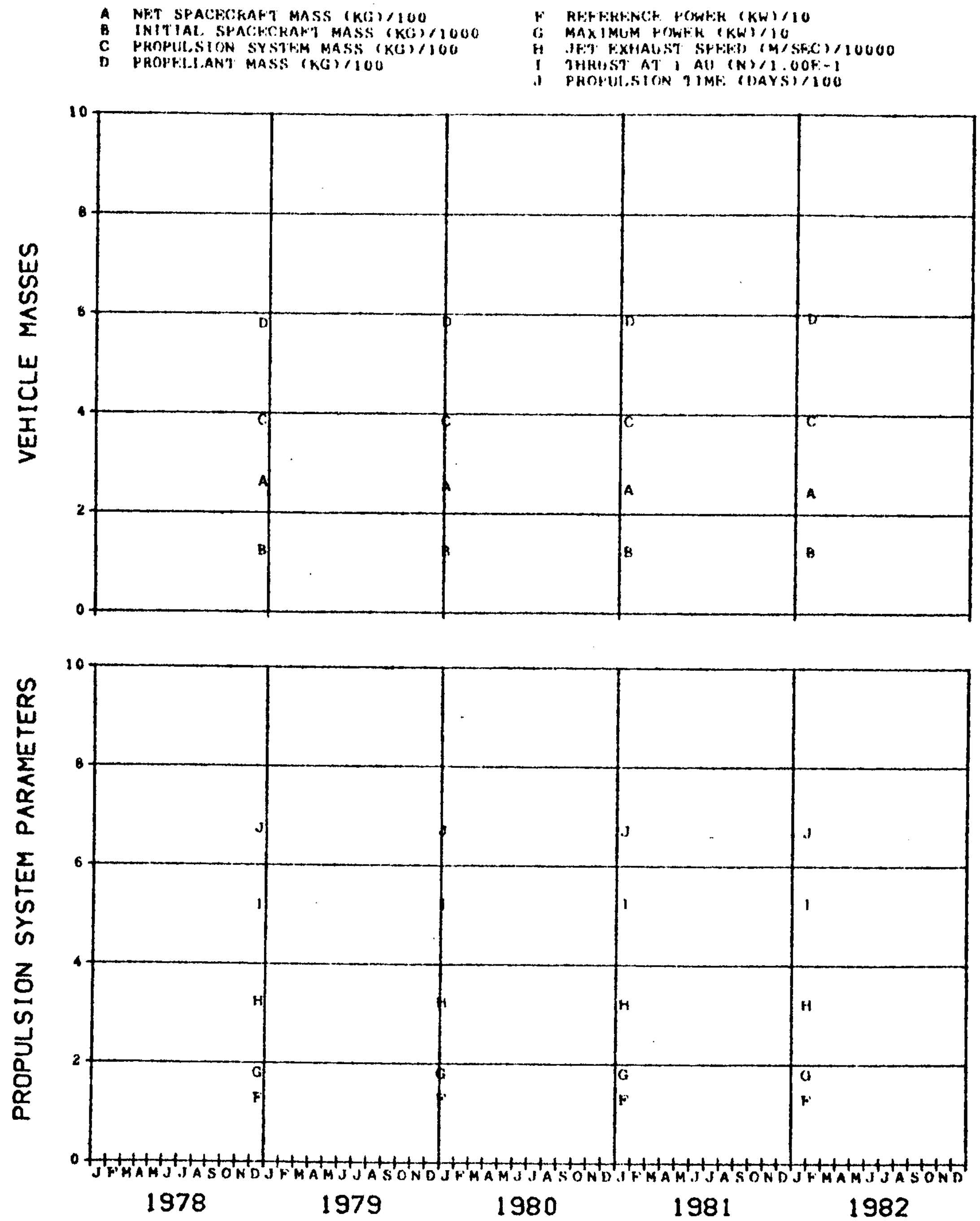

FIG. 19B. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

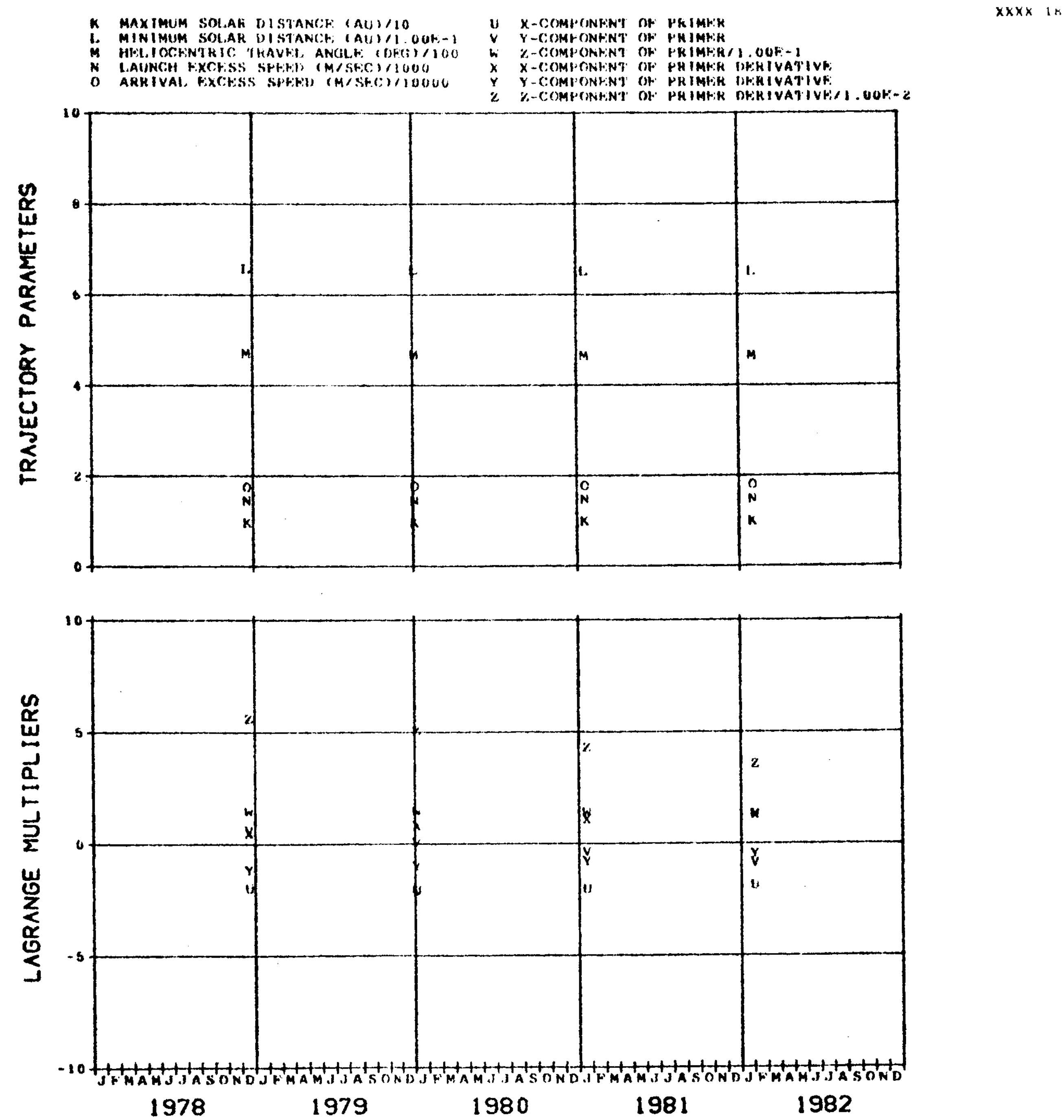

FIG. 19B. (CONCLUDED)

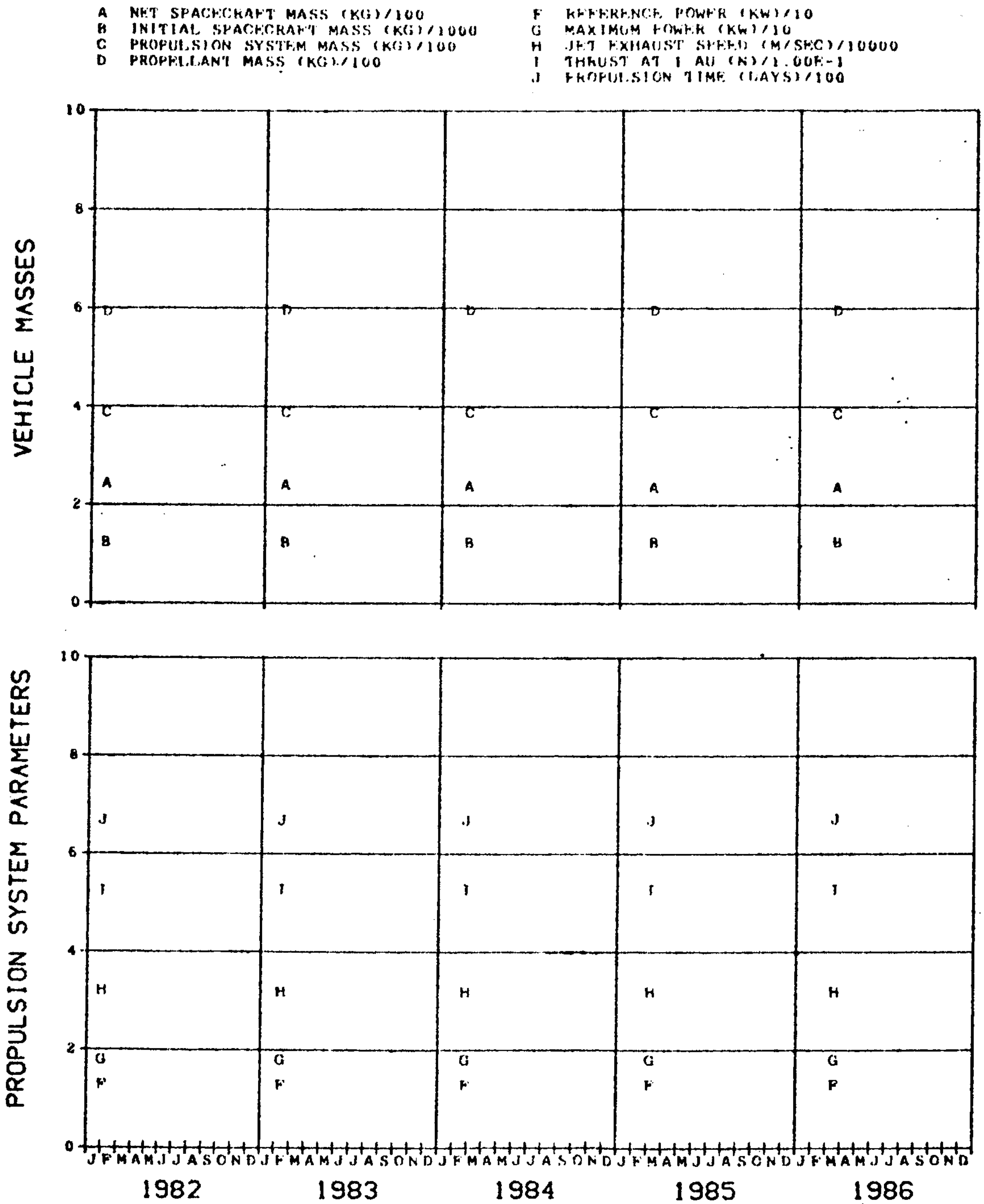

FIG. 19C. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

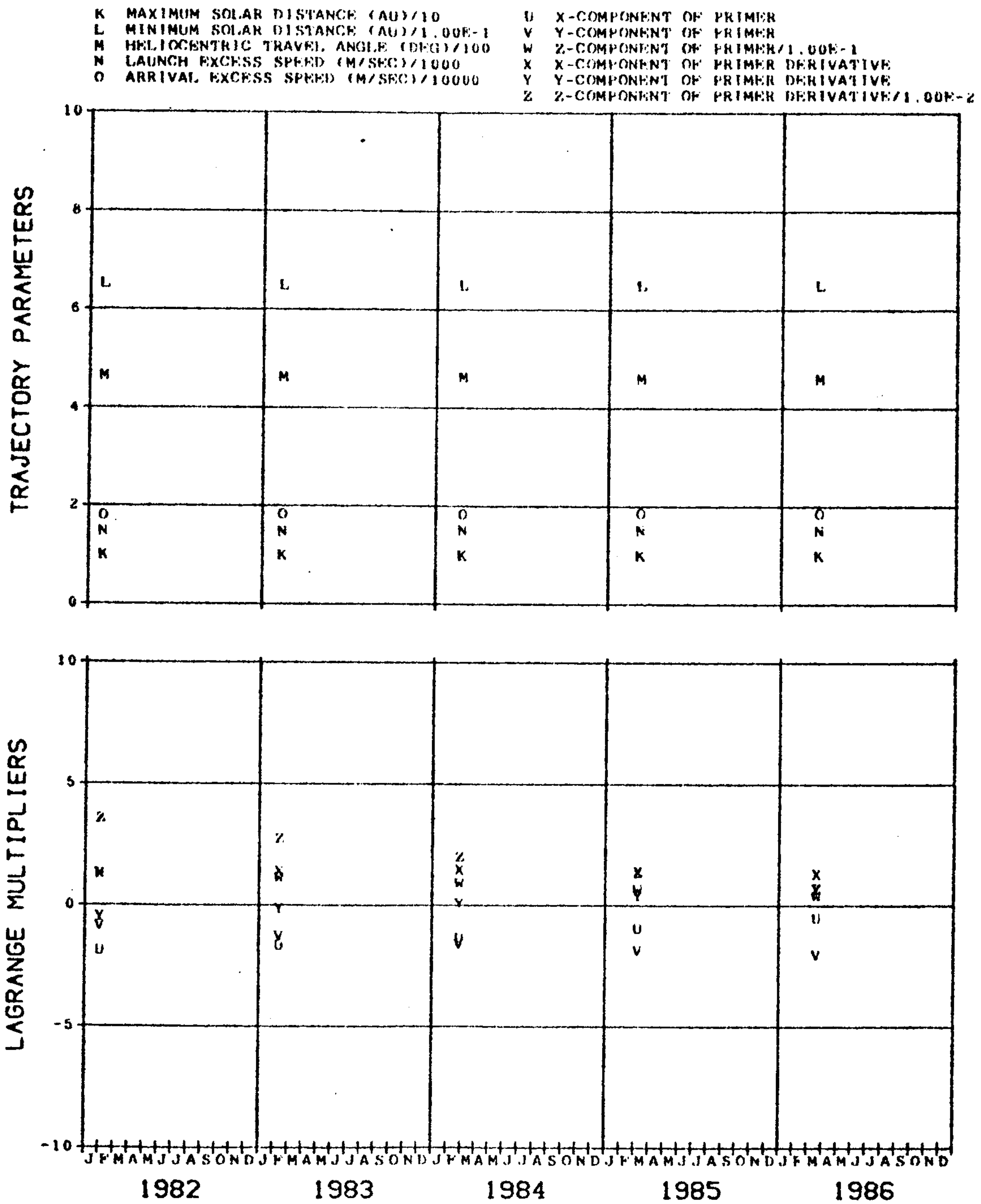

FIG. 19C. (CONCLUDED)

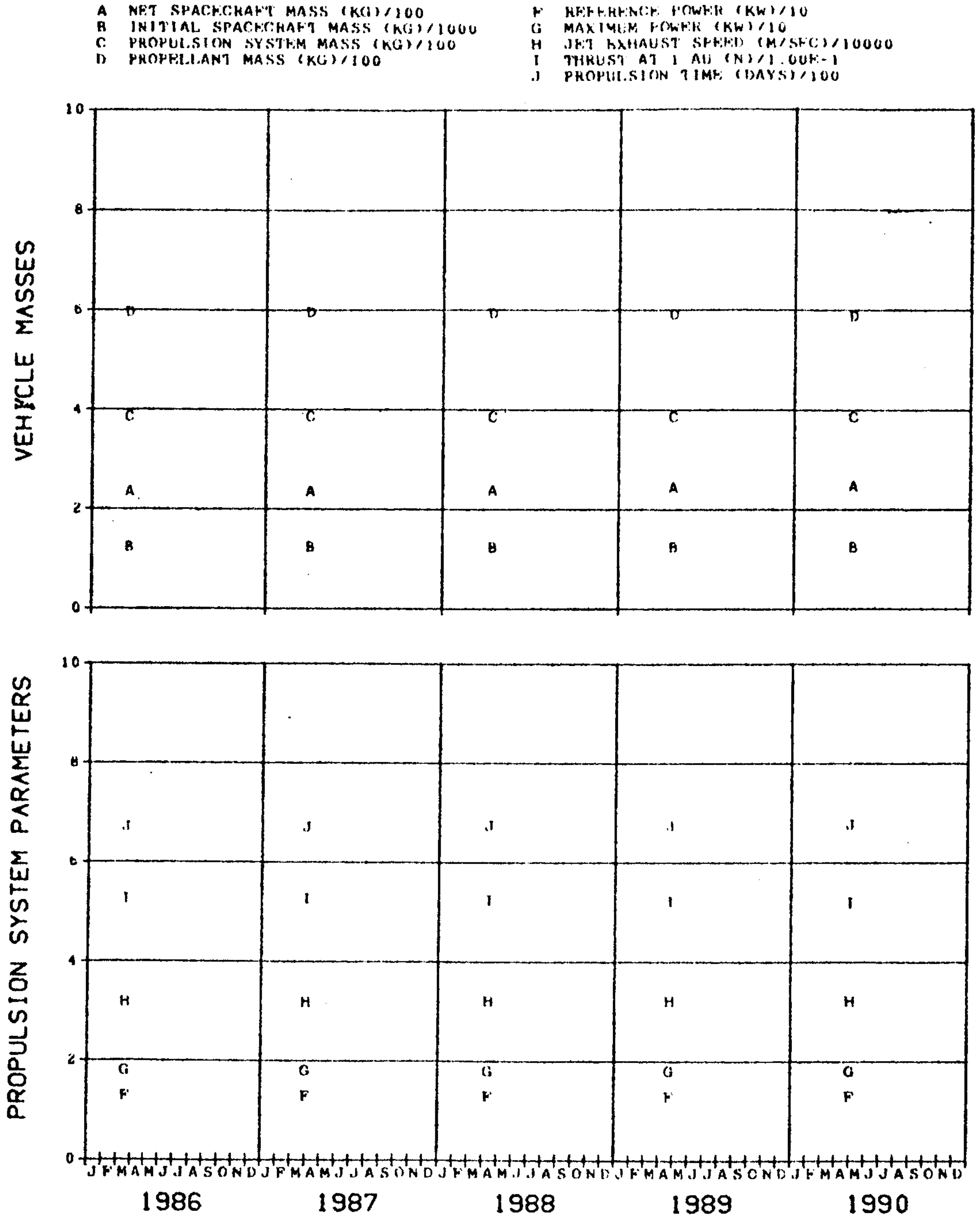

FIG. 19D. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 1200 DAYS

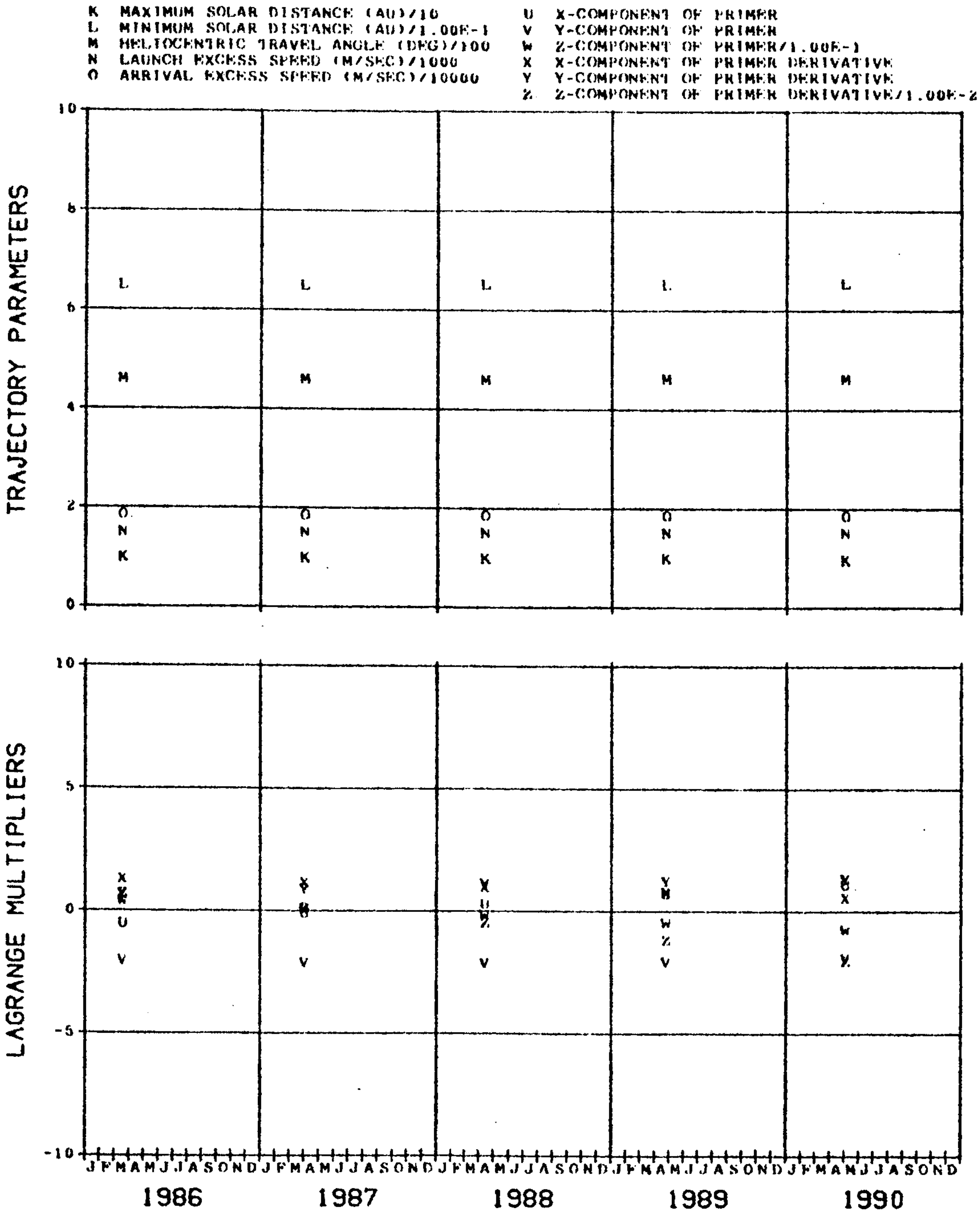

FIG. 19D. (CONCLUDED)

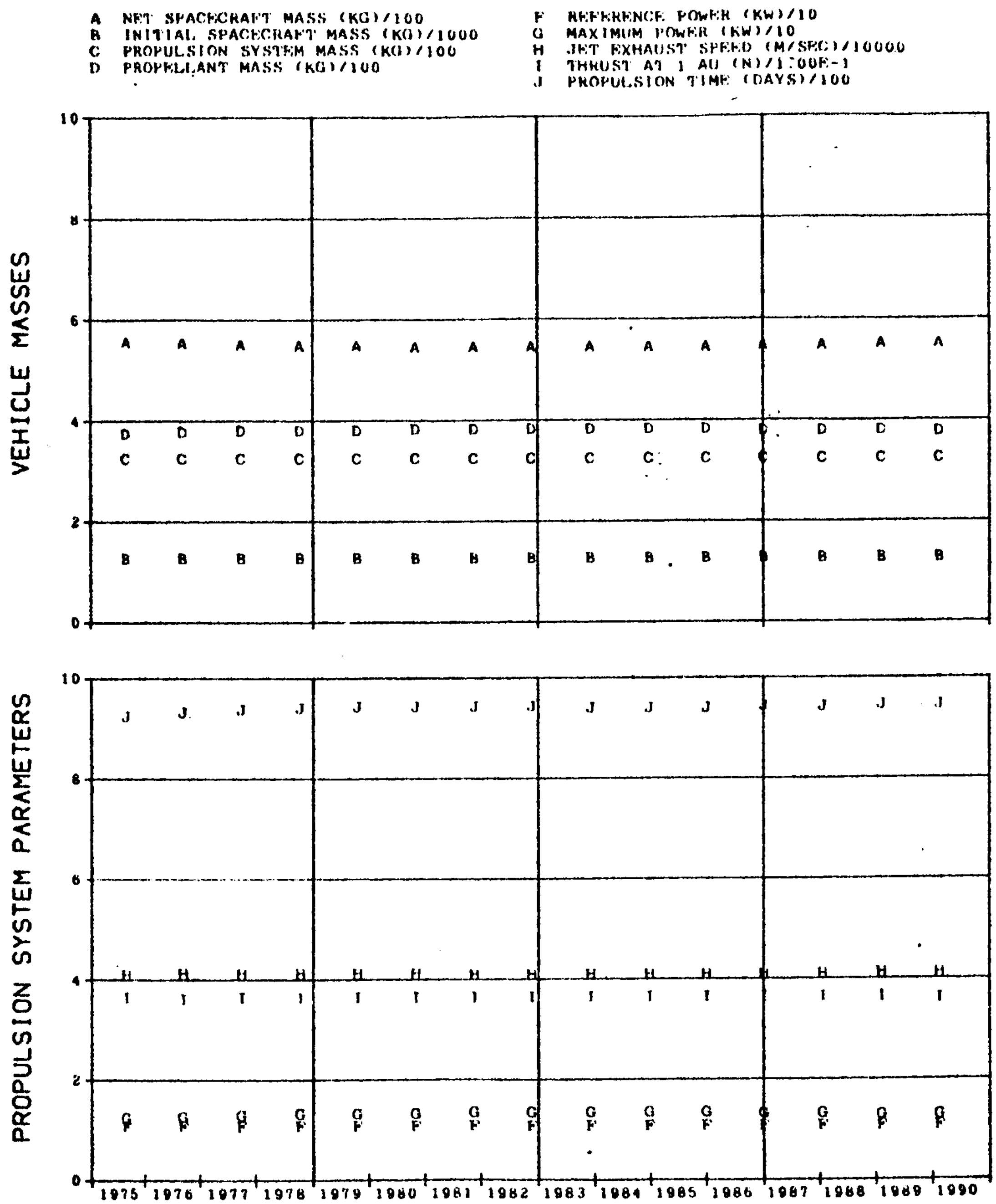

FIG. 20. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

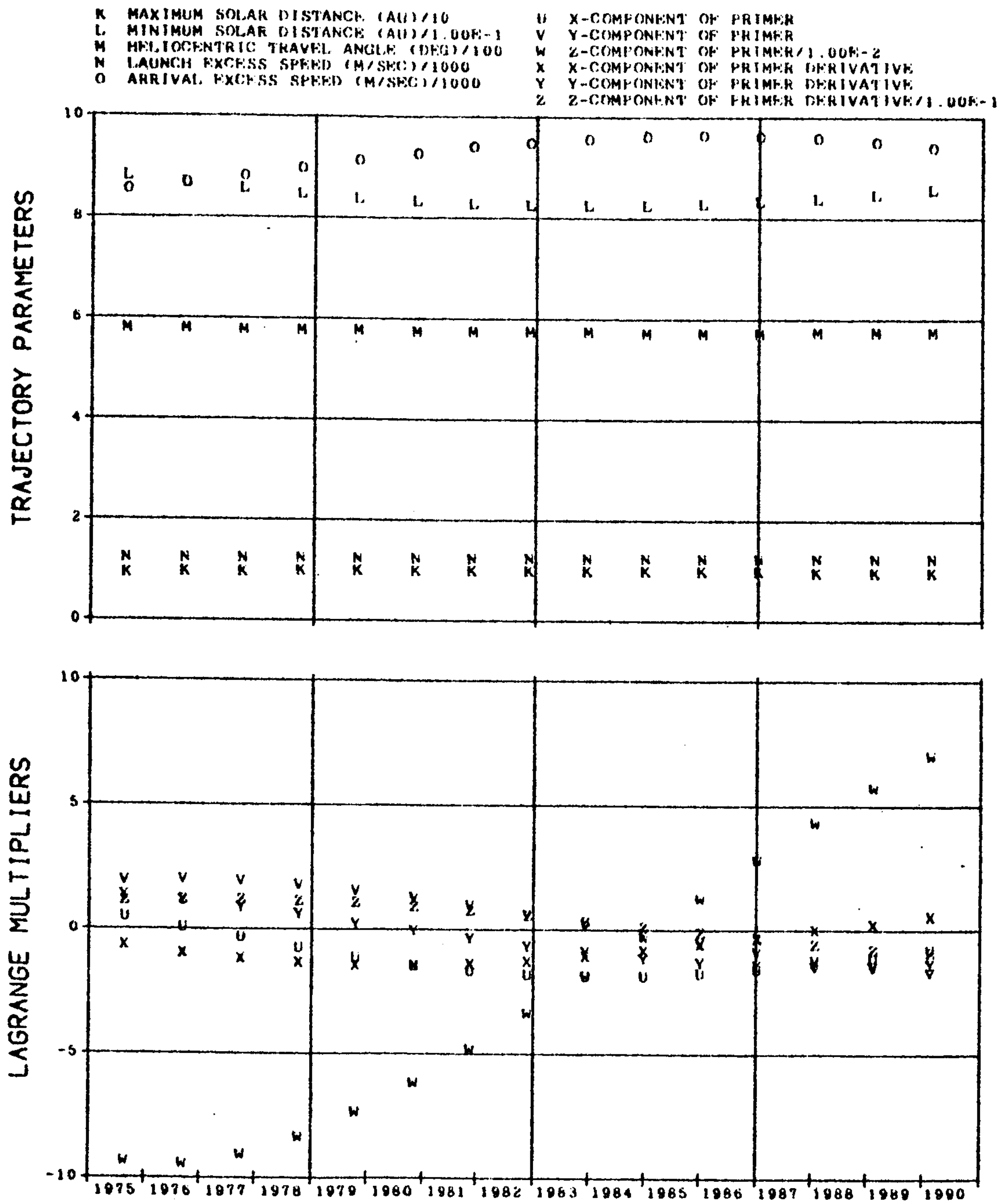

FIG. 20. (CONCLUDED)

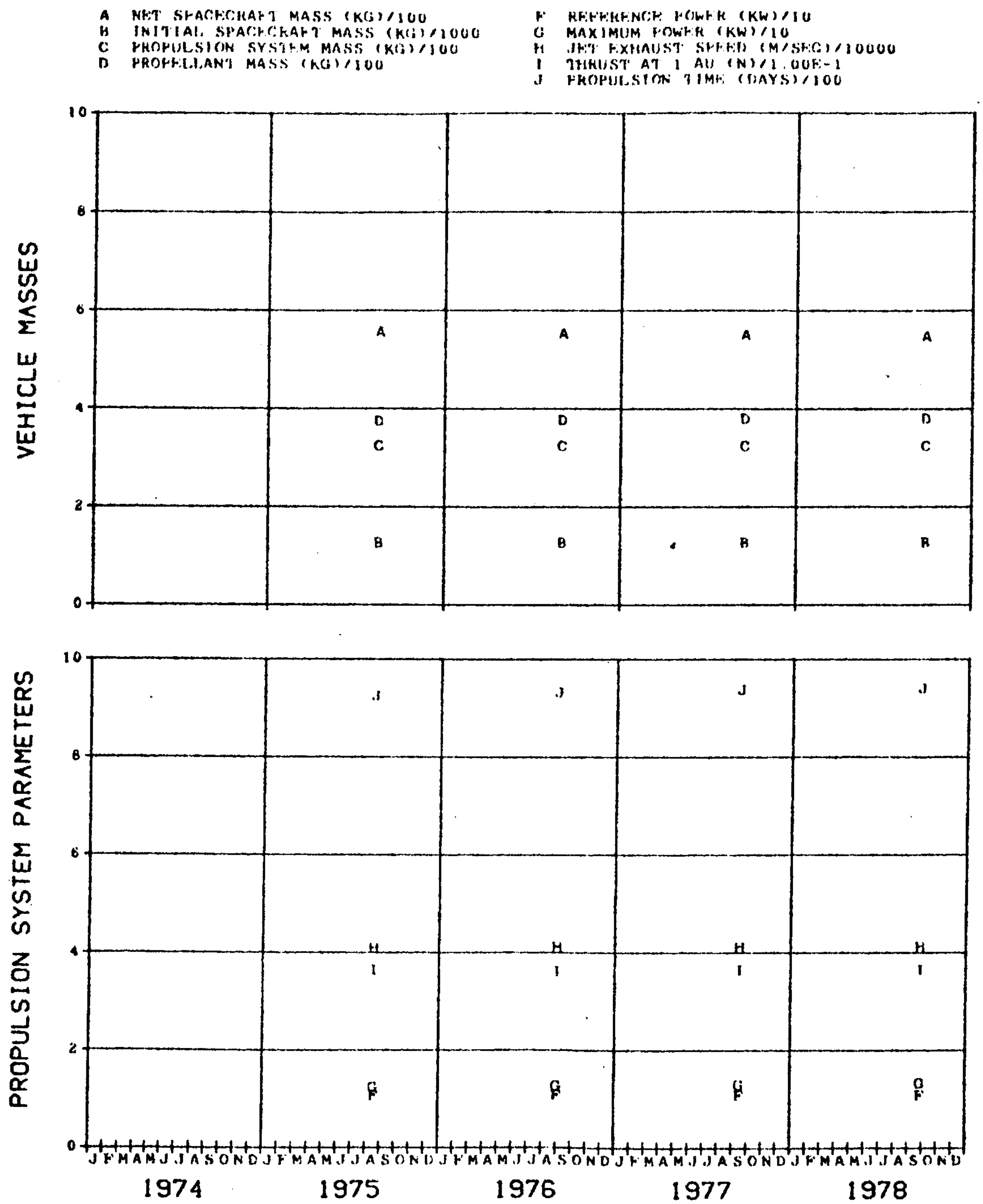

FIG. 20A. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

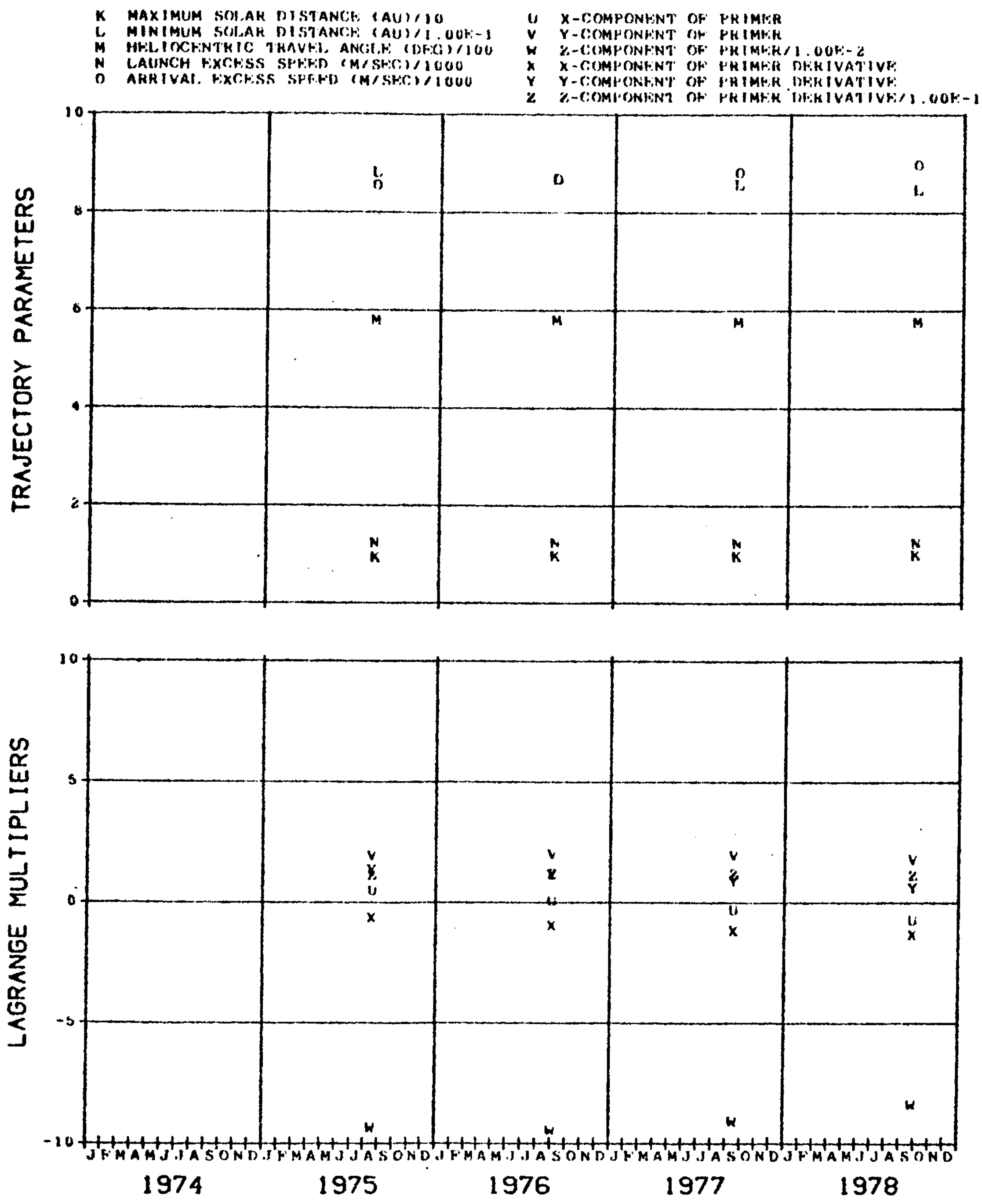

FIG. 20A. (CONCLUDED)

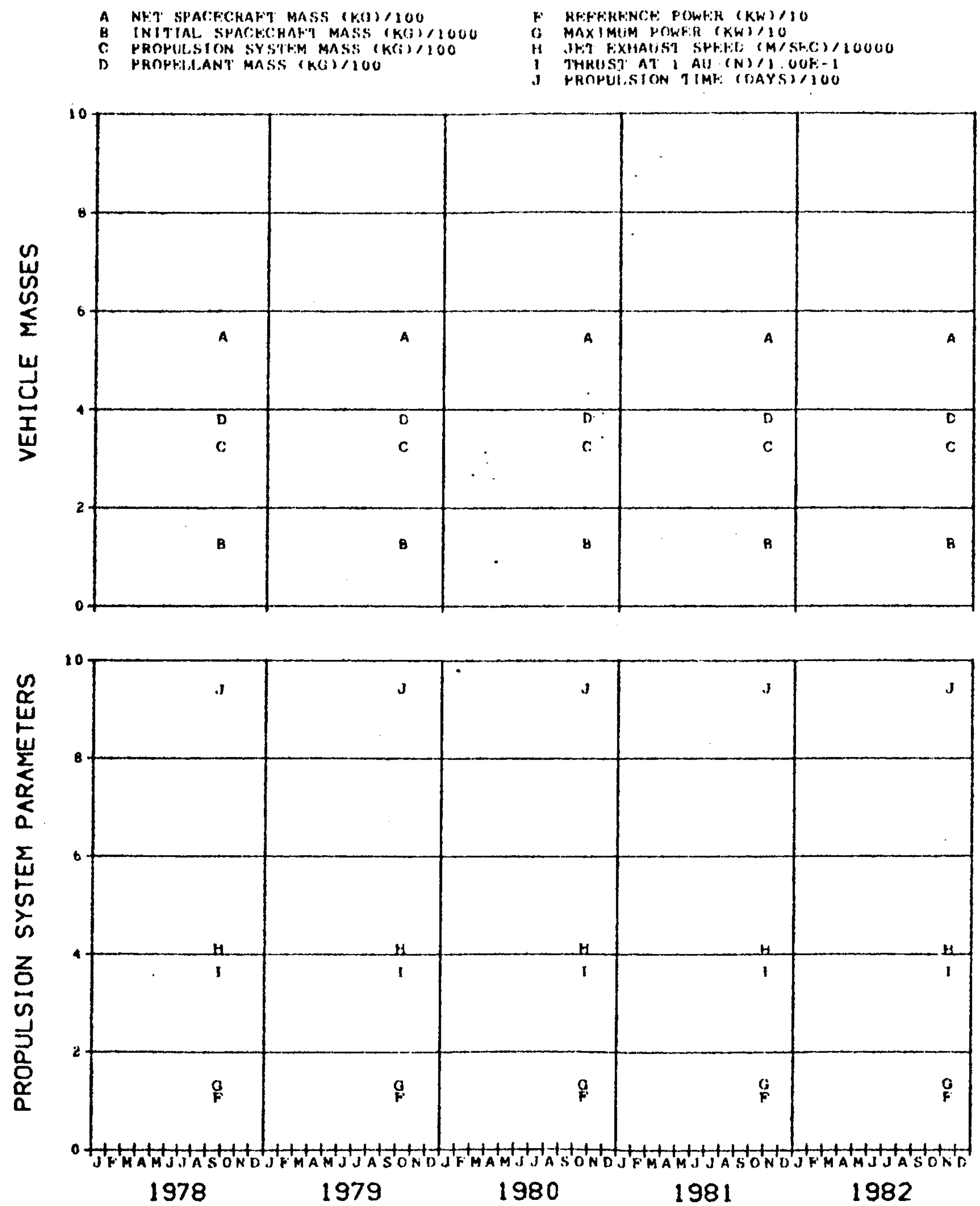

FIG. 20B. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

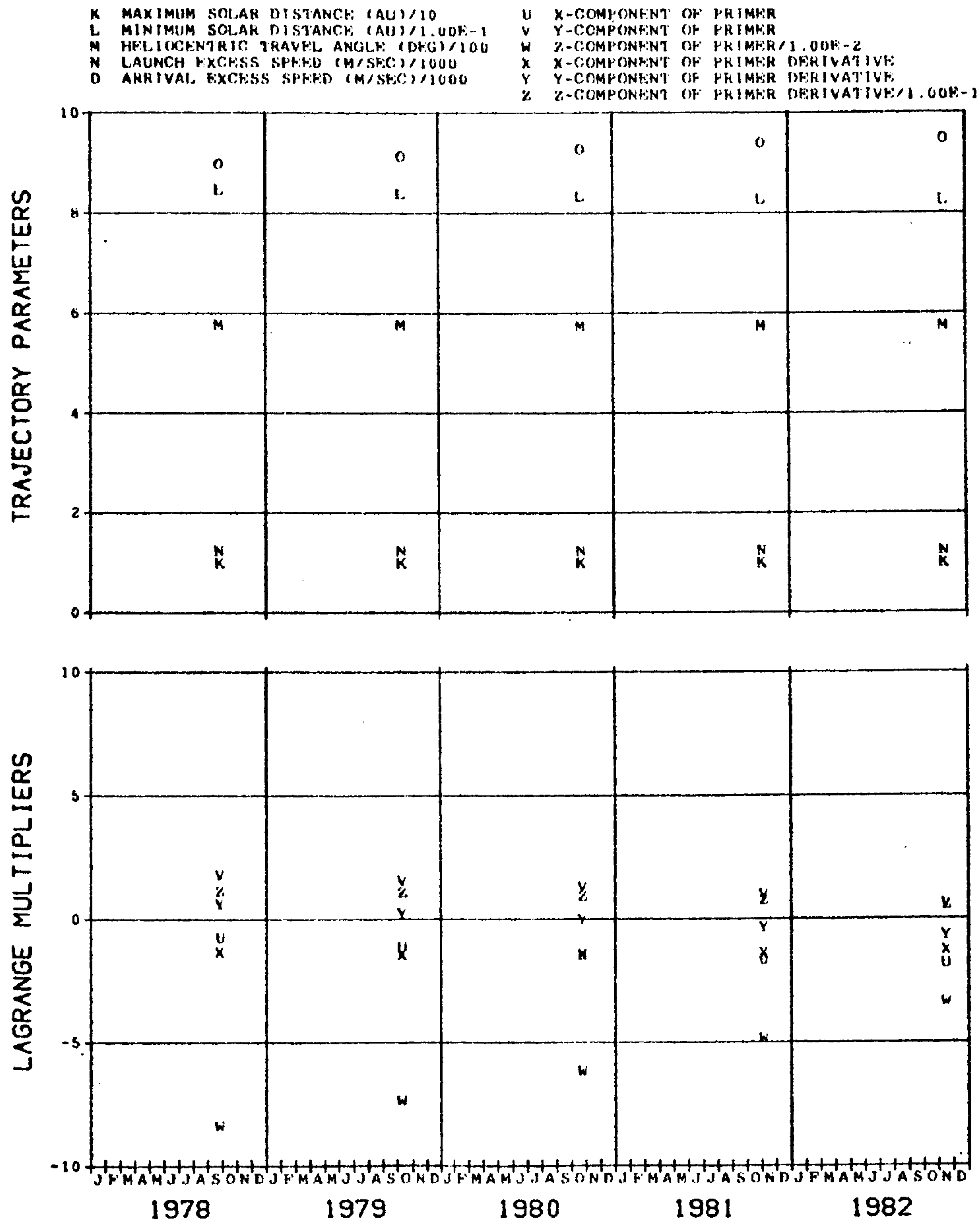

FIG. 20B. (CONCLUDED)

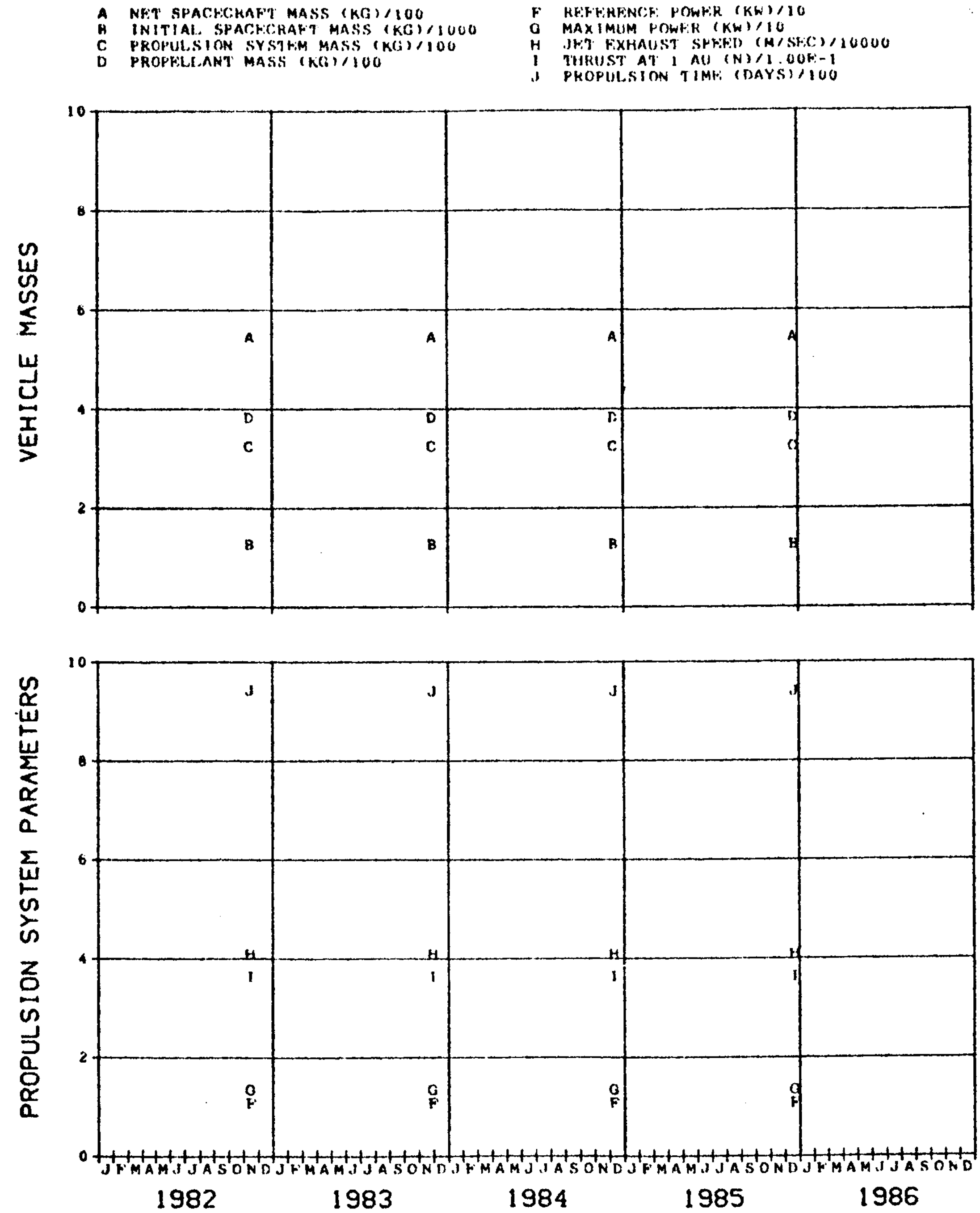

FIG. 20C. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

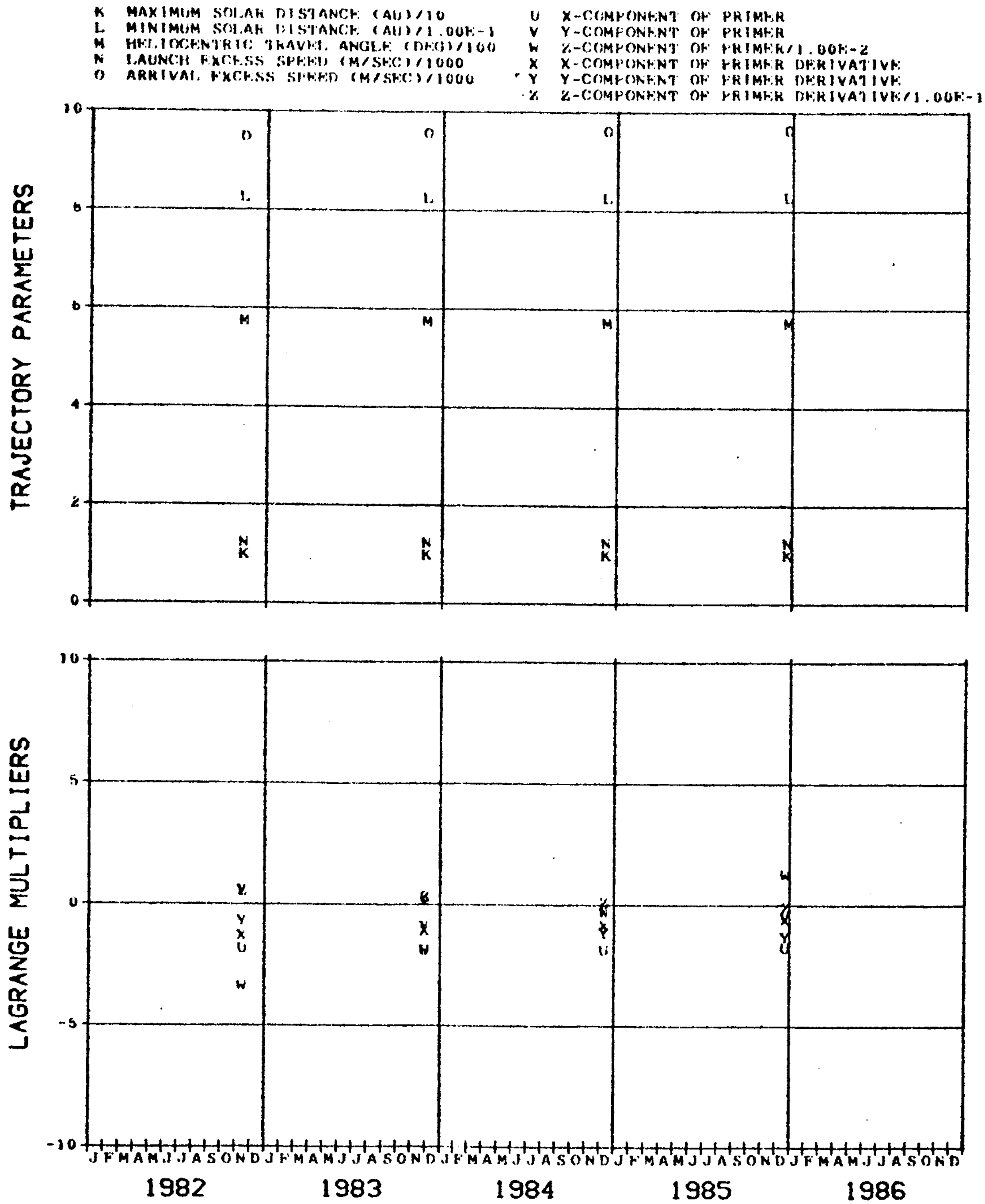

FIG. 20C. (CONCLUDED)

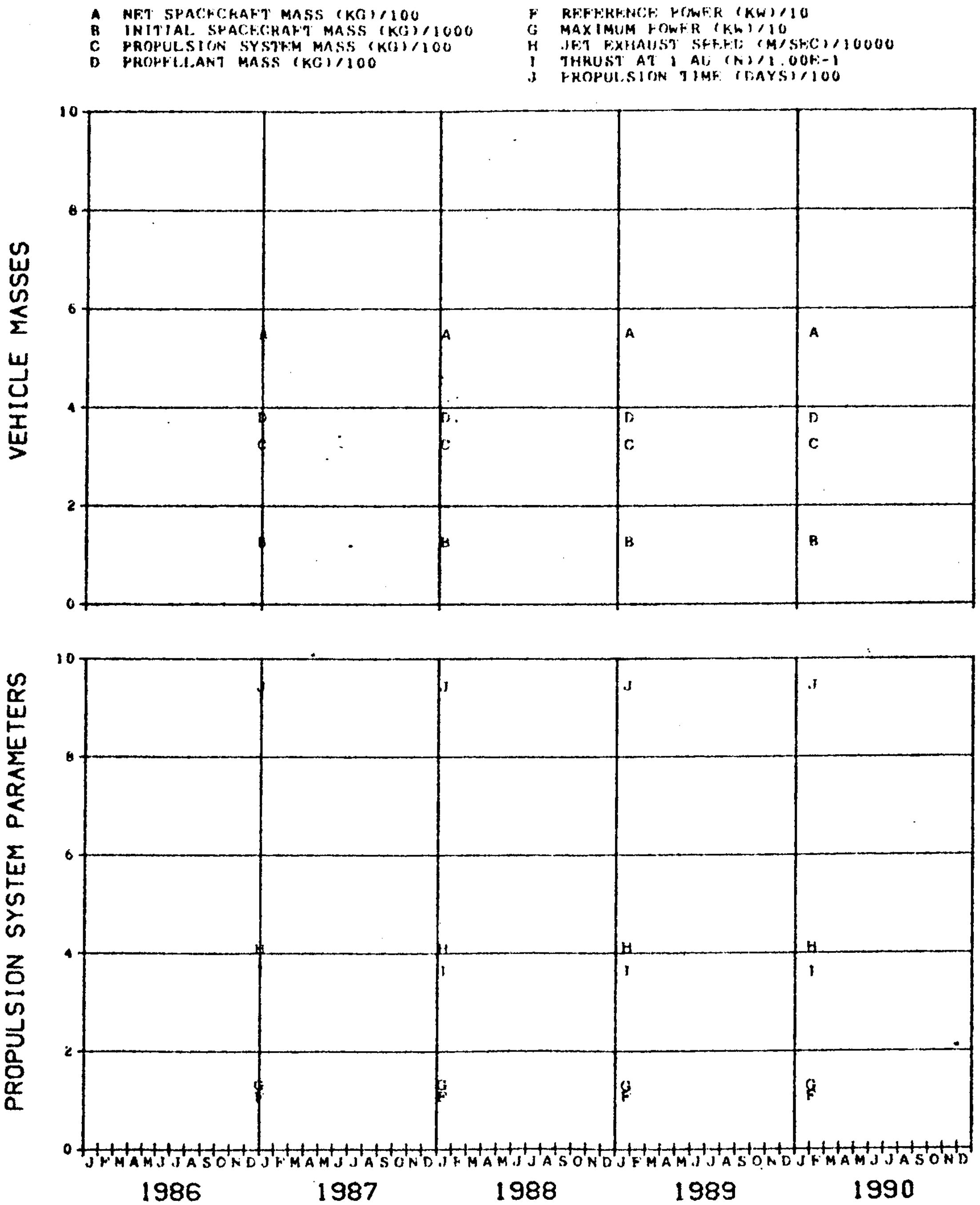

FIG. 20D. SATURN MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

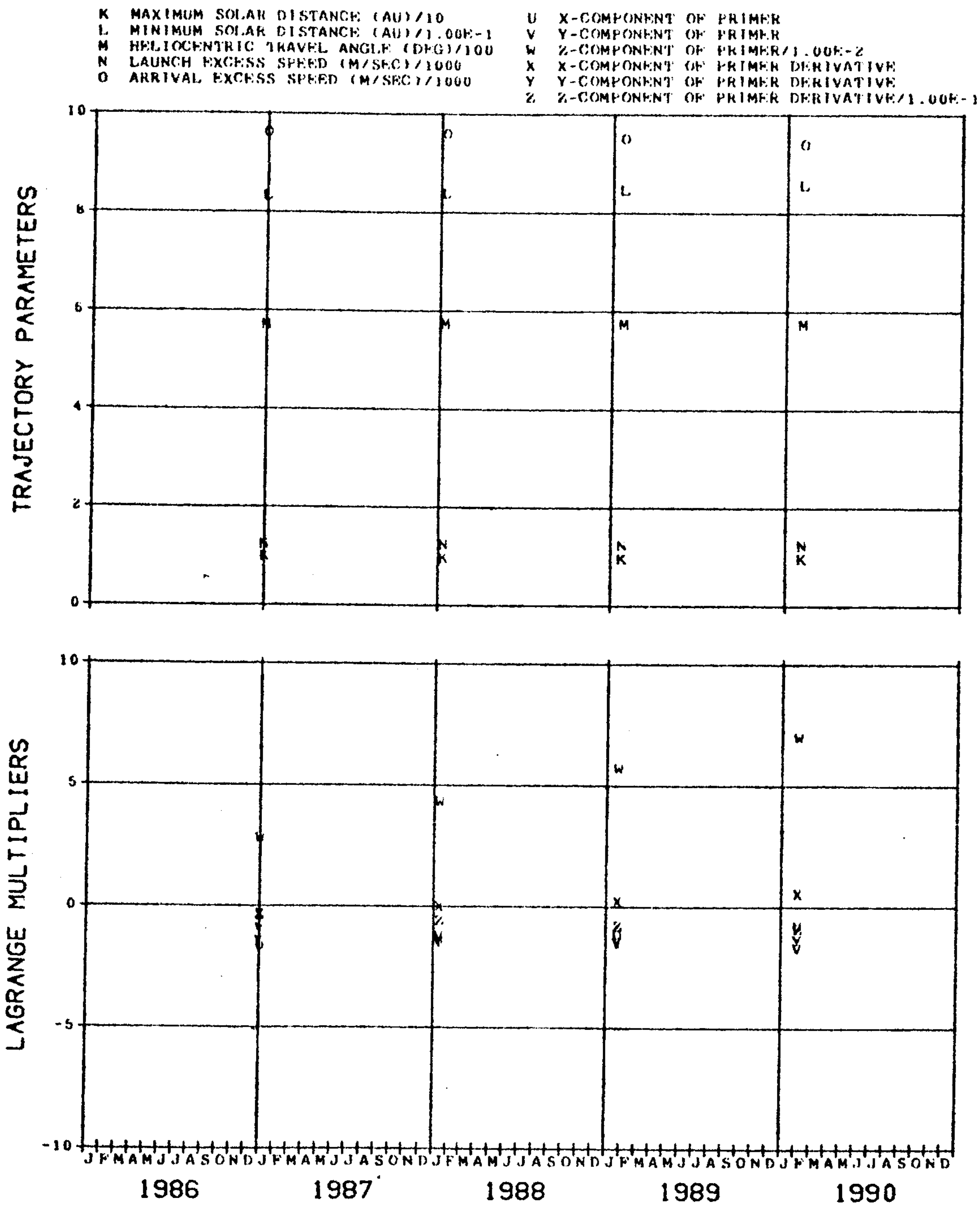

FIG. 20D. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/10
B INITIAL SPACECRAFT MASS (KG)/100
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

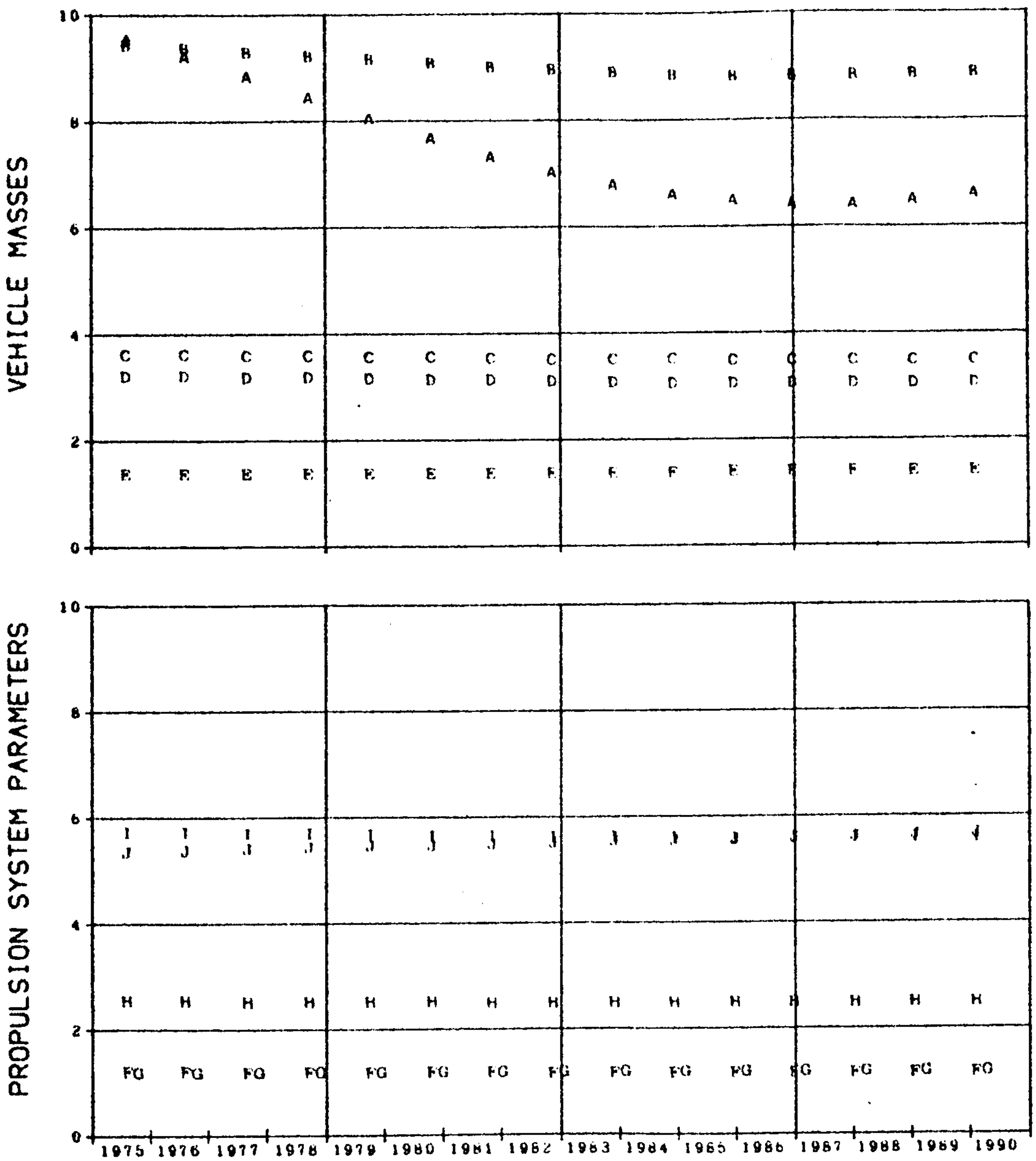

FIG. 21. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1200 DAYS

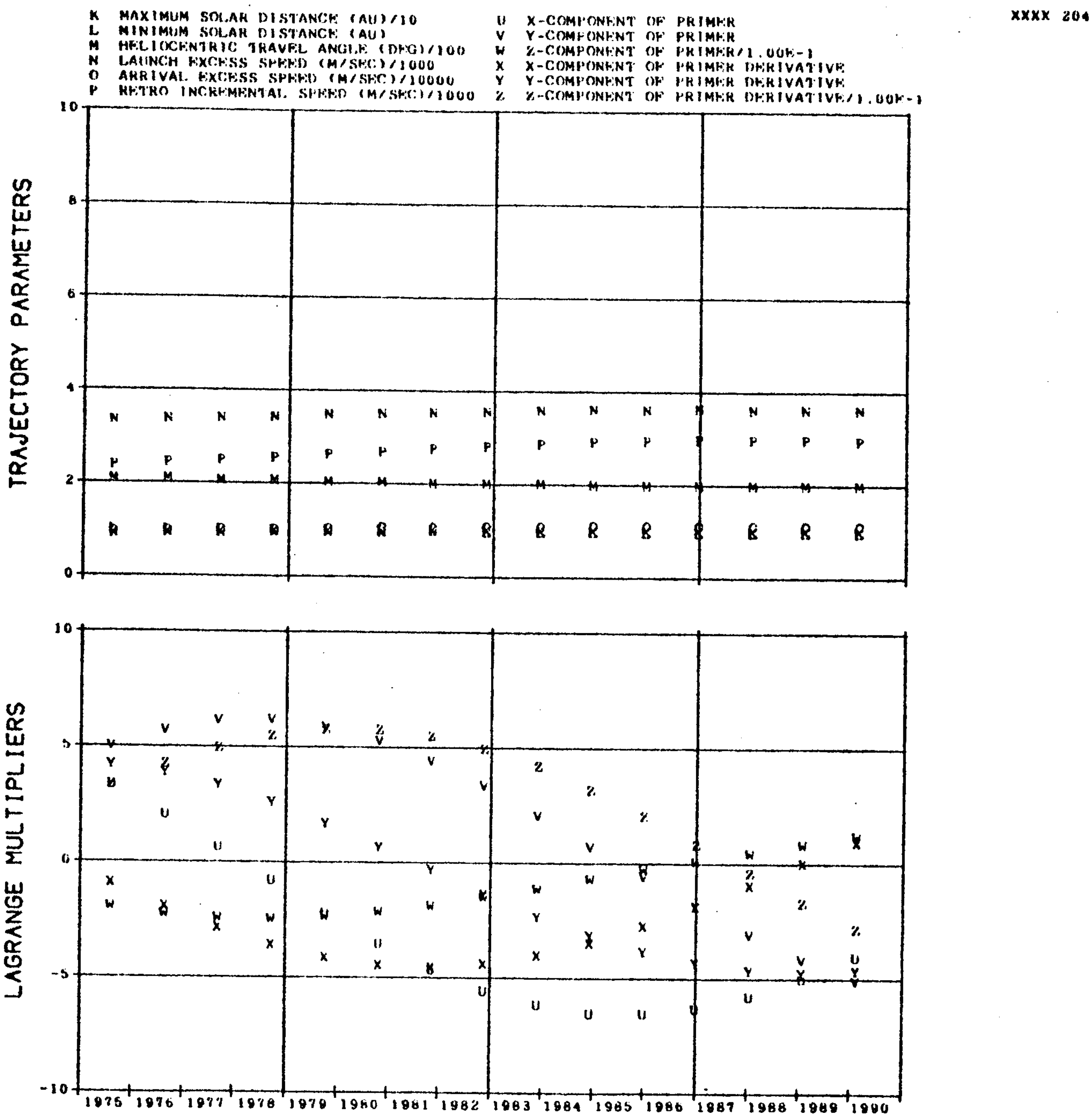

FIG. 21. (CONCLUDED)

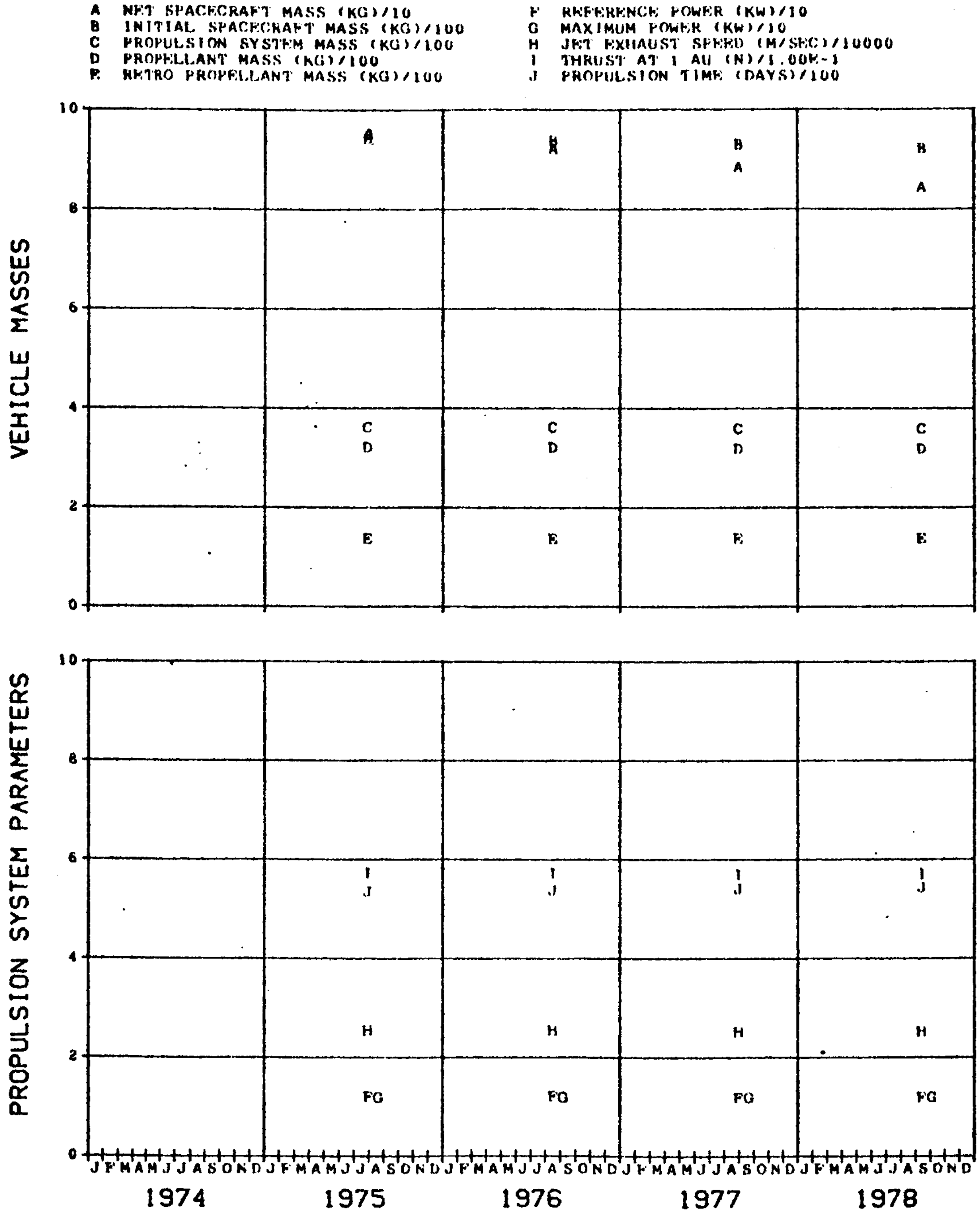

FIG. 21A. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1200 DAYS

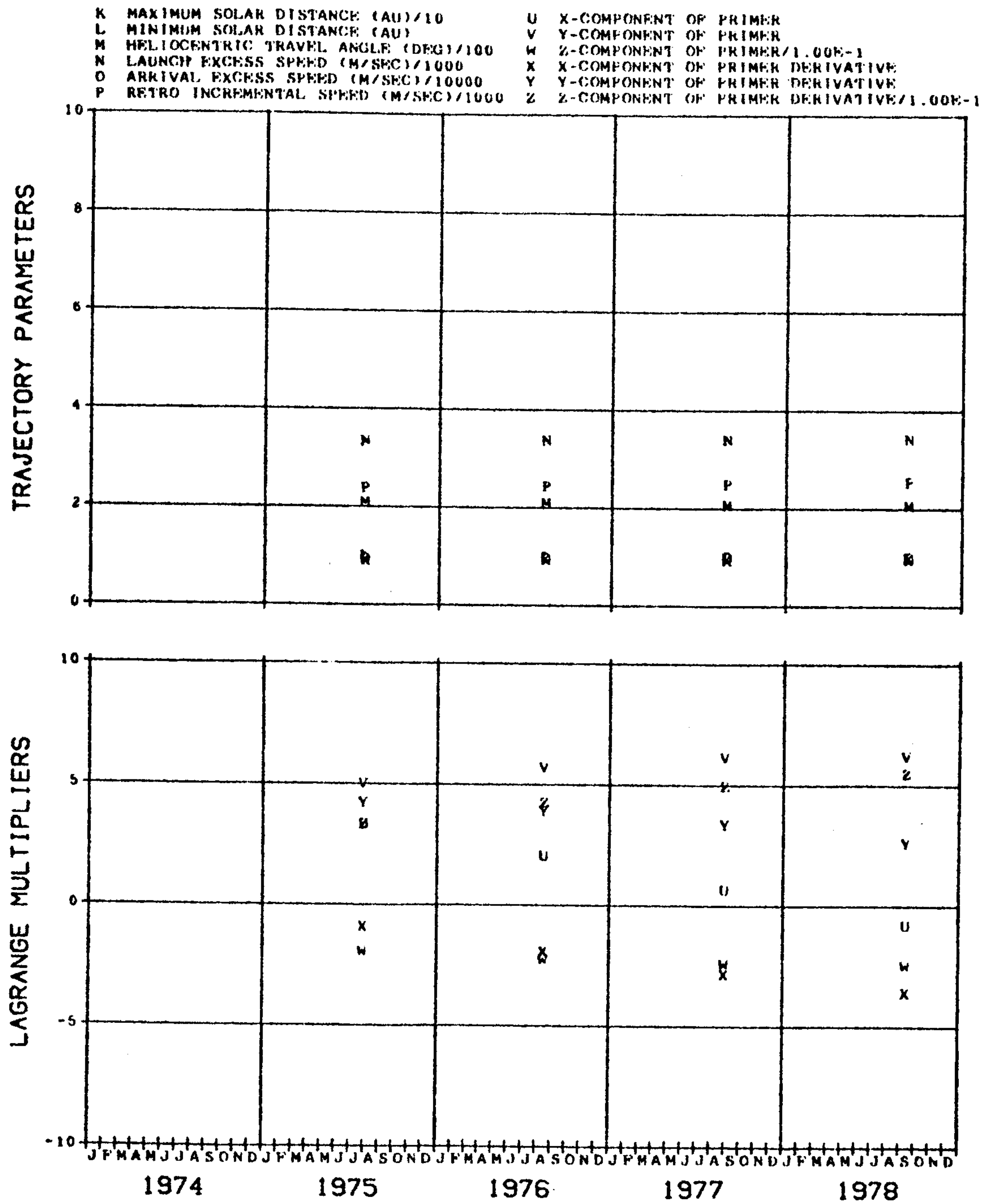

FIG. 21A. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/10
B INITIAL SPACECRAFT MASS (KG)/100
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

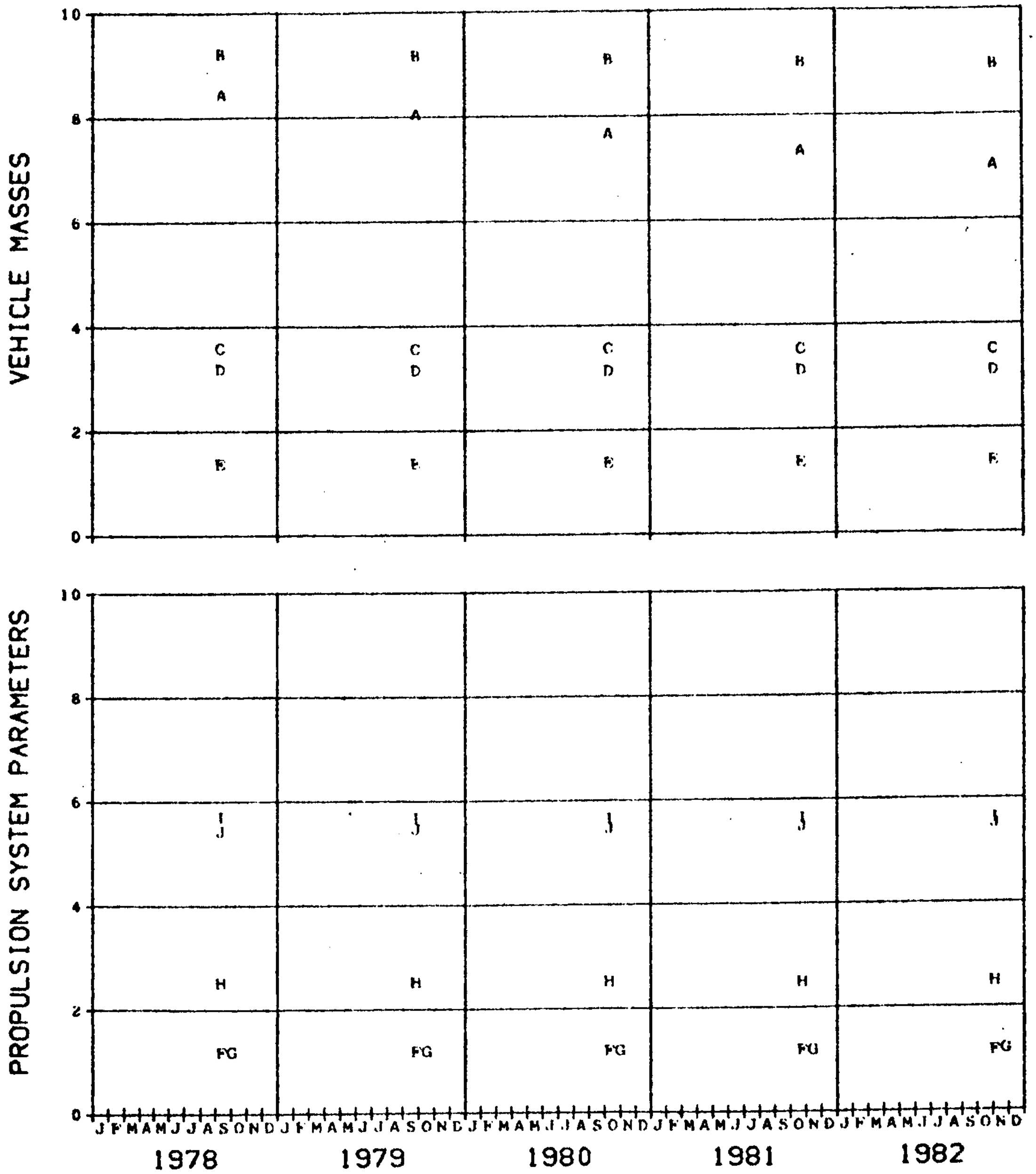

FIG. 21B. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1200 DAYS

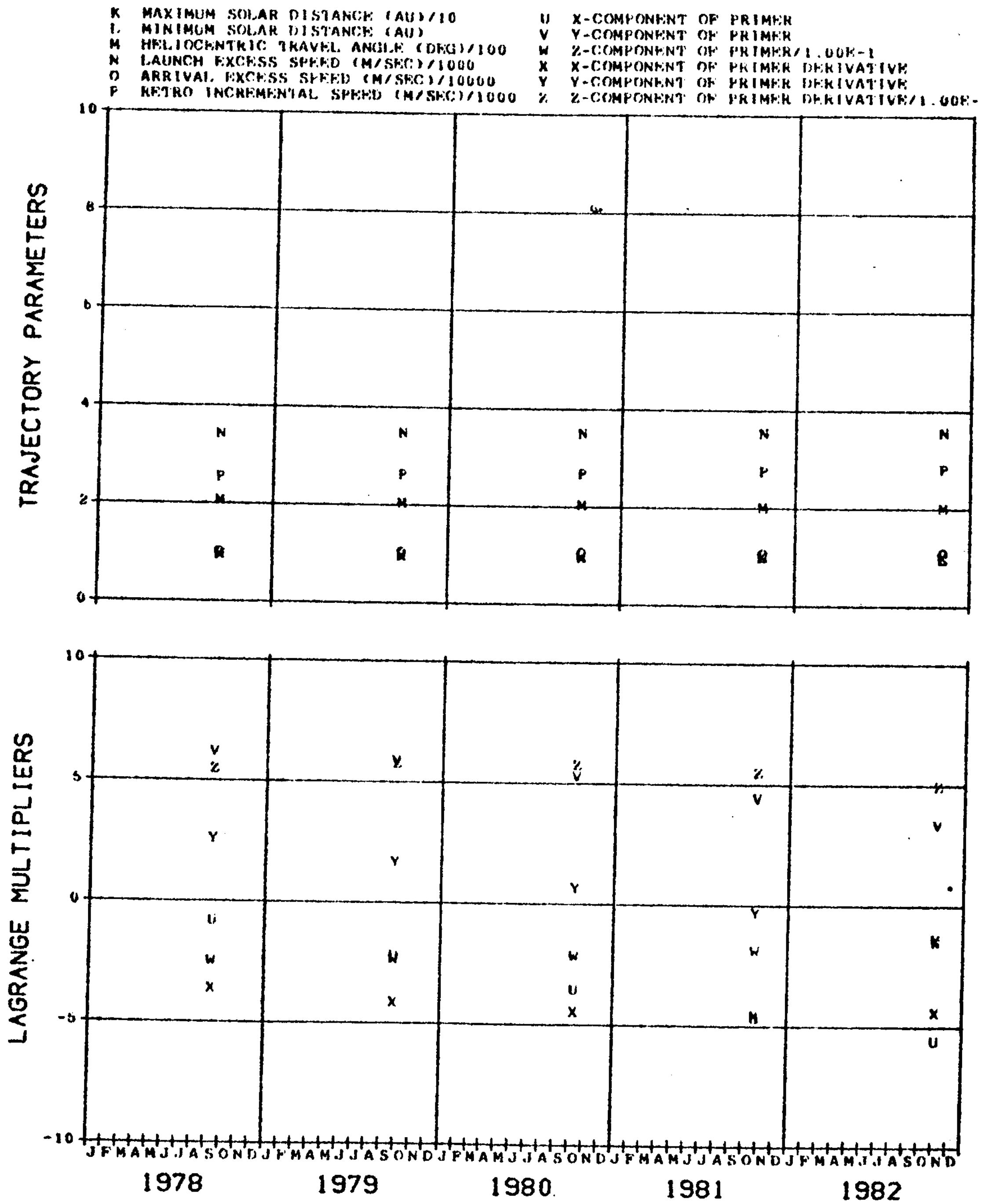

FIG. 21B. (CONCLUDED)

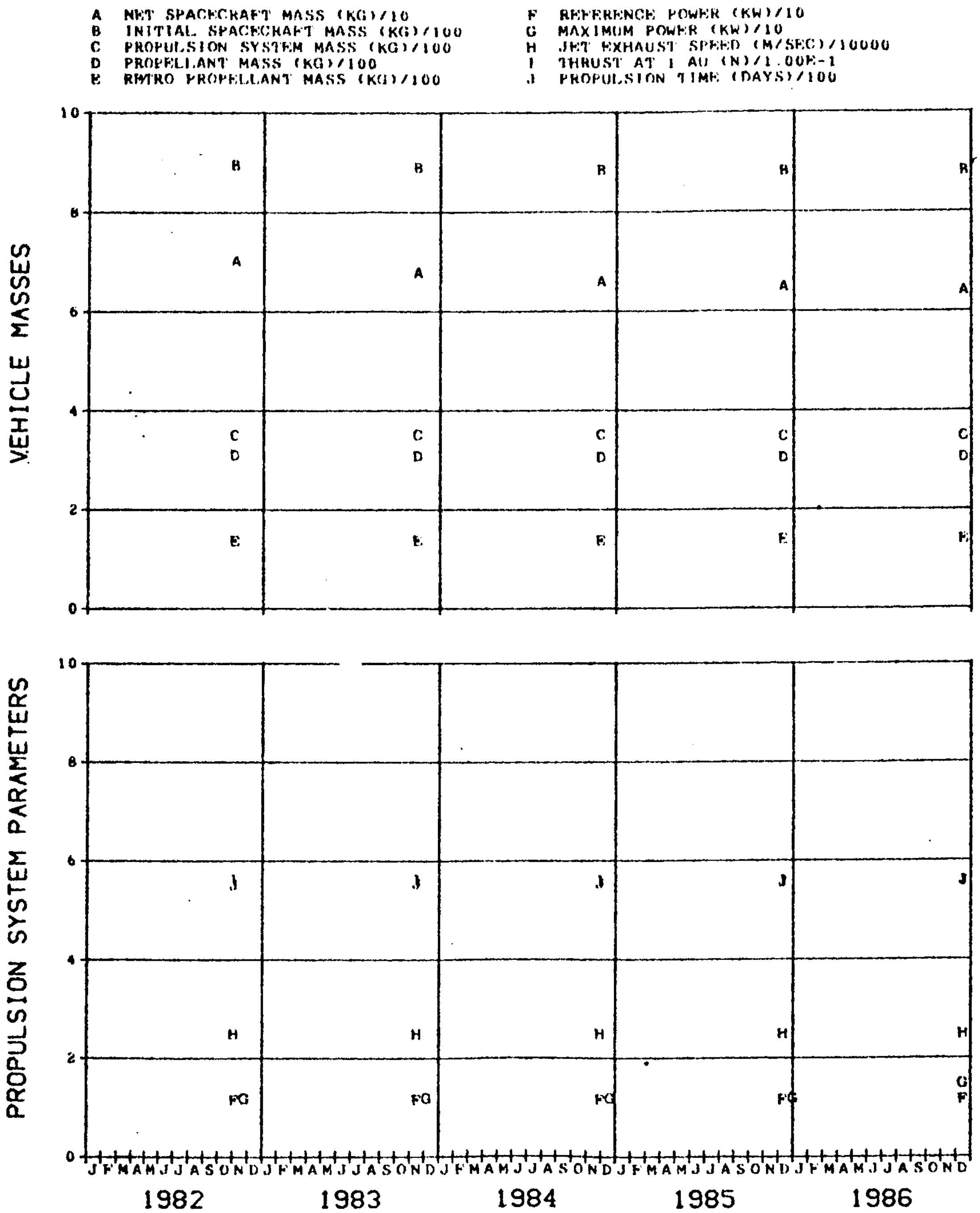

FIG. 21C. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1200 DAYS

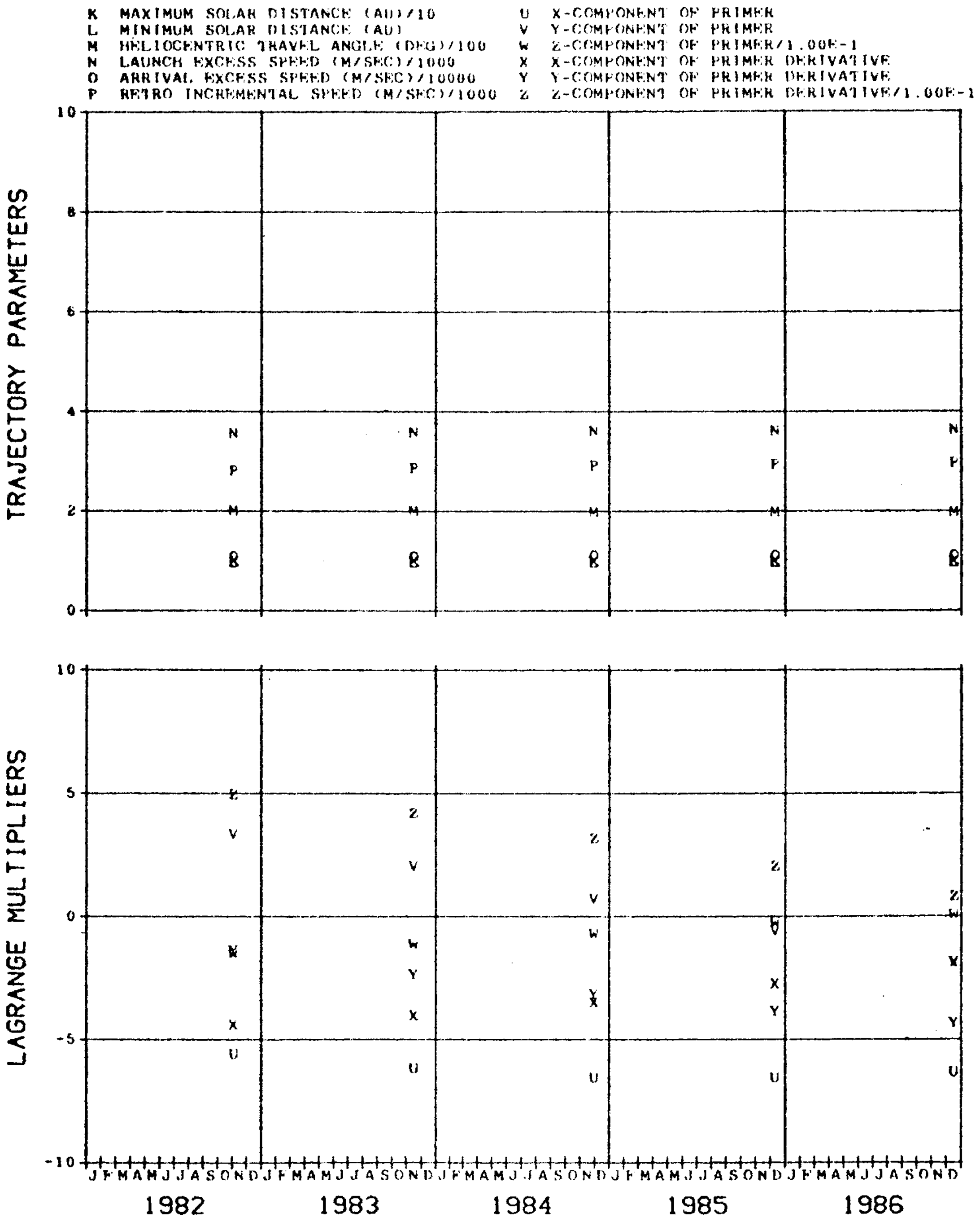

FIG. 21C. (CONCLUDED)

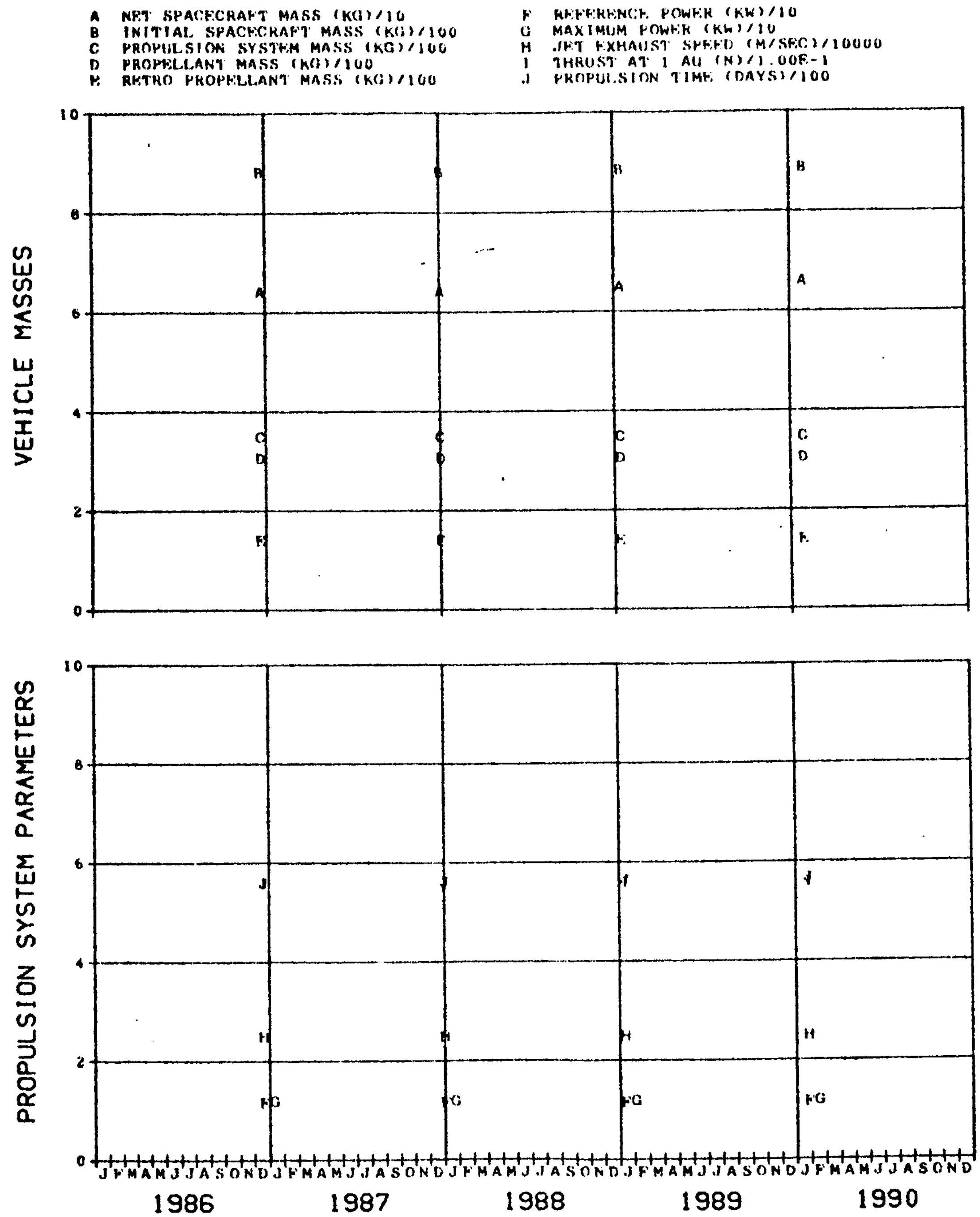

FIG. 21D. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 1200 DAYS

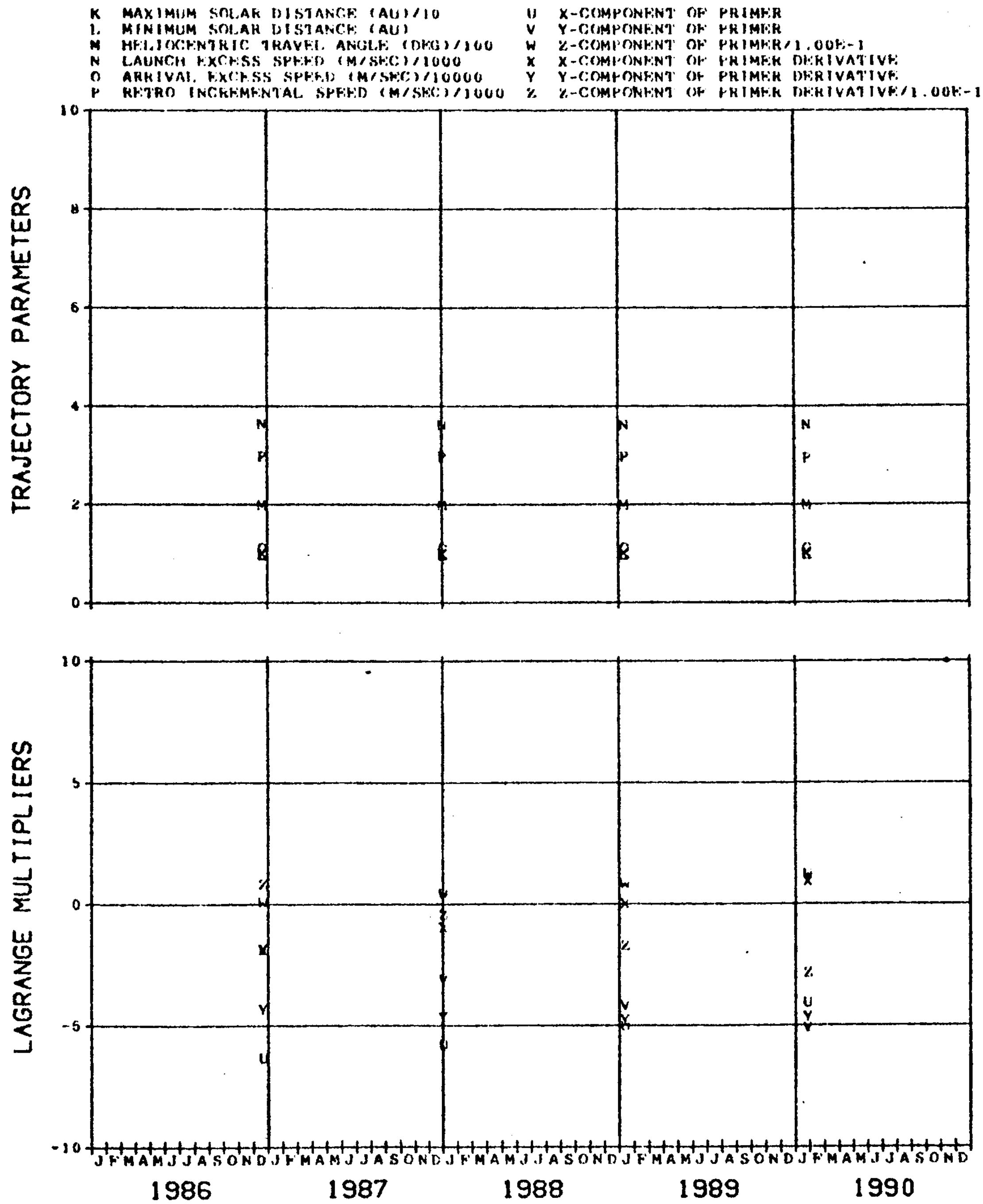

FIG. 21D. (CONCLUDED)

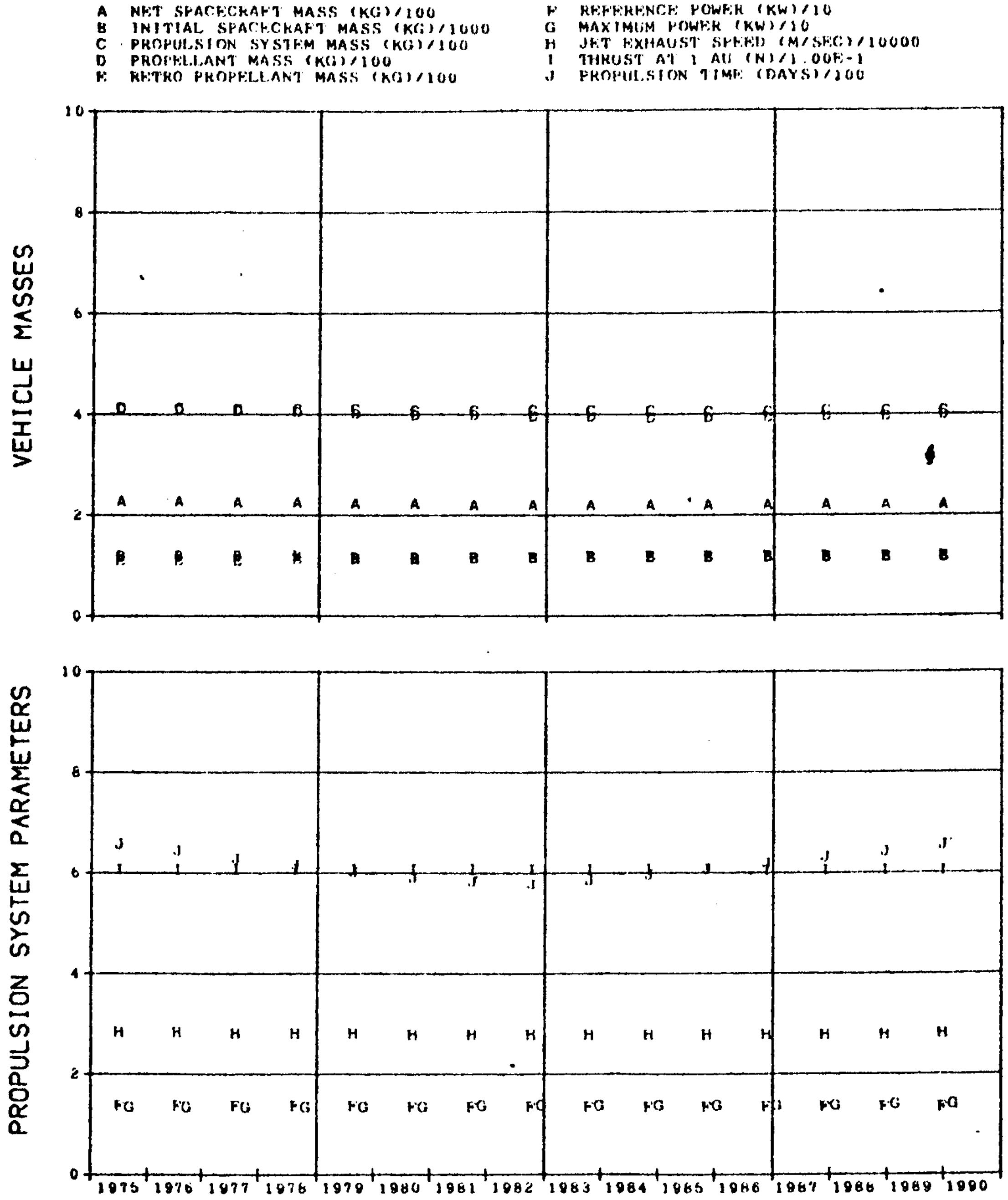

FIG. 22. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

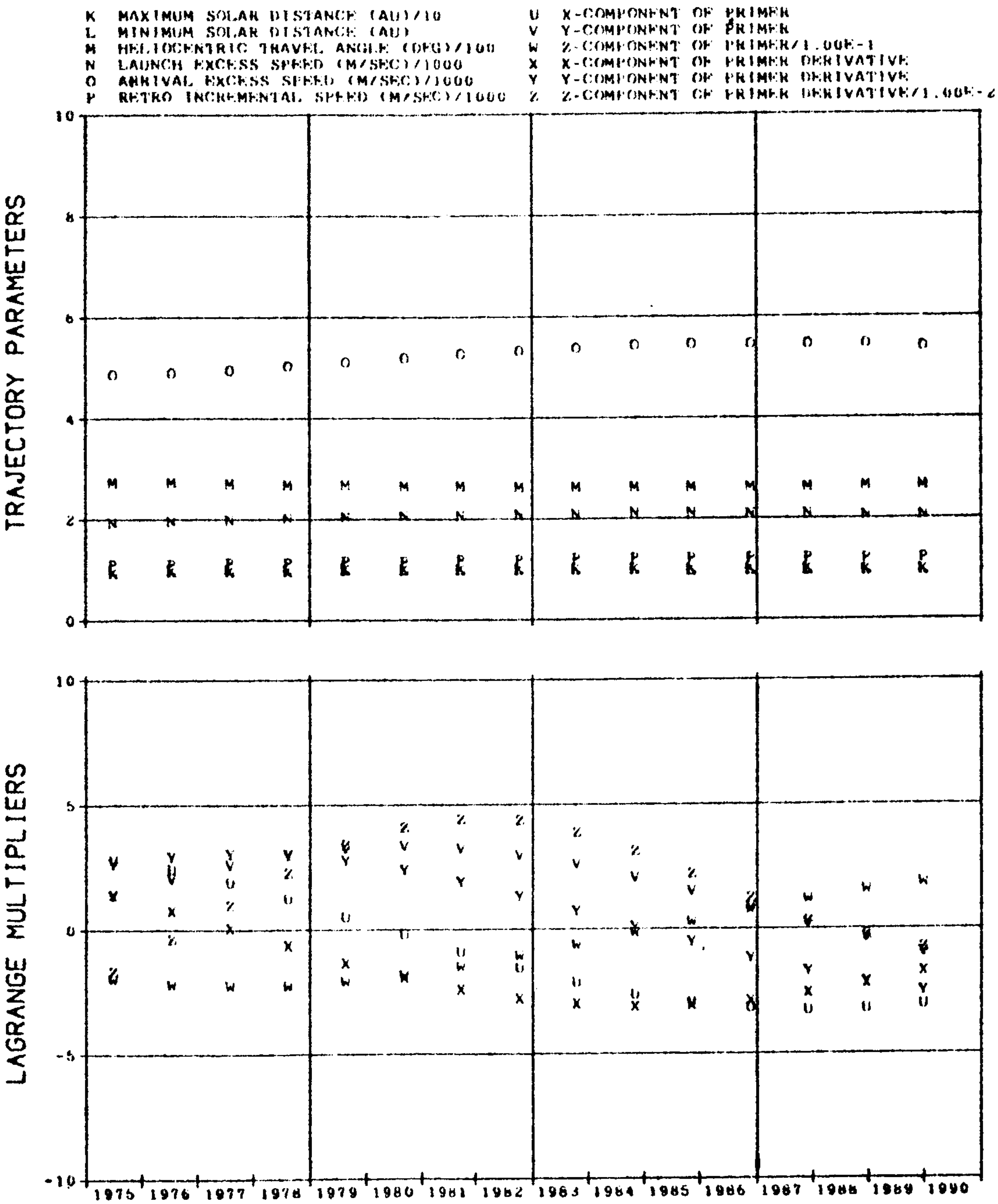

FIG. 22. (CONCLUDED)

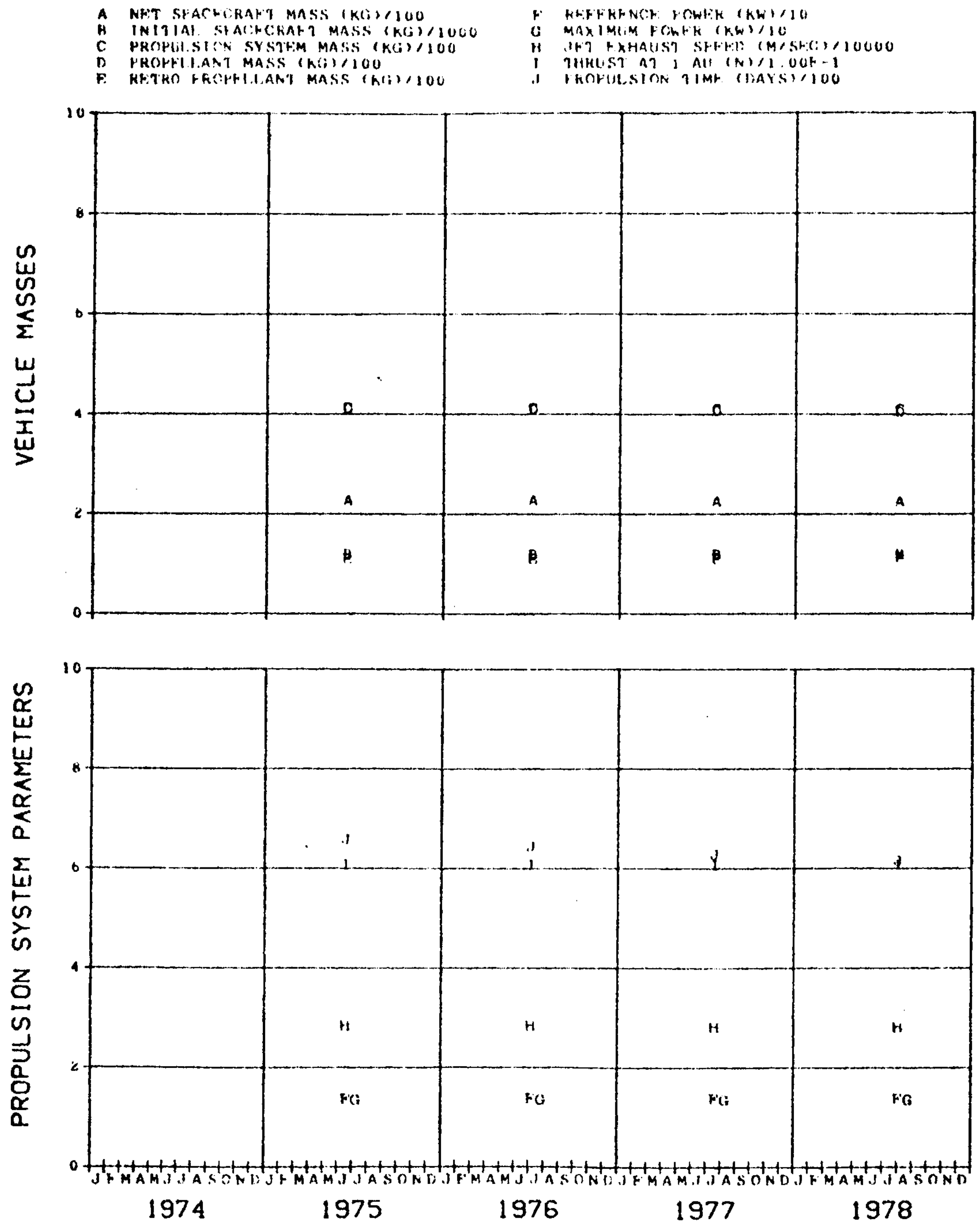

FIG. 22A. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

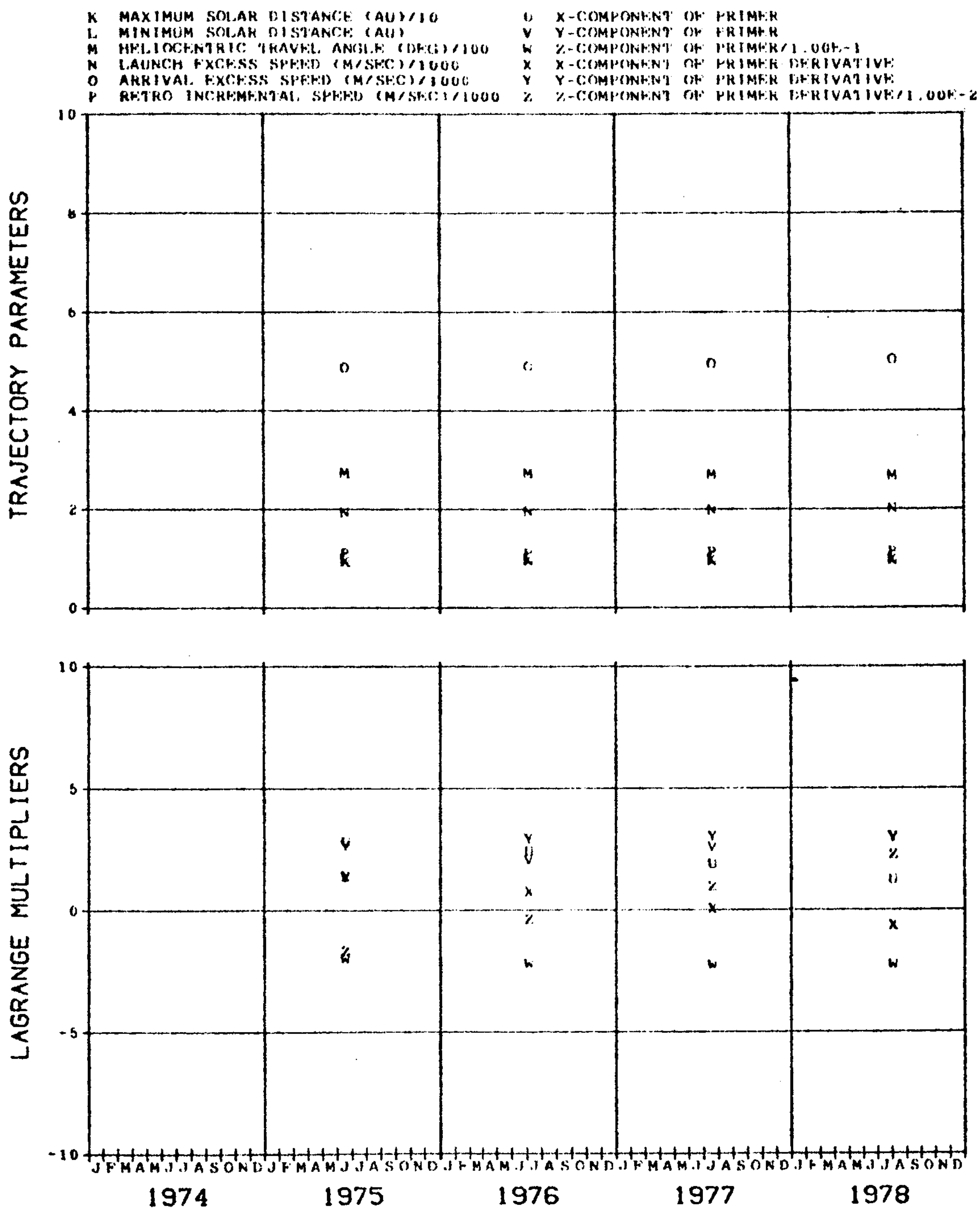

FIG. 22A. (CONCLUDED)

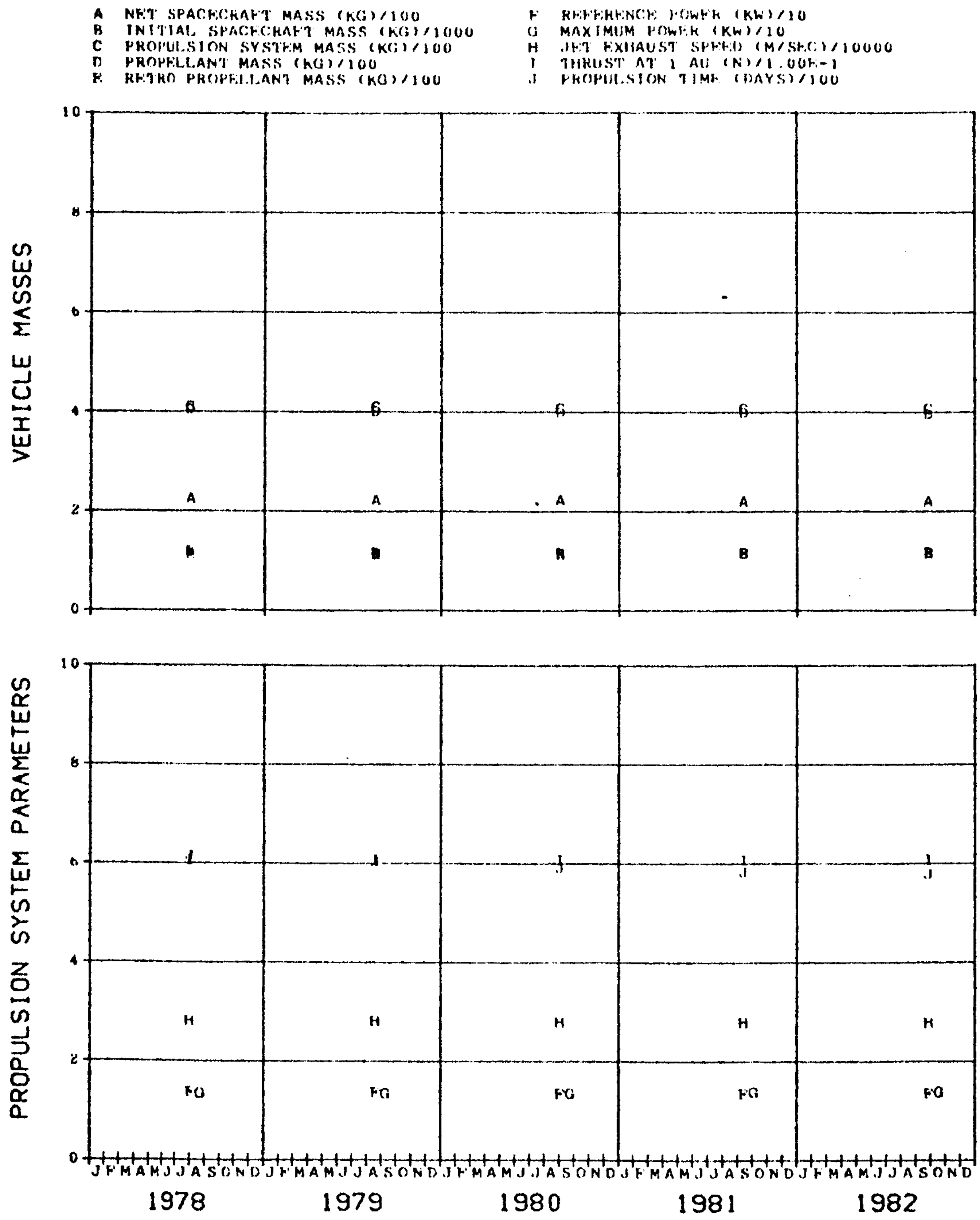

FIG. 22B. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

XXXX 218

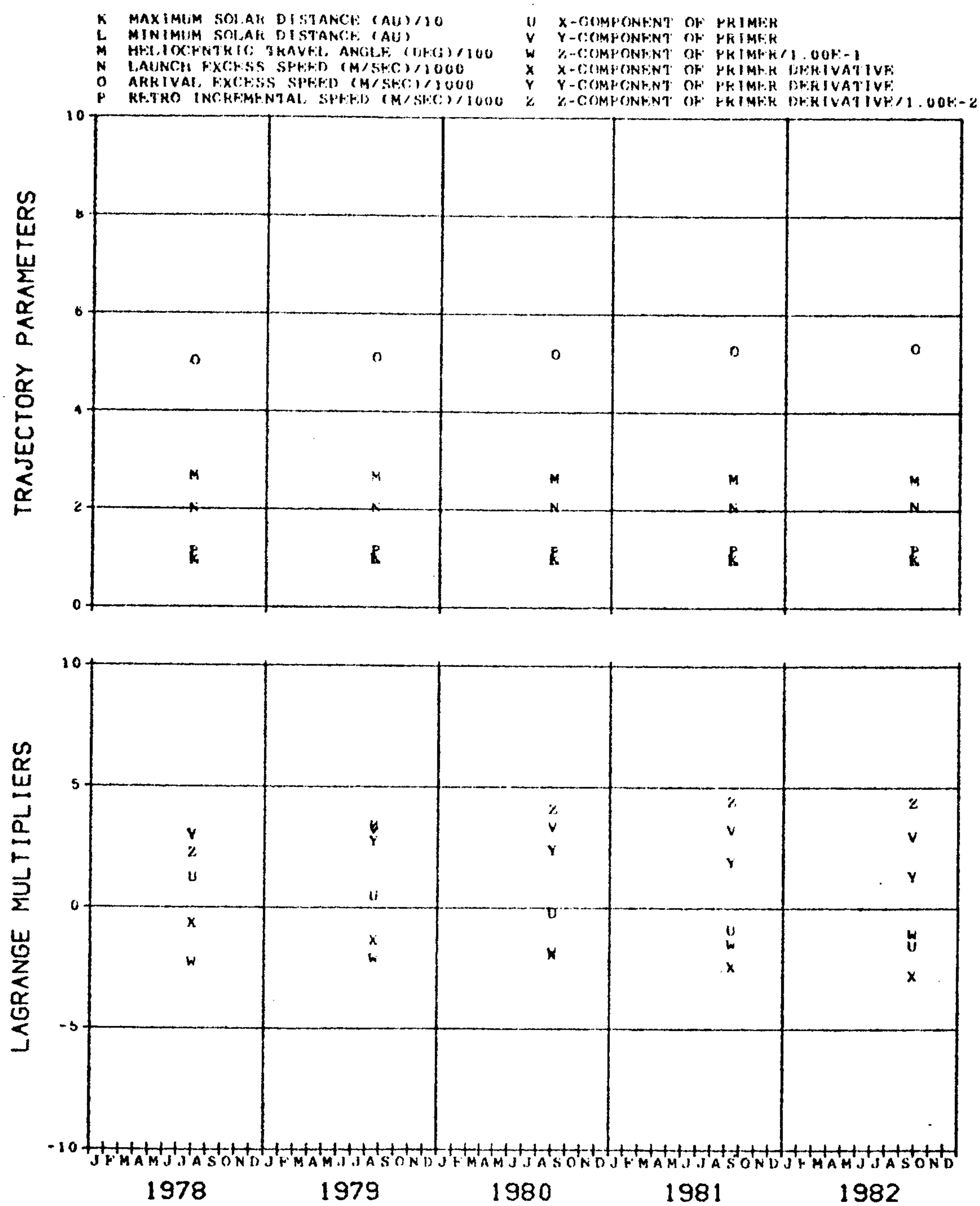

FIG. 22B. (CONCLUDED)

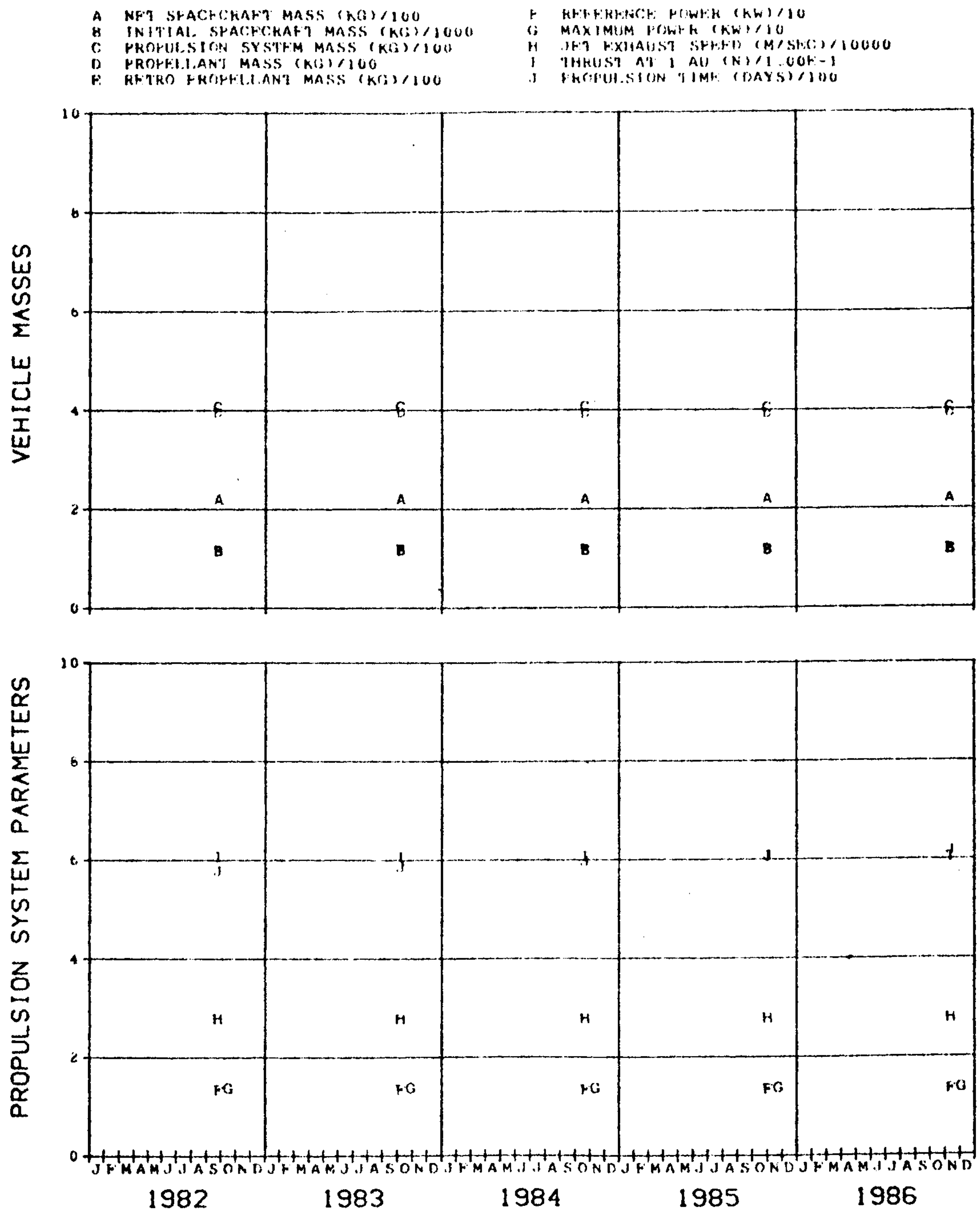

FIG. 22C. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

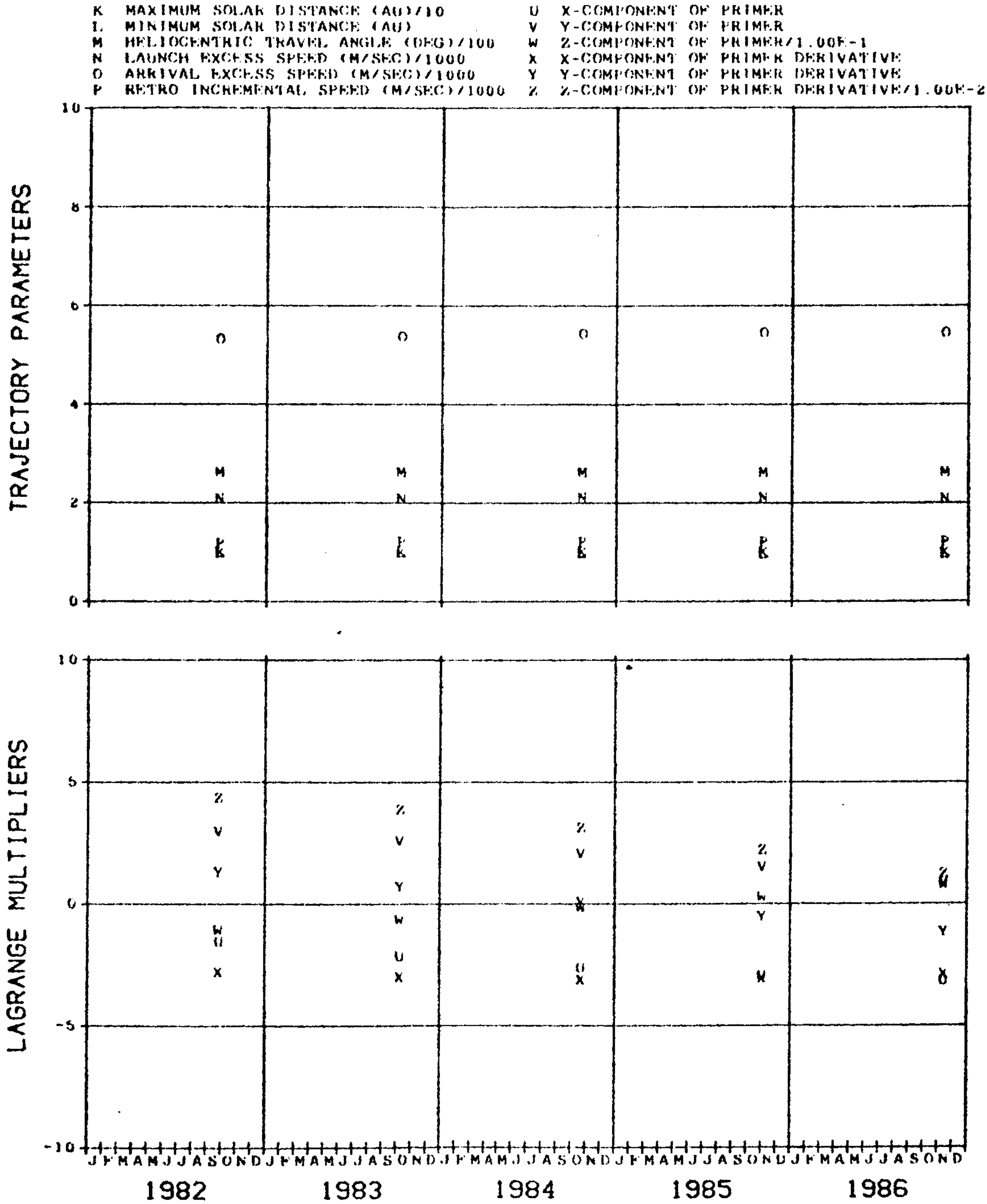

FIG. 22C. (CONCLUDED)

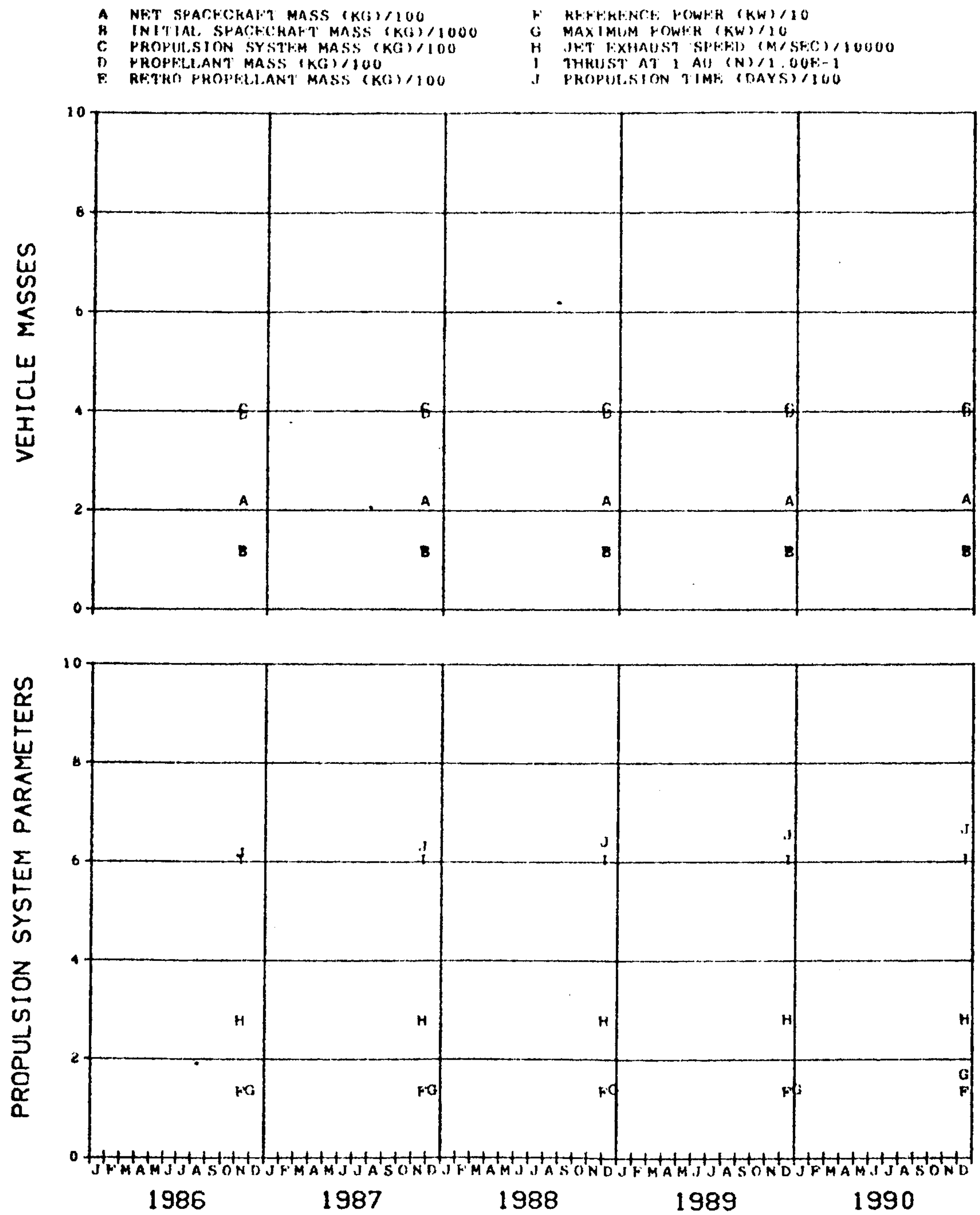

FIG. 22D. SATURN MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

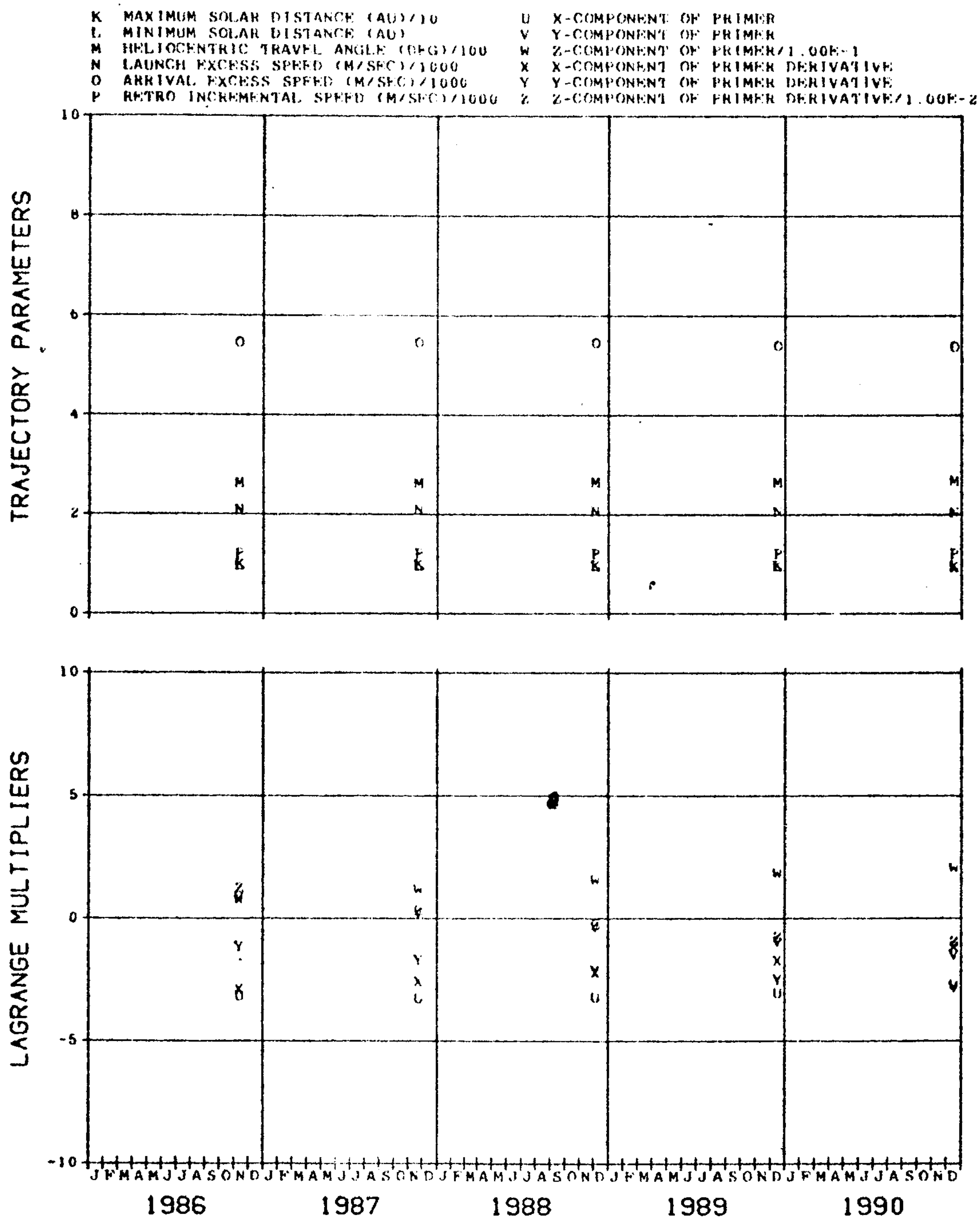

FIG. 22D. (CONCLUDED)

XXXX 223

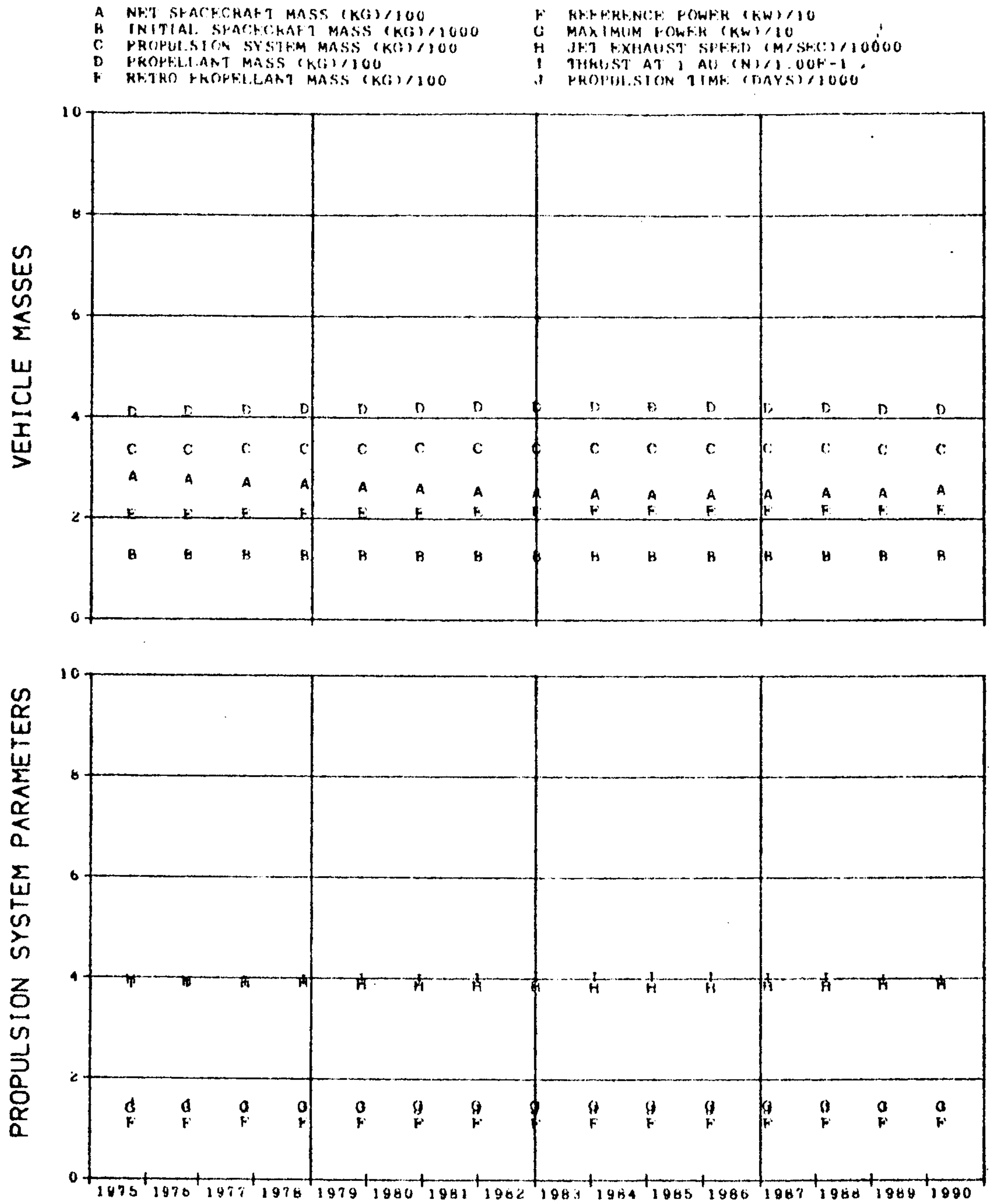

FIG. 23. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

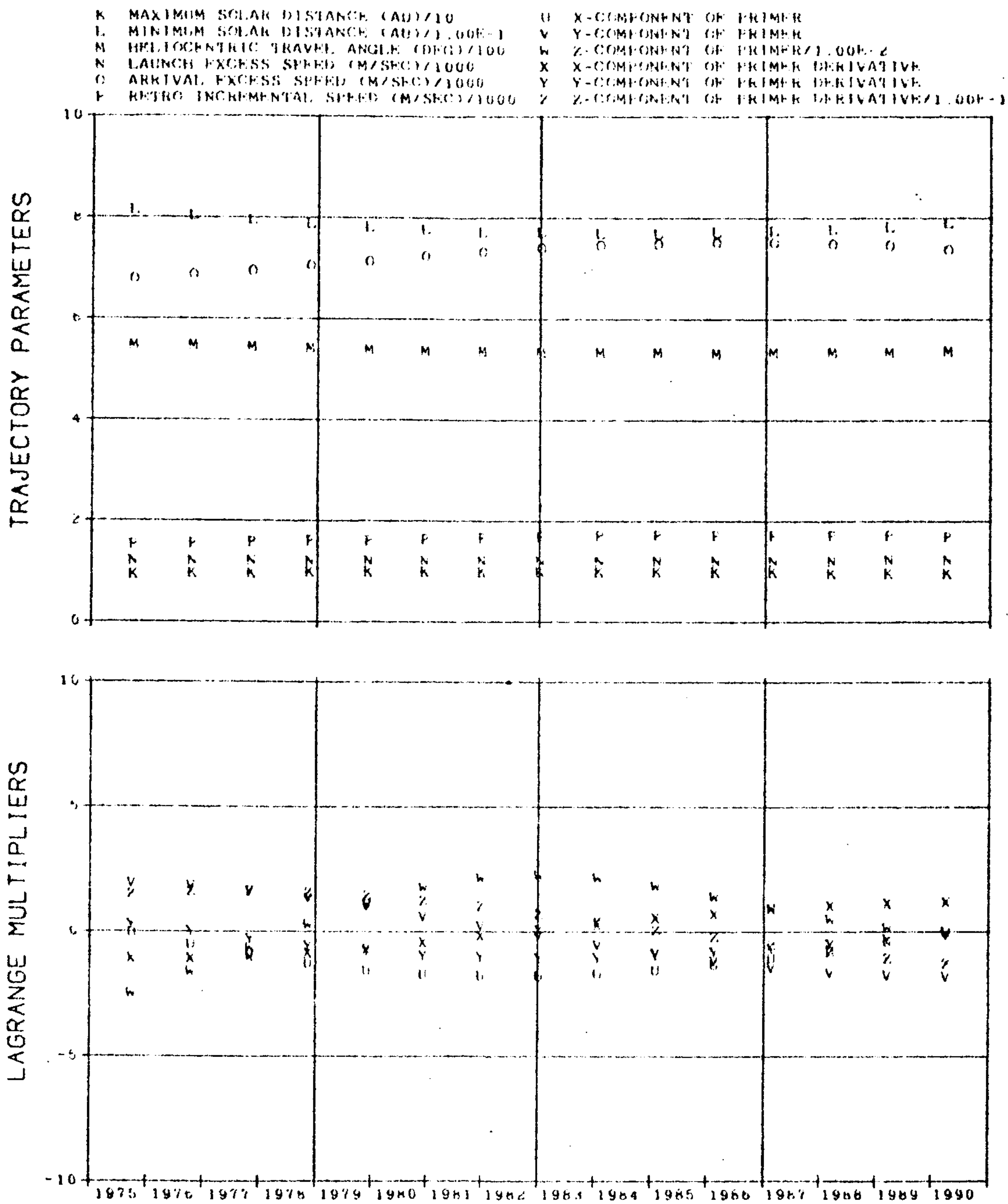

FIG. 23. (CONCLUDED)

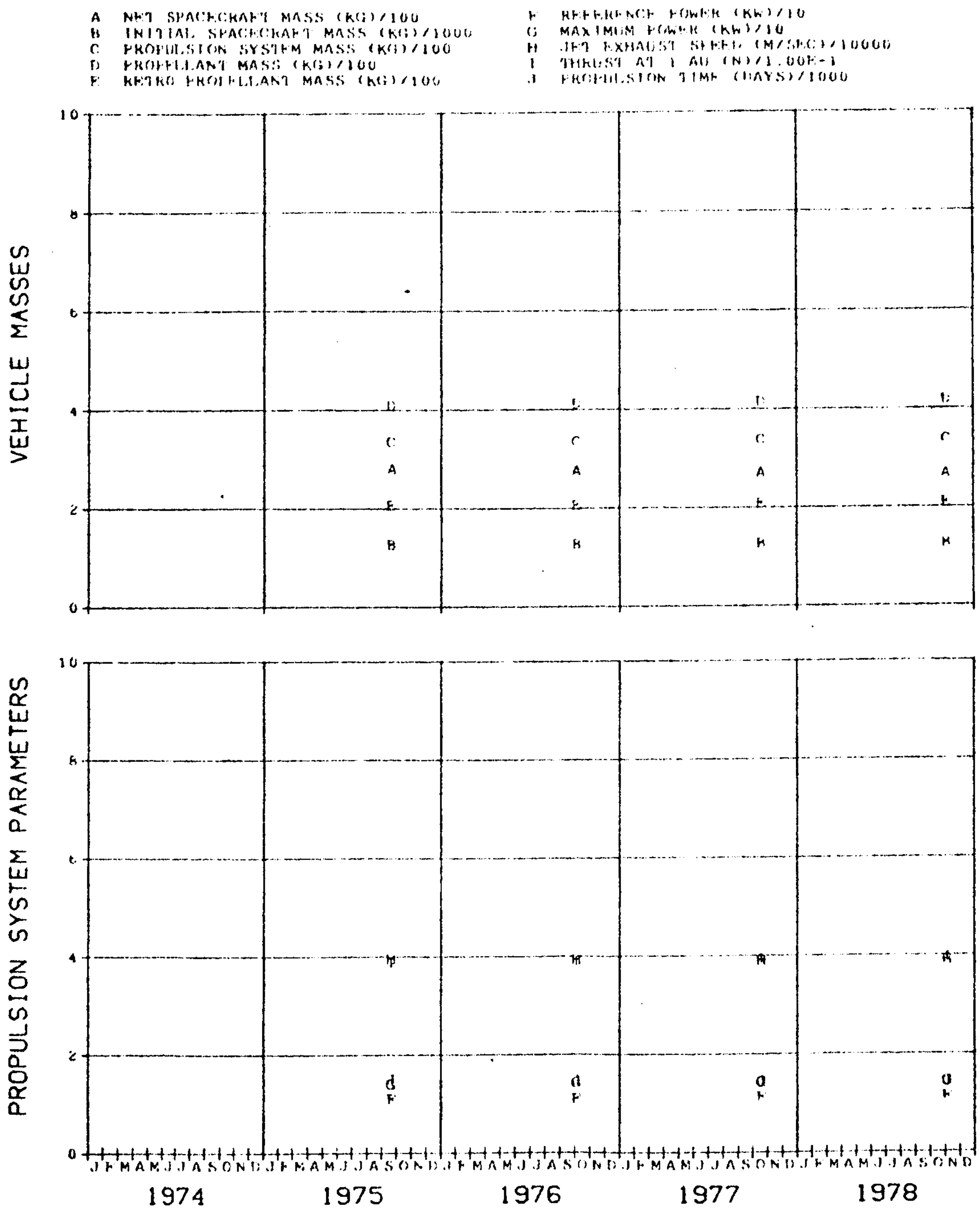

FIG. 23A. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

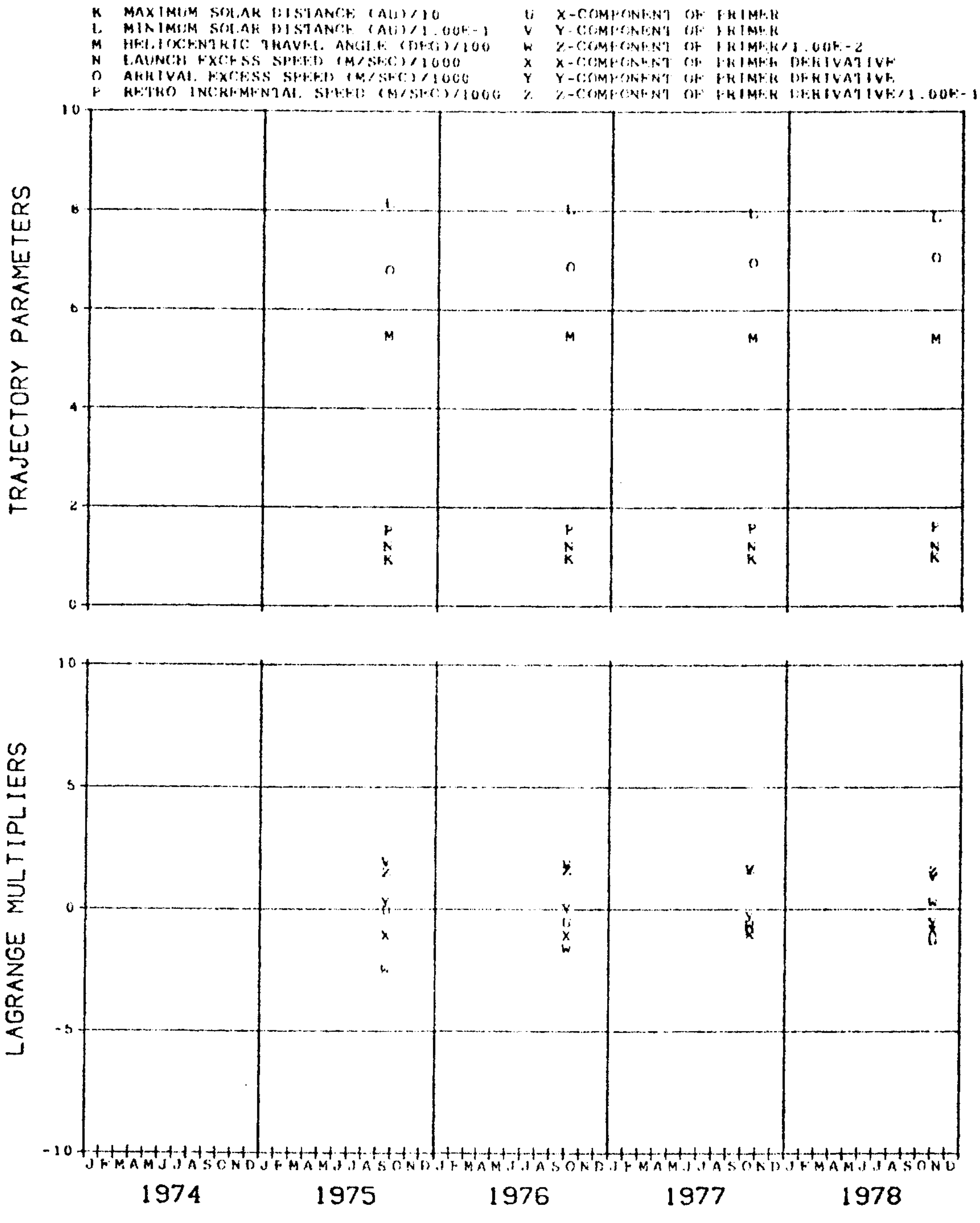

FIG. 23A. (CONCLUDED)

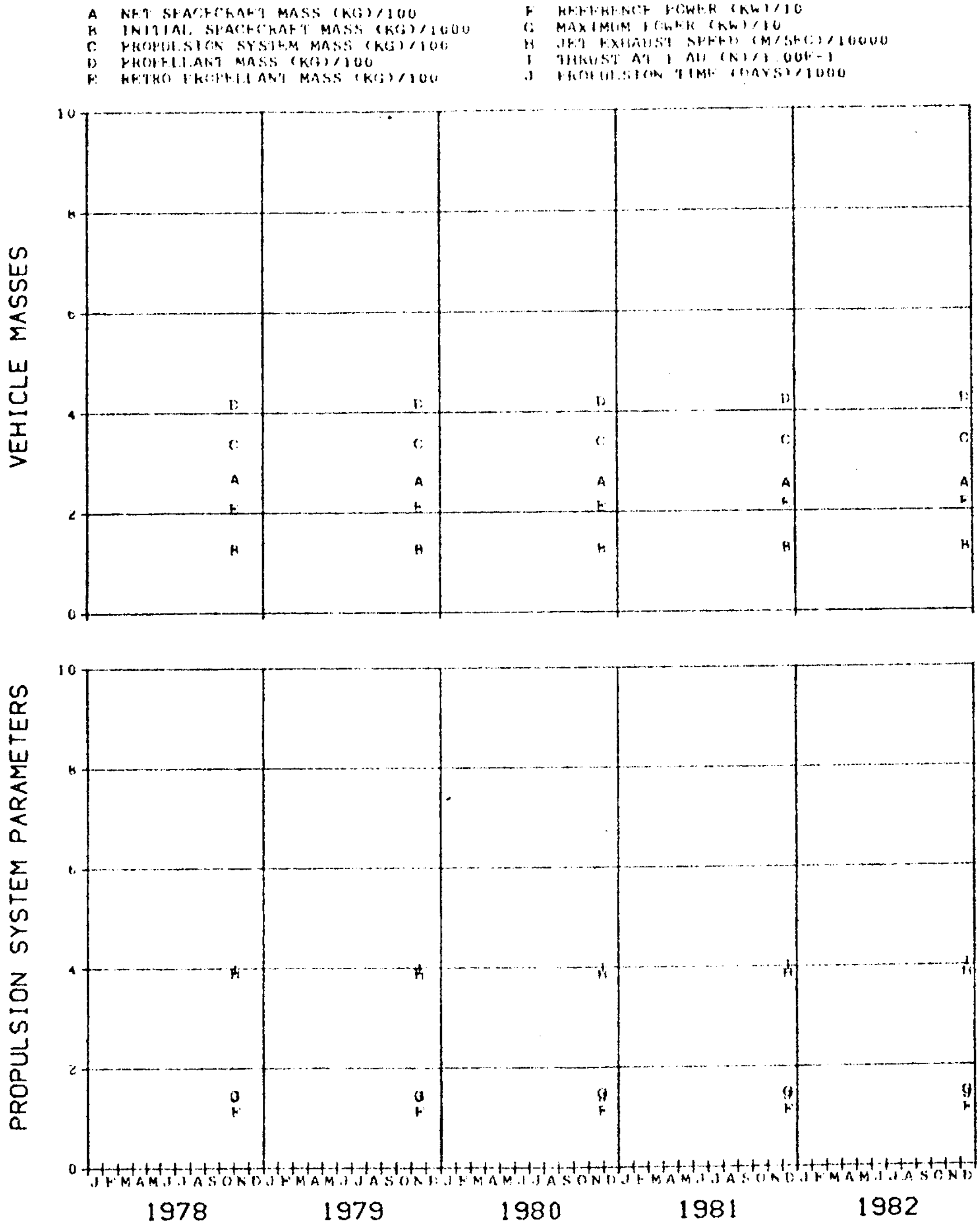

FIG. 23B. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

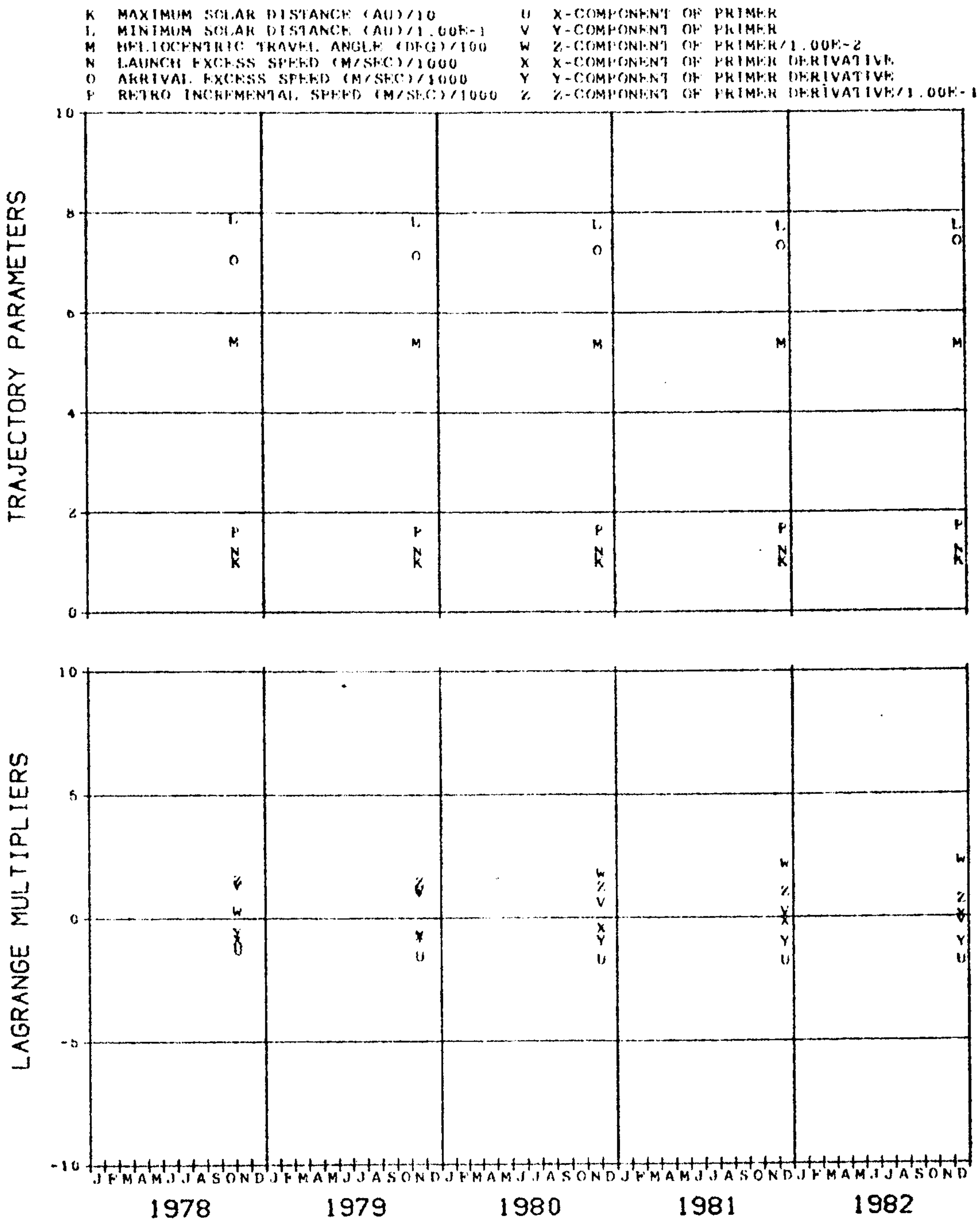

FIG. 23B. (CONCLUDED)

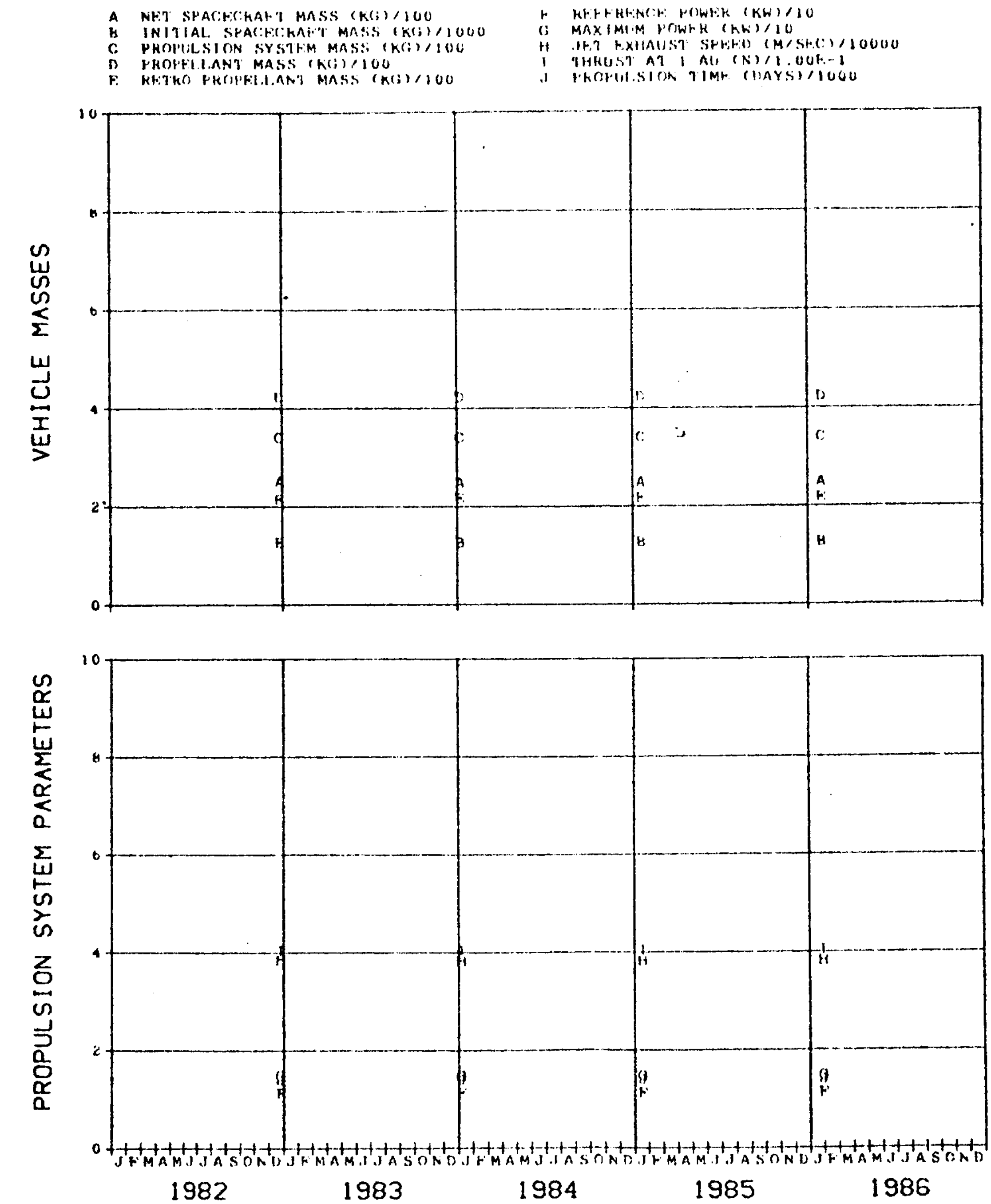

FIG. 23C. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

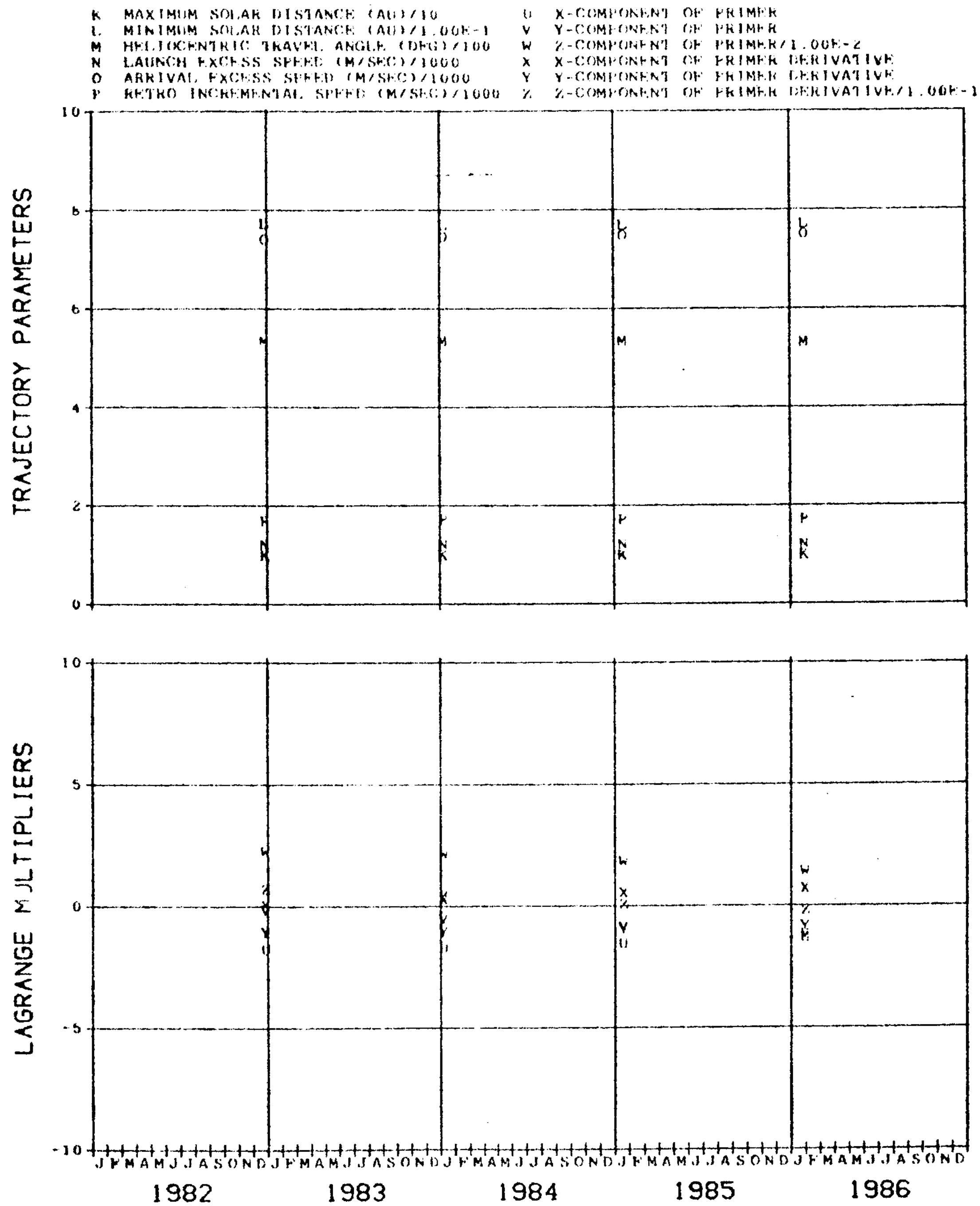

FIG. 23C. (CONCLUDED)

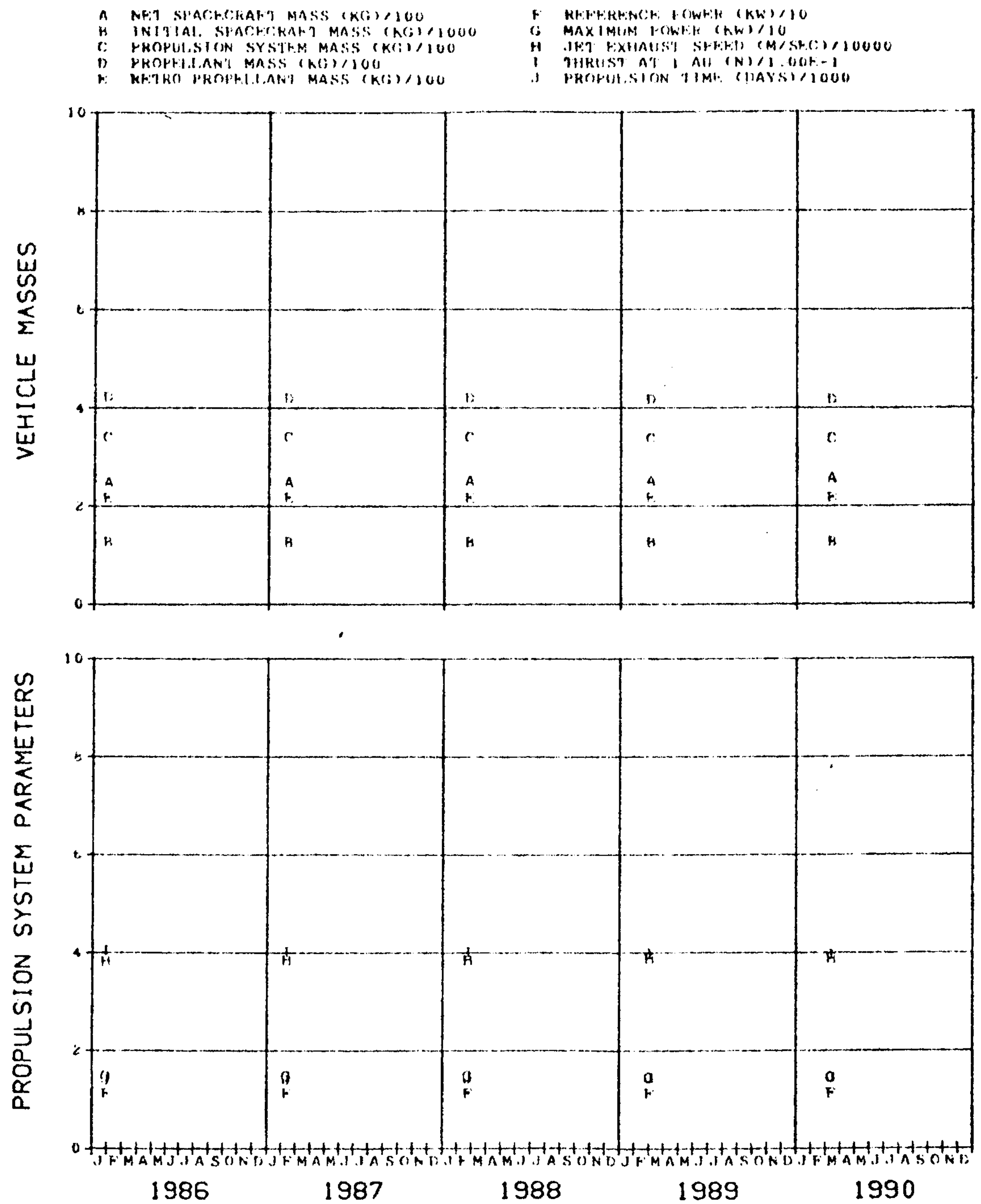

FIG. 23D. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2000 DAYS

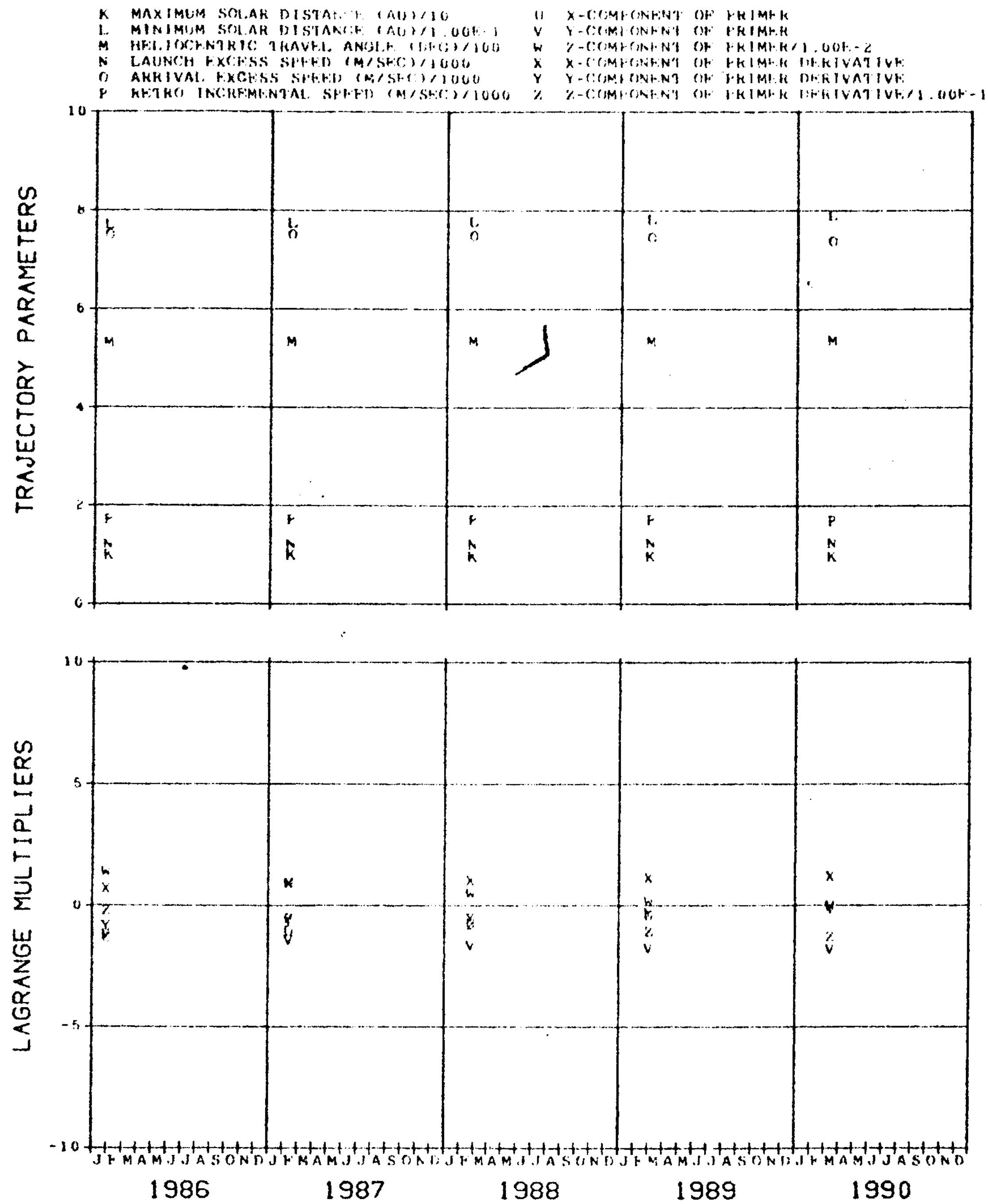

FIG. 23D. (CONCLUDED)

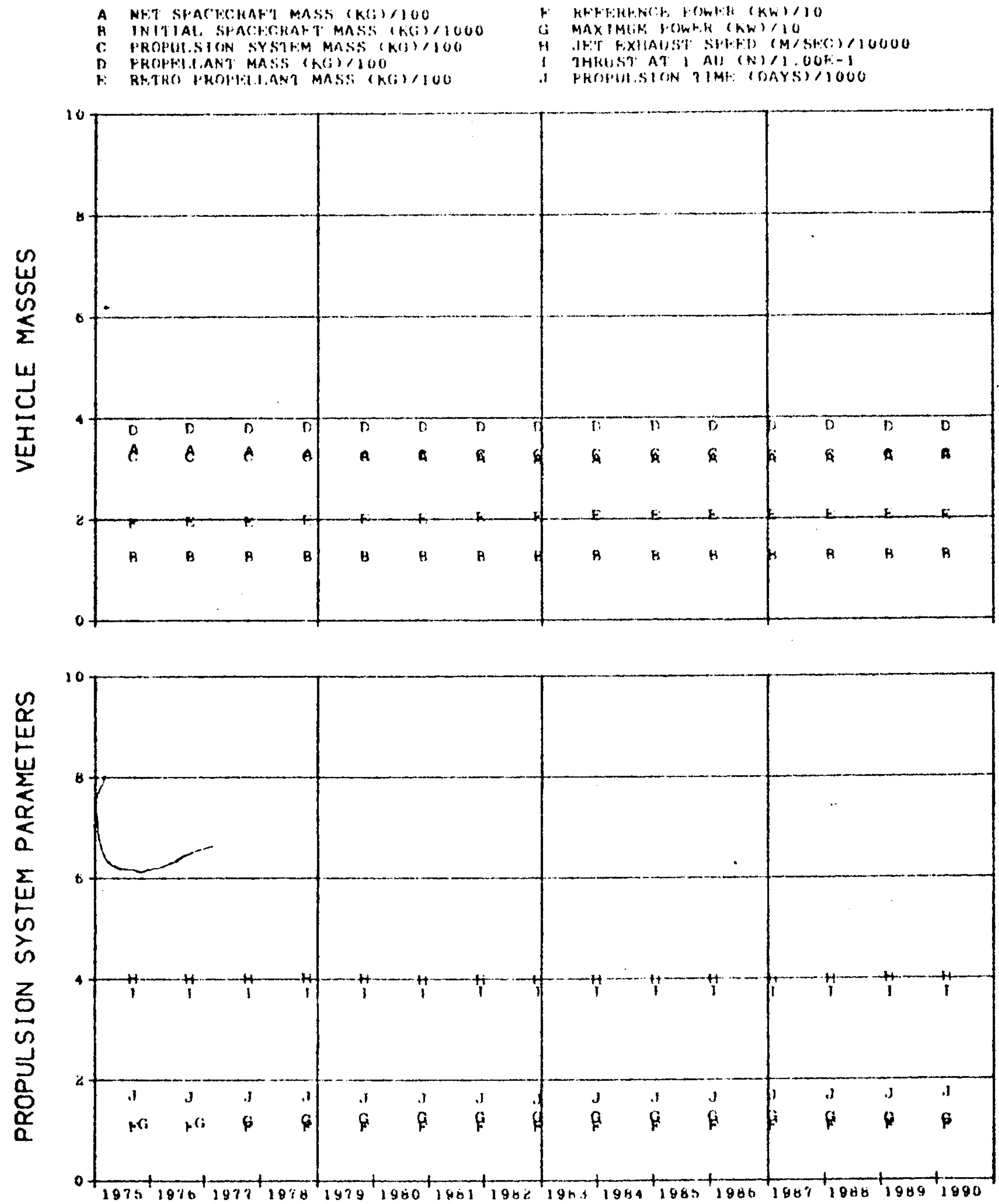

FIG. 24. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2300 DAYS

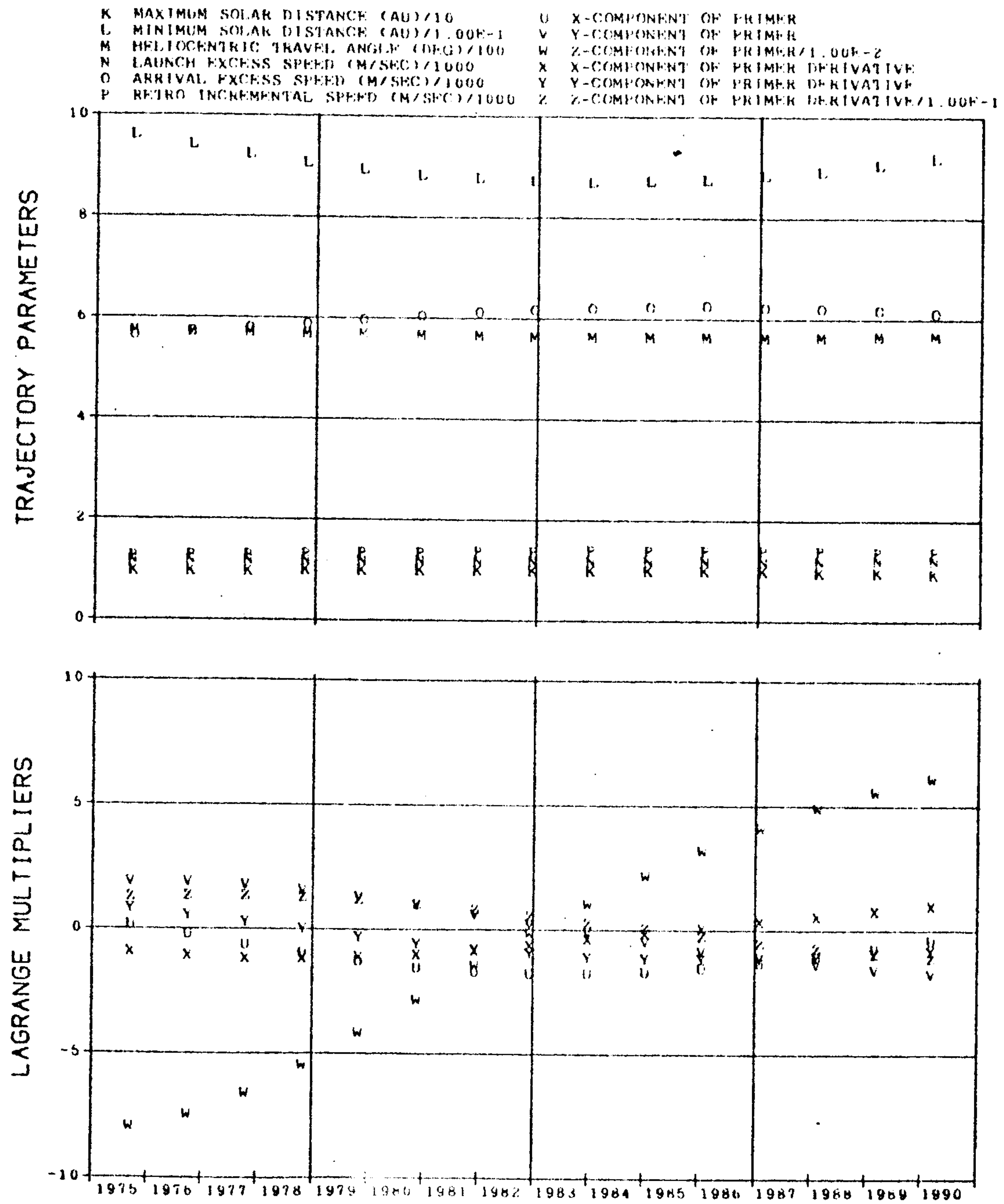

FIG. 24. (CONCLUDED)

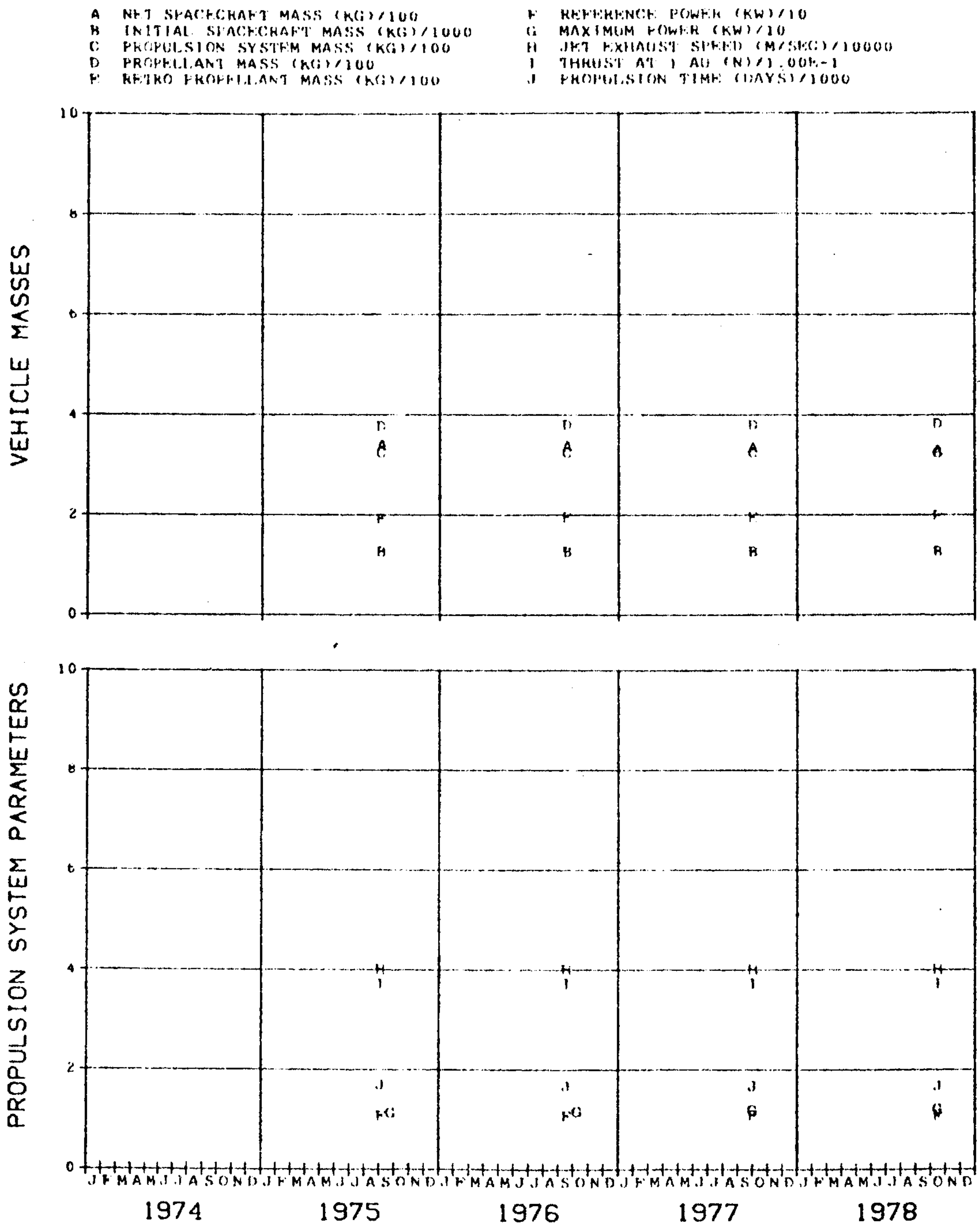

FIG. 24A. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2300 DAYS

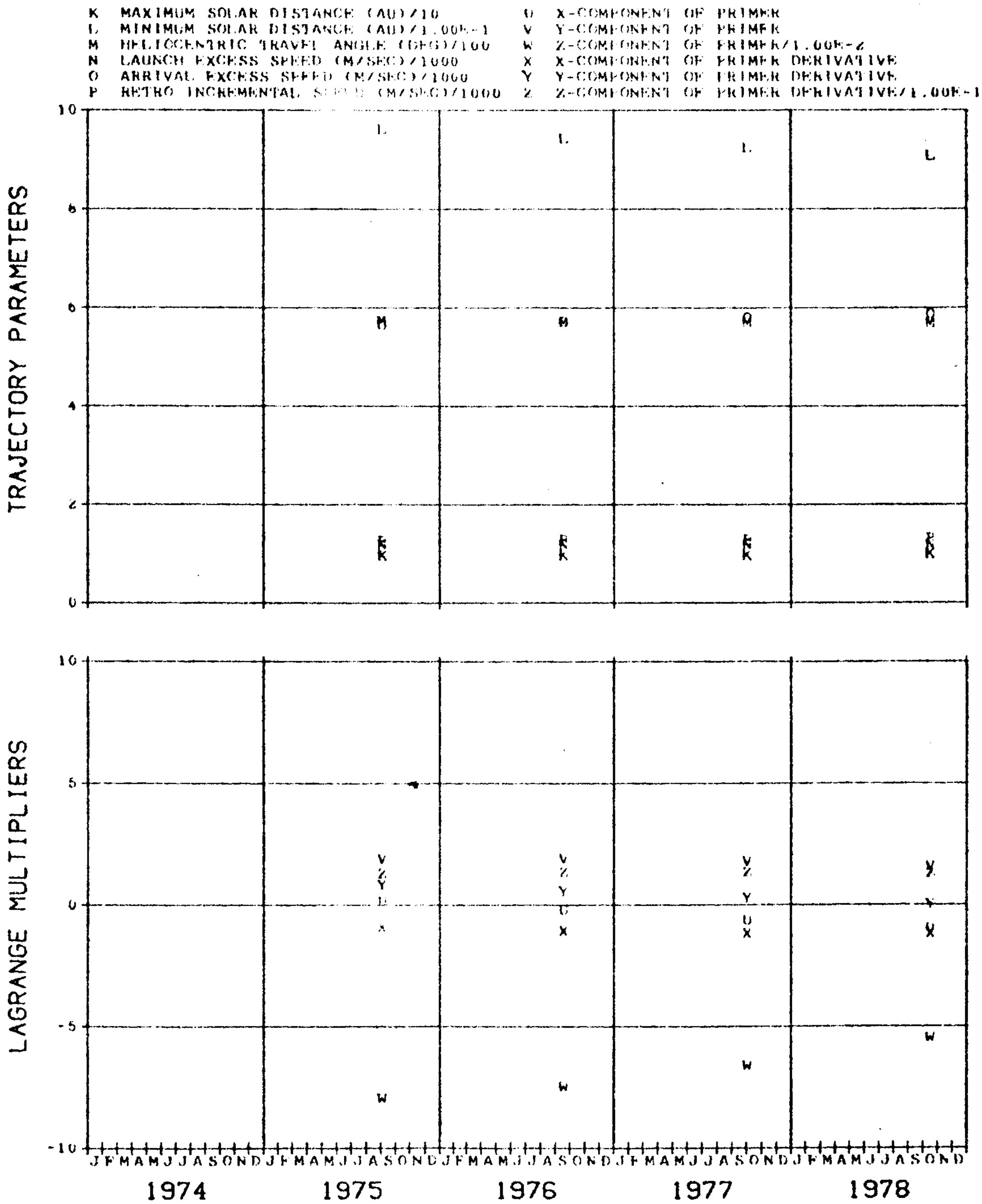

FIG. 24A. (CONCLUDED)

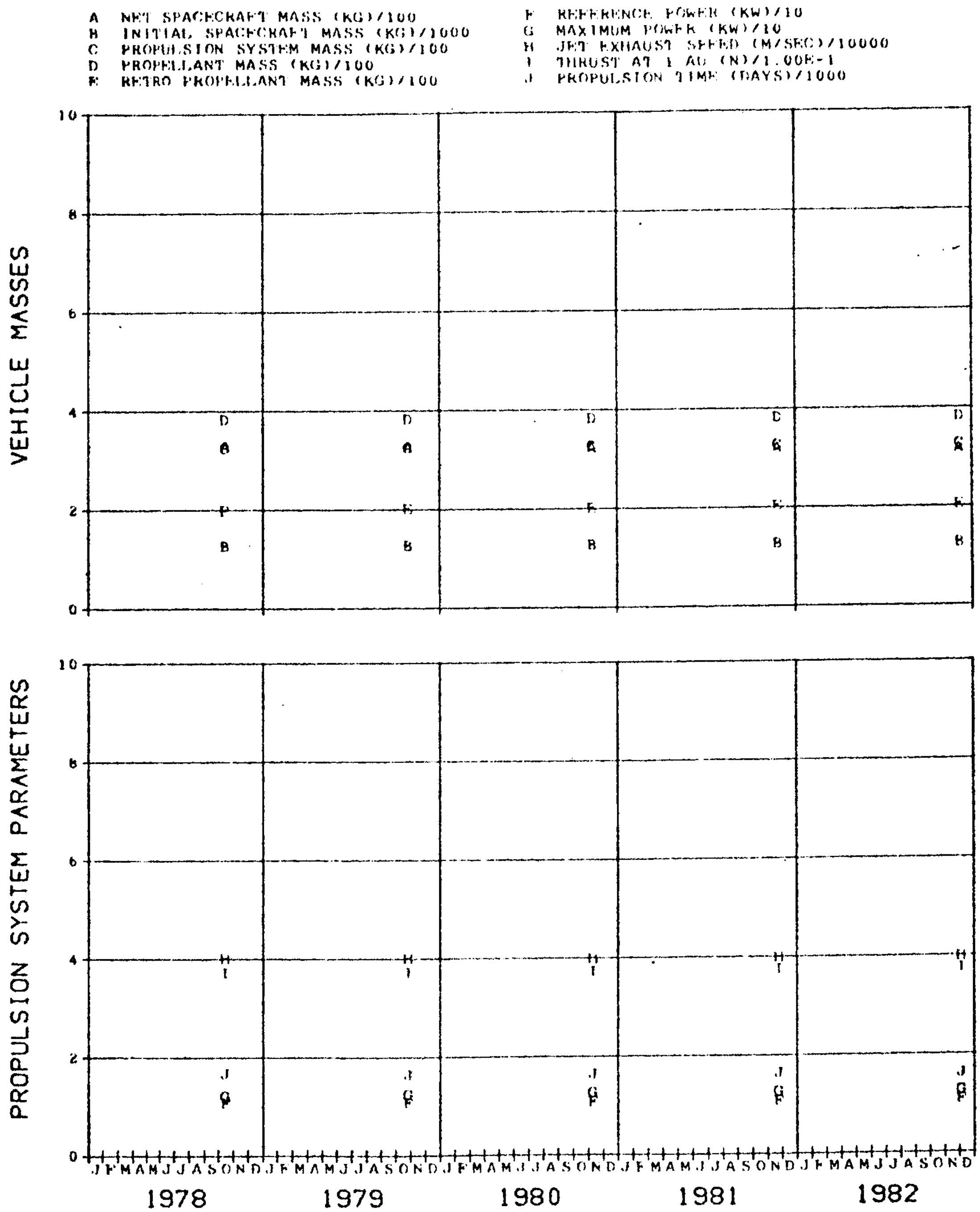

FIG. 24B. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2300 DAYS

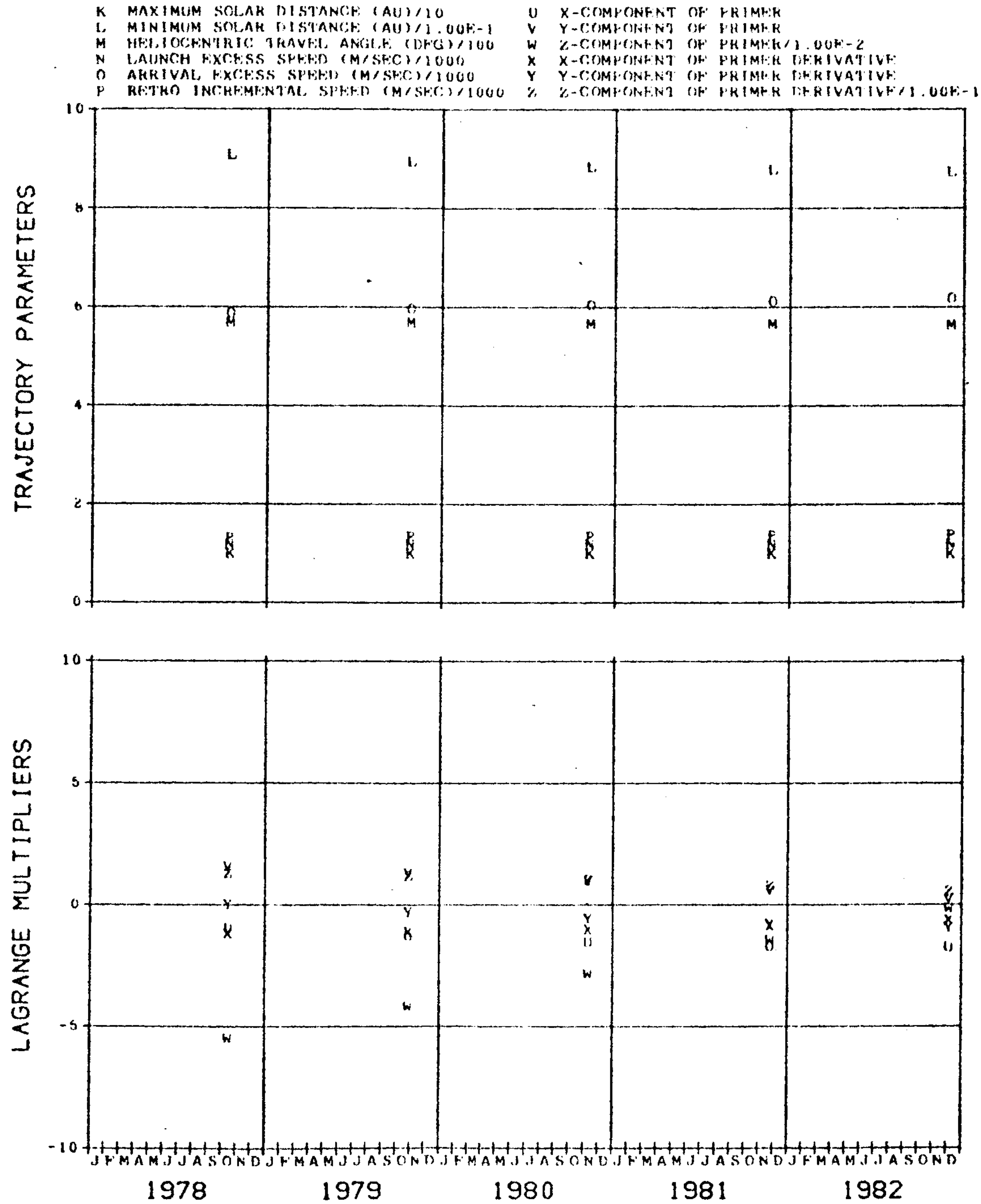

FIG. 24B. (CONCLUDED)

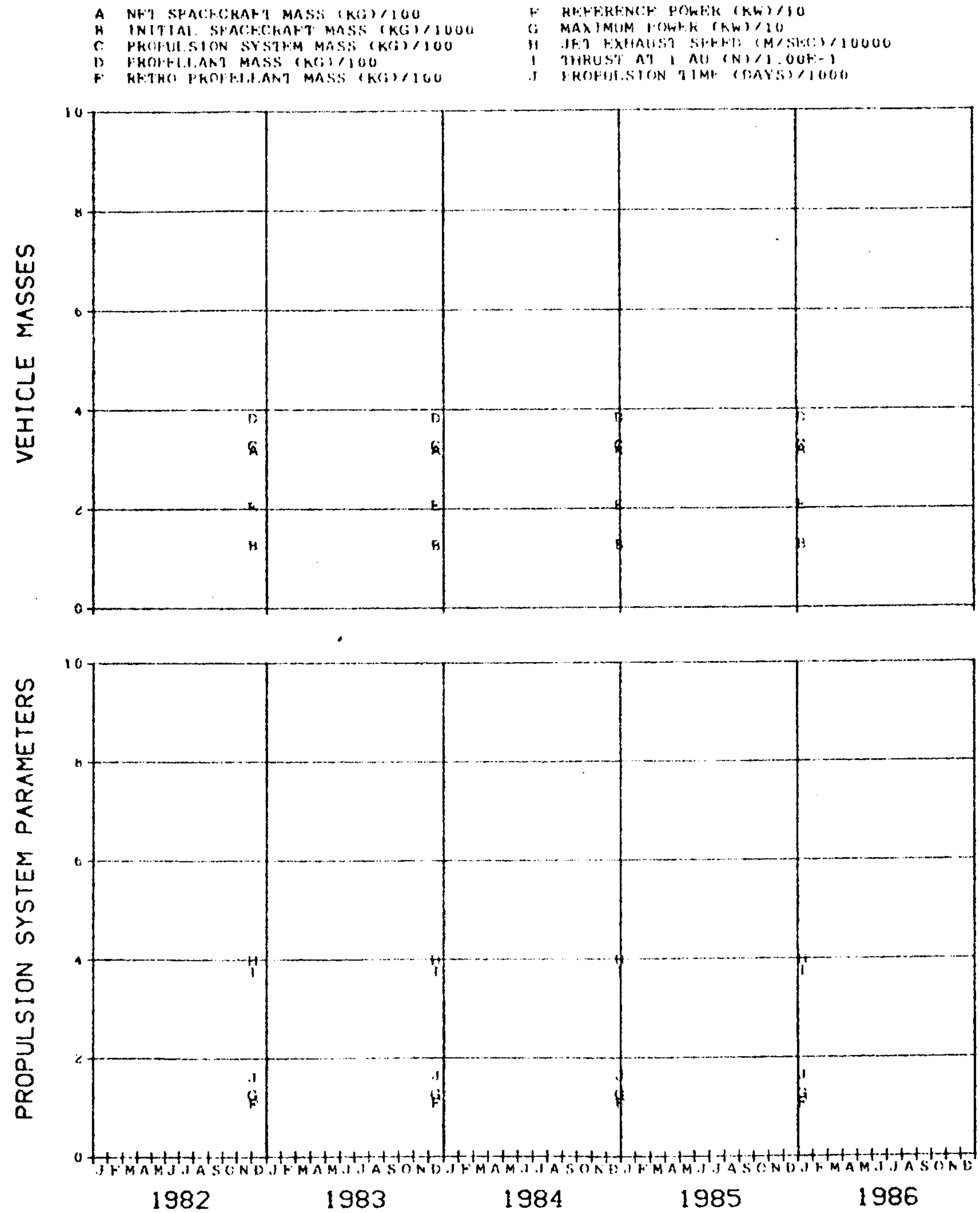

FIG. 24C. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2300 DAYS

XXXX 240

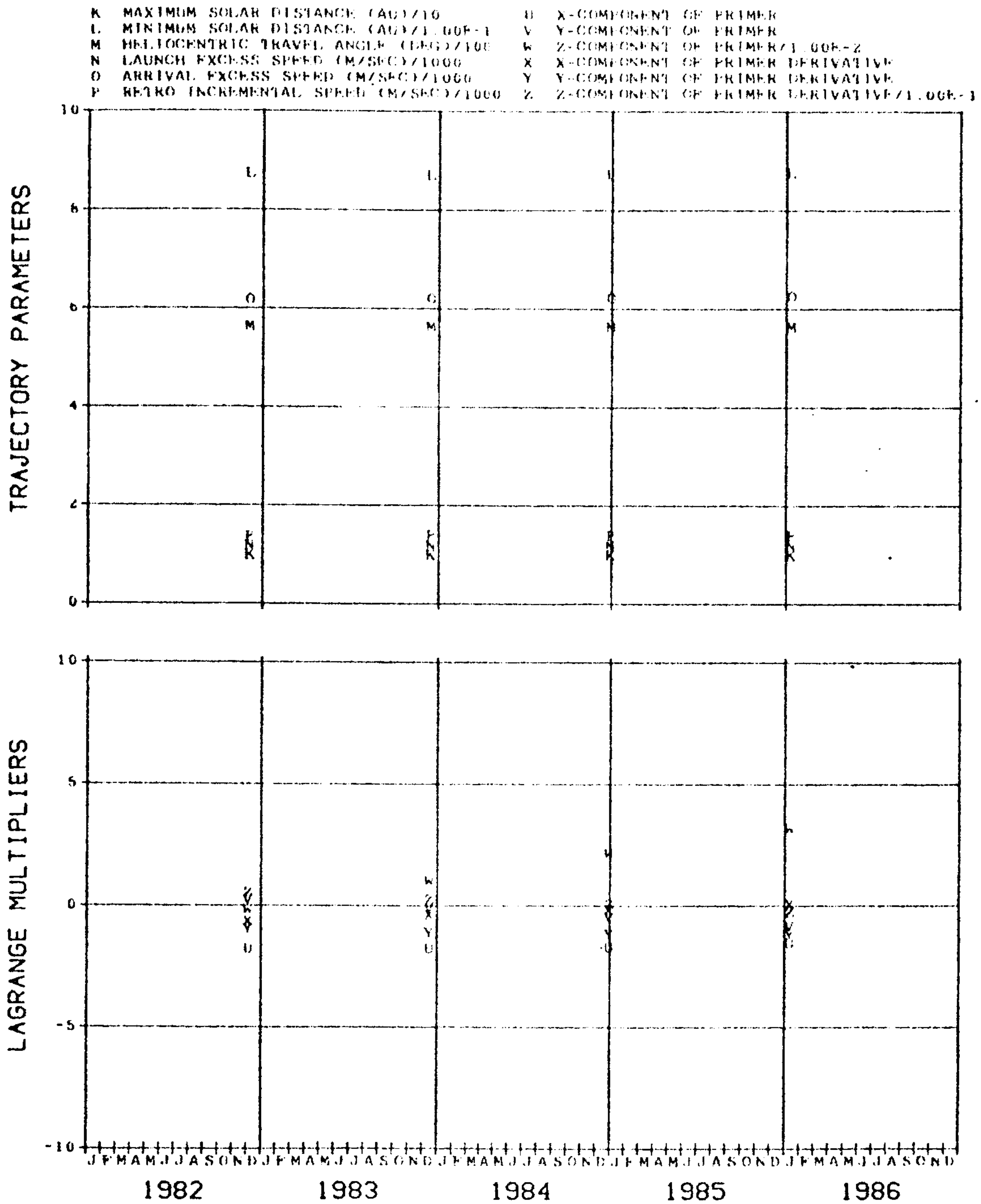

FIG. 24C. (CONCLUDED)

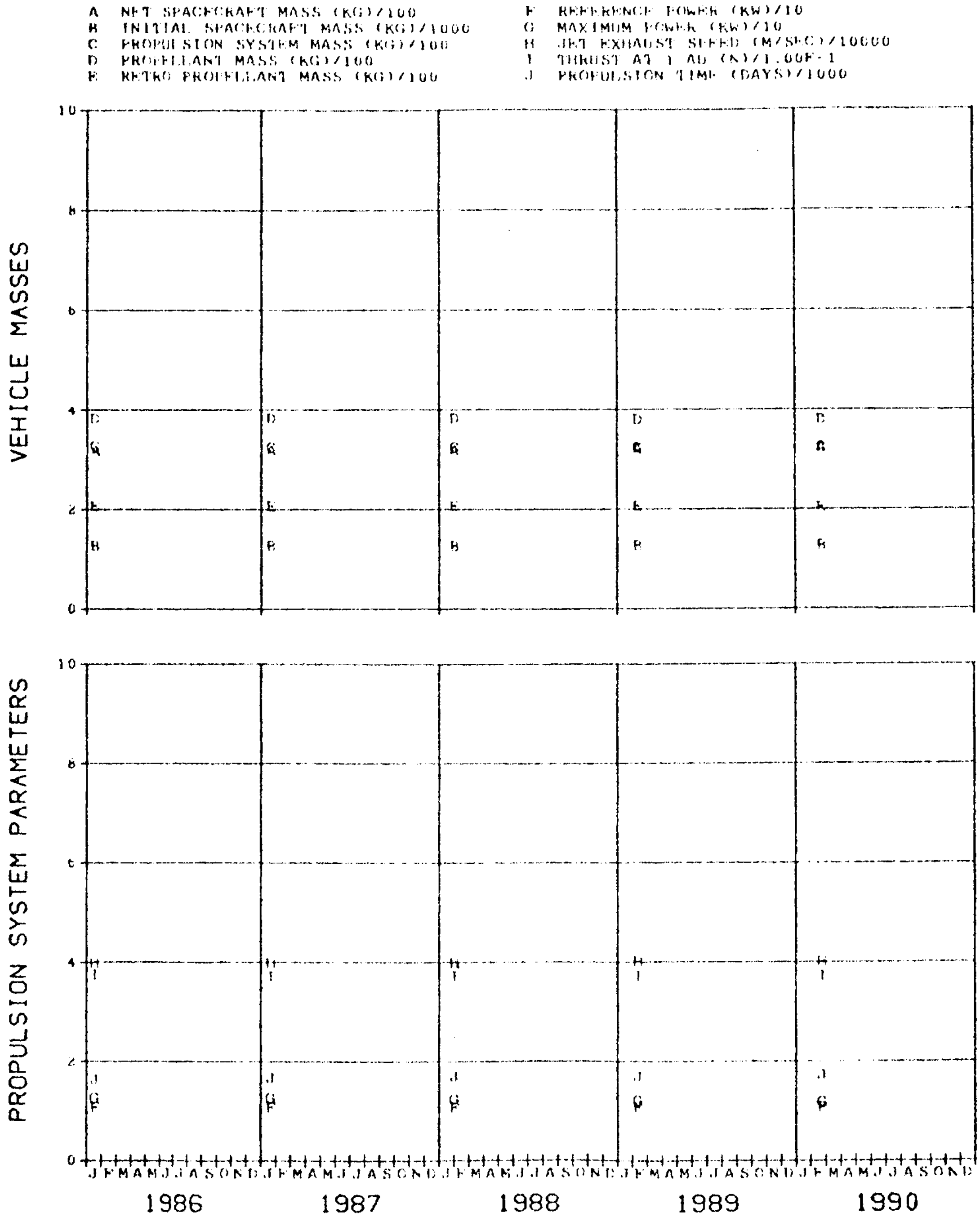

FIG. 24D. SATURN MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 2300 DAYS

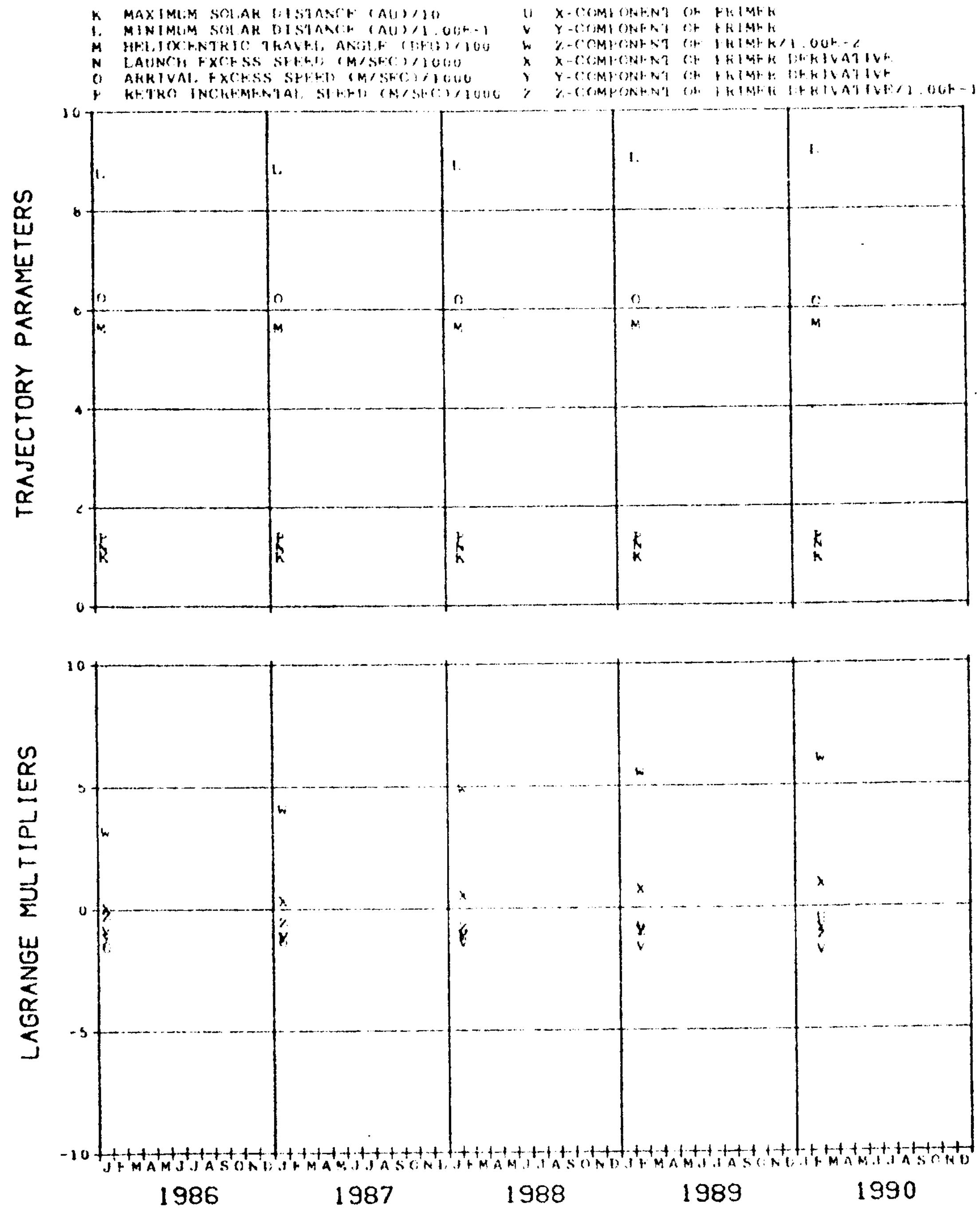

FIG. 24D. (CONCLUDED)

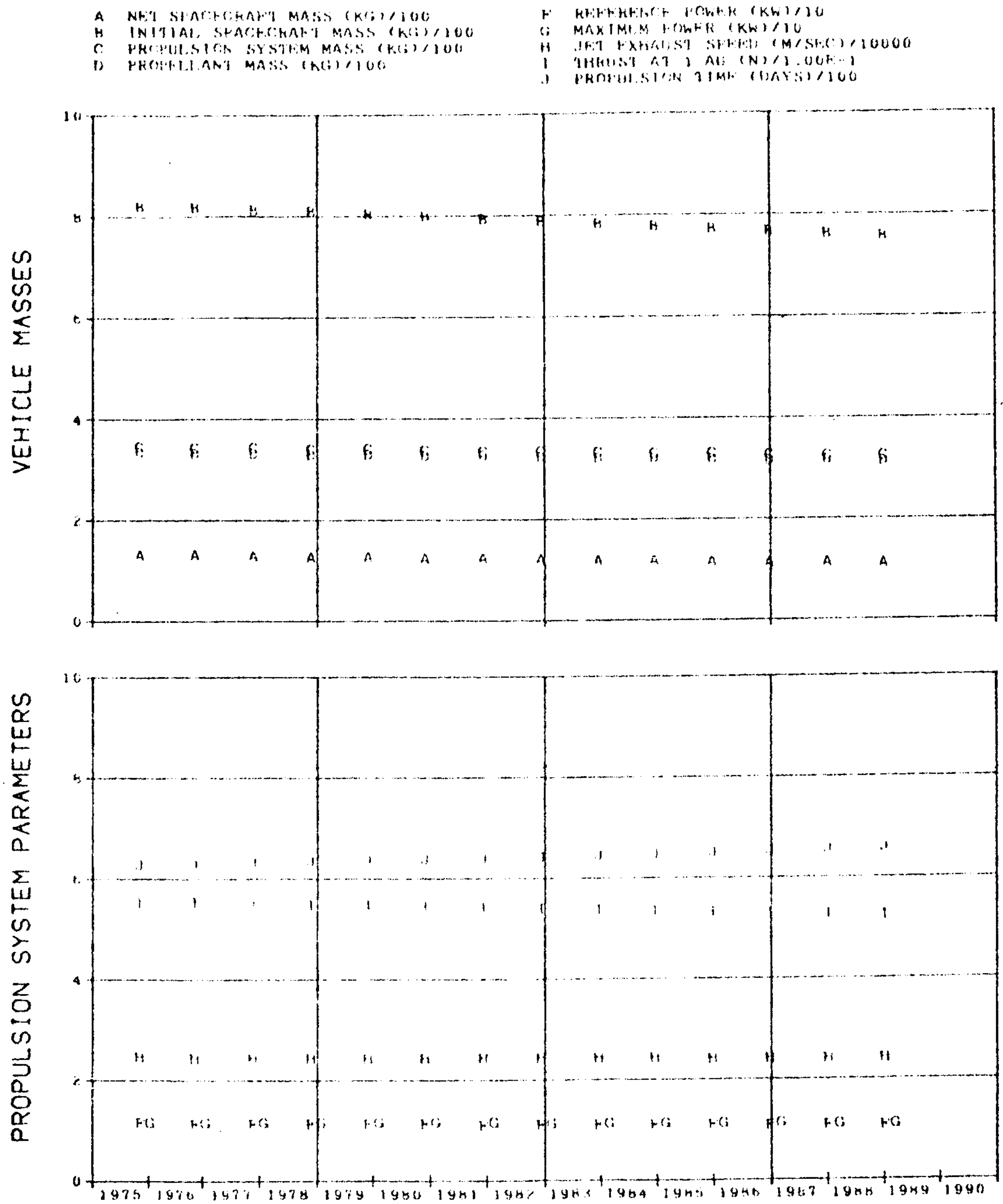

FIG. 25. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

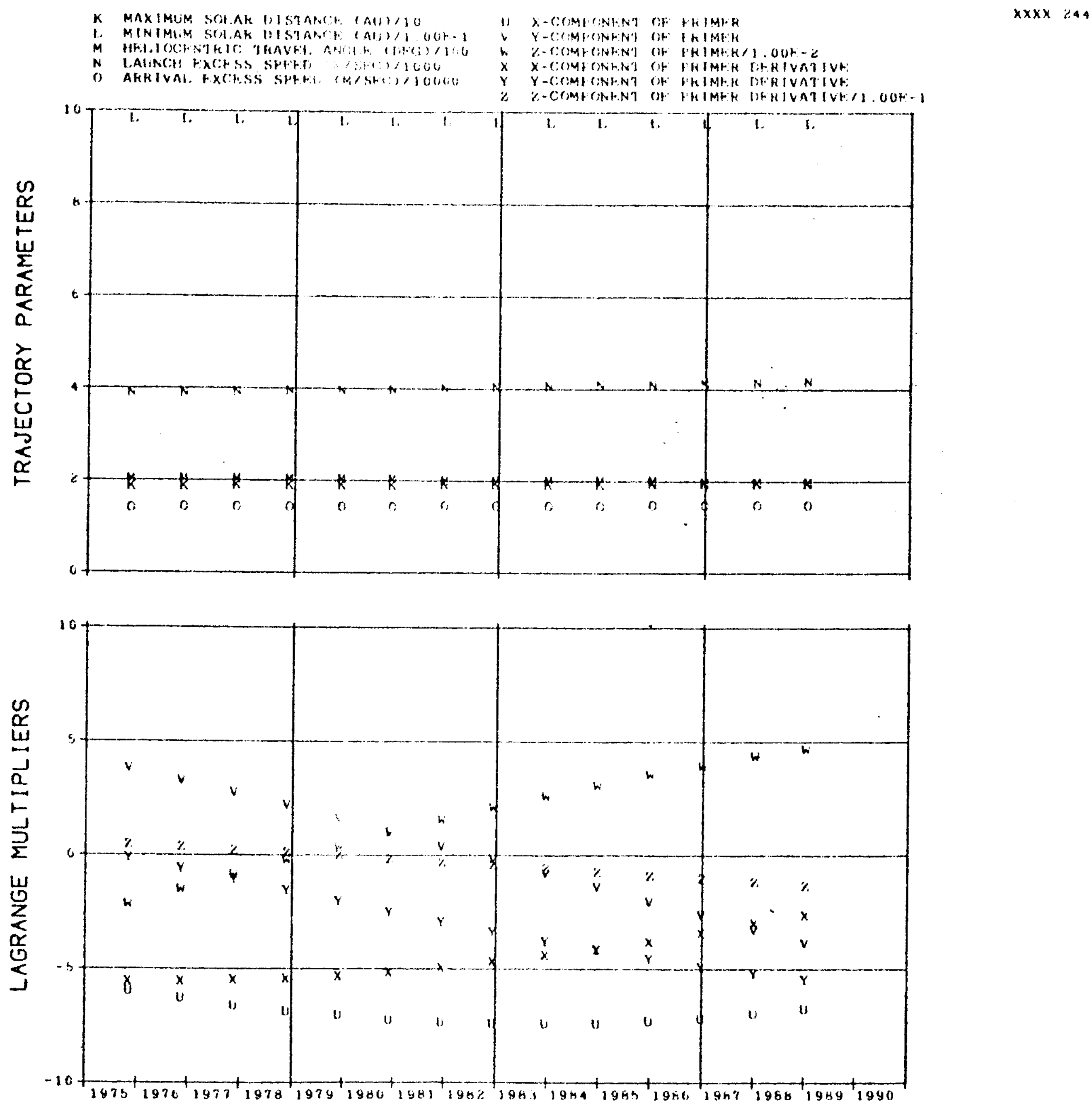

FIG. 25. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/100
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/100

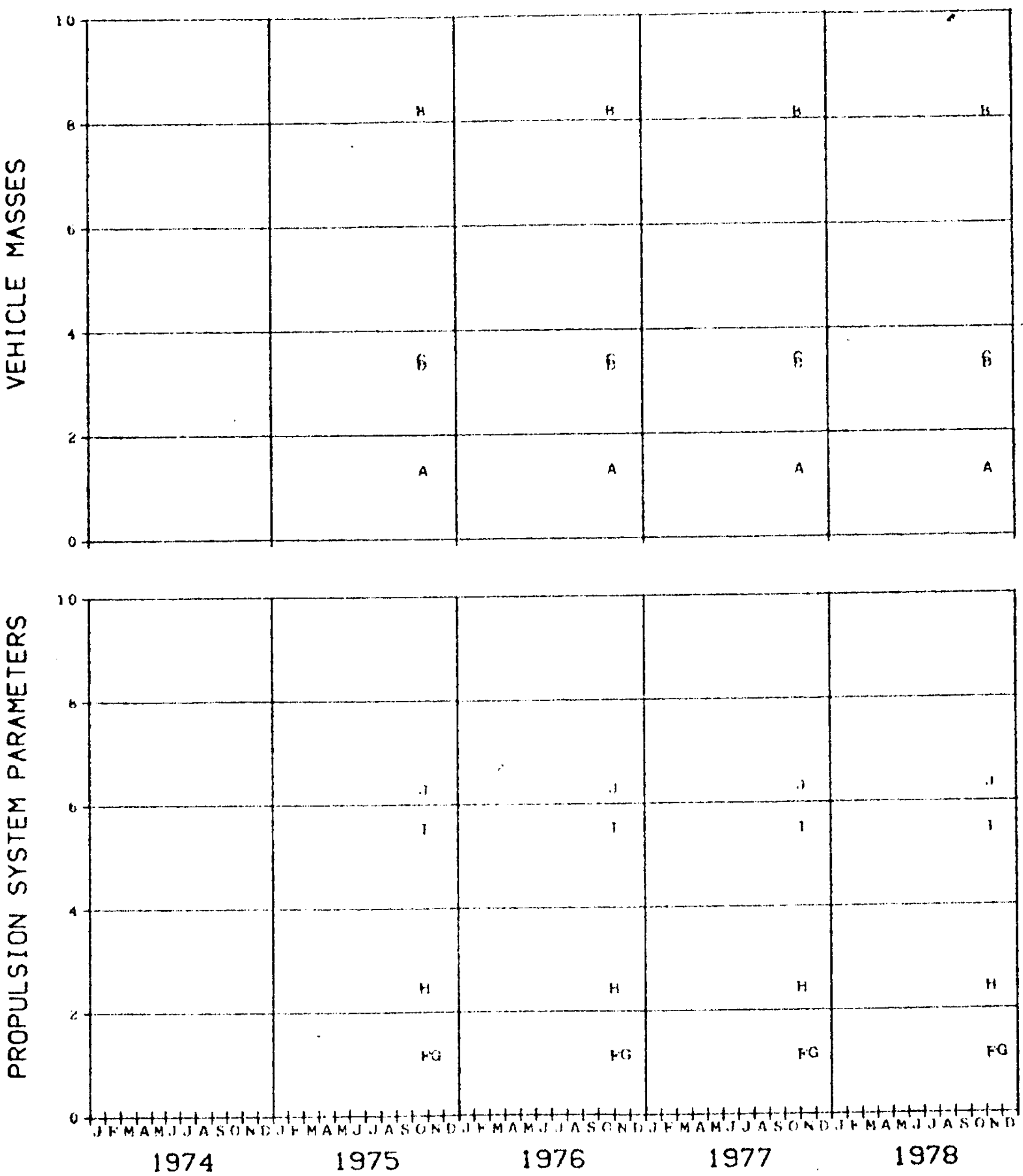

FIG. 25A. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

XXXX 246

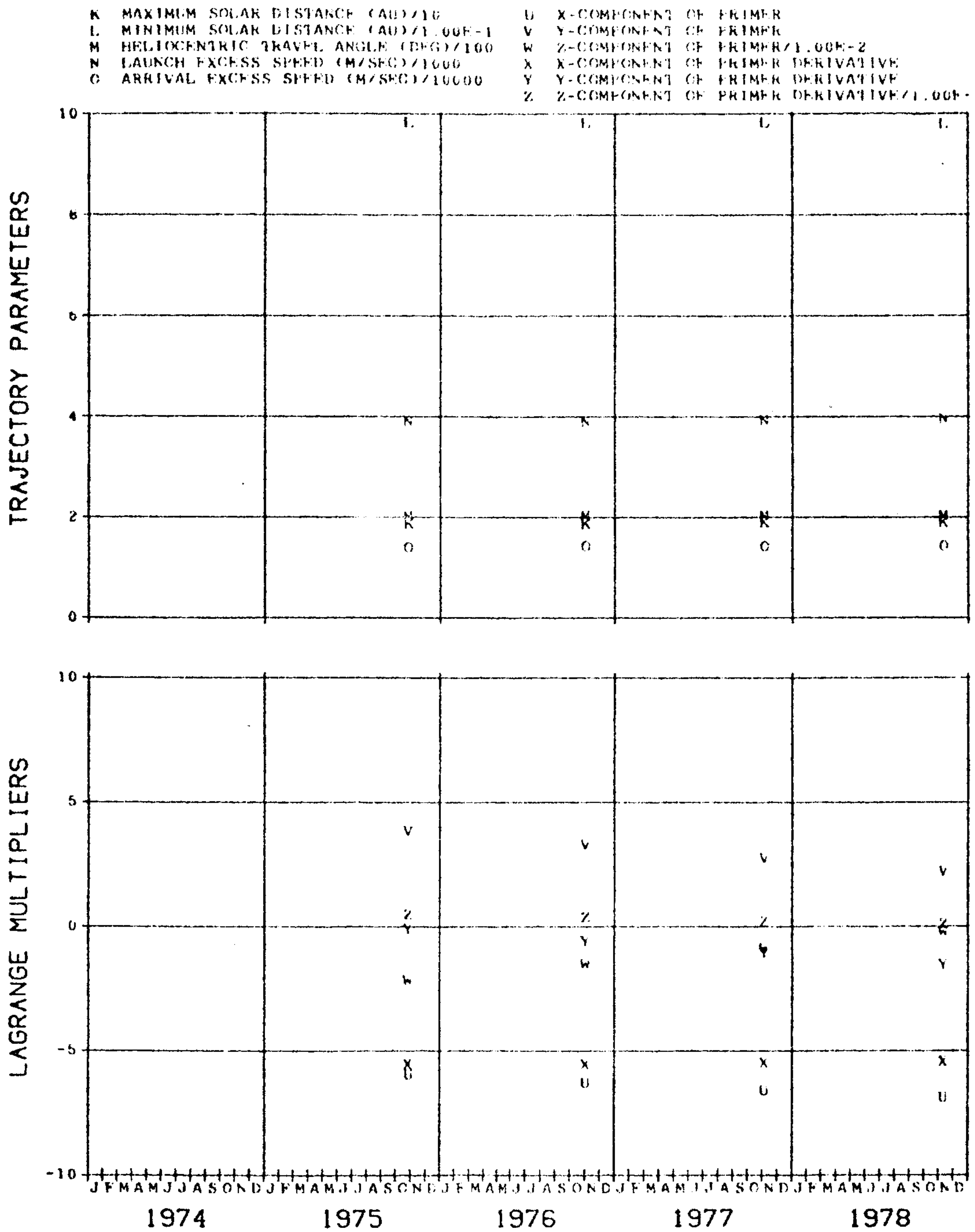

FIG. 25A. (CONCLUDED)

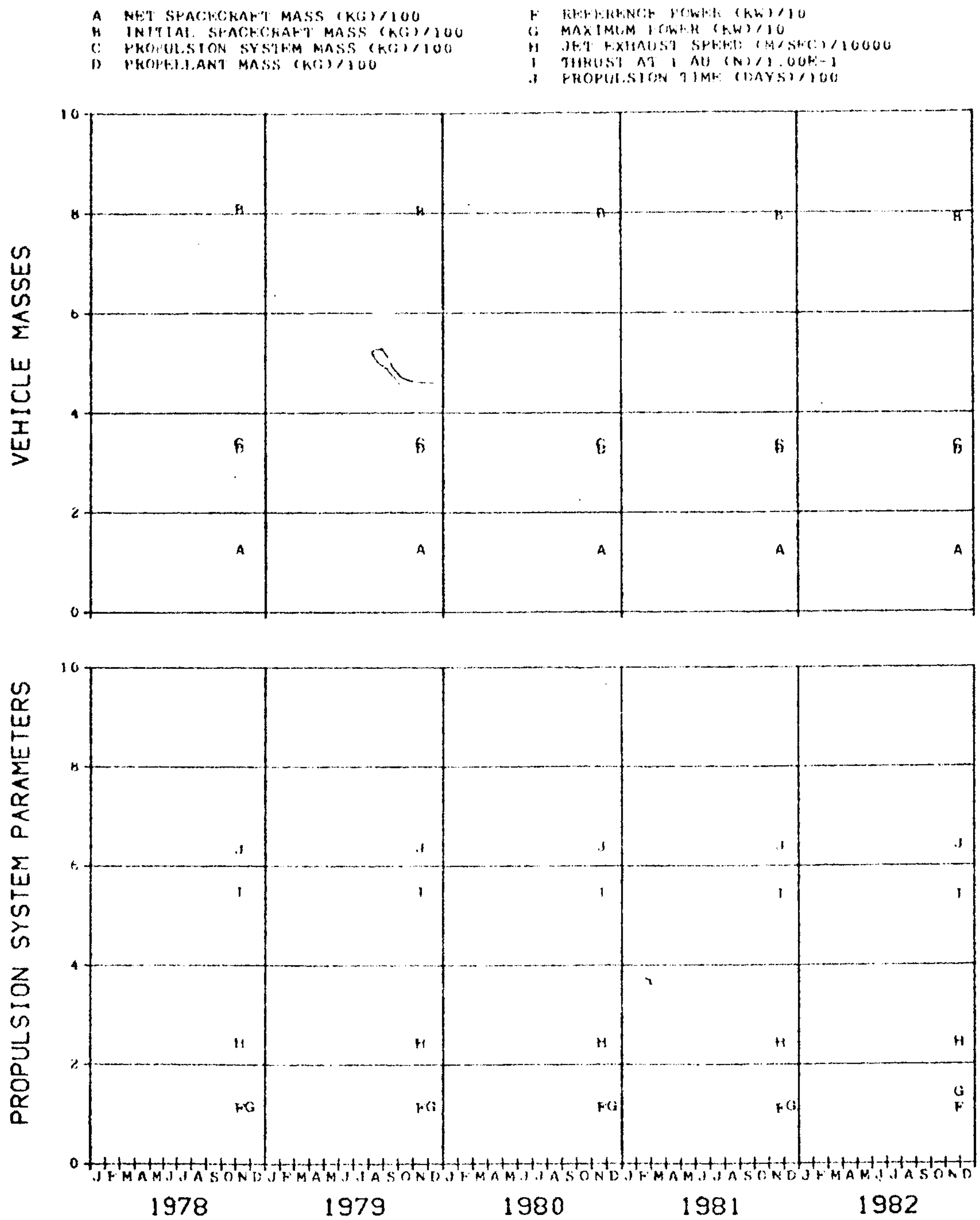

FIG. 25B. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

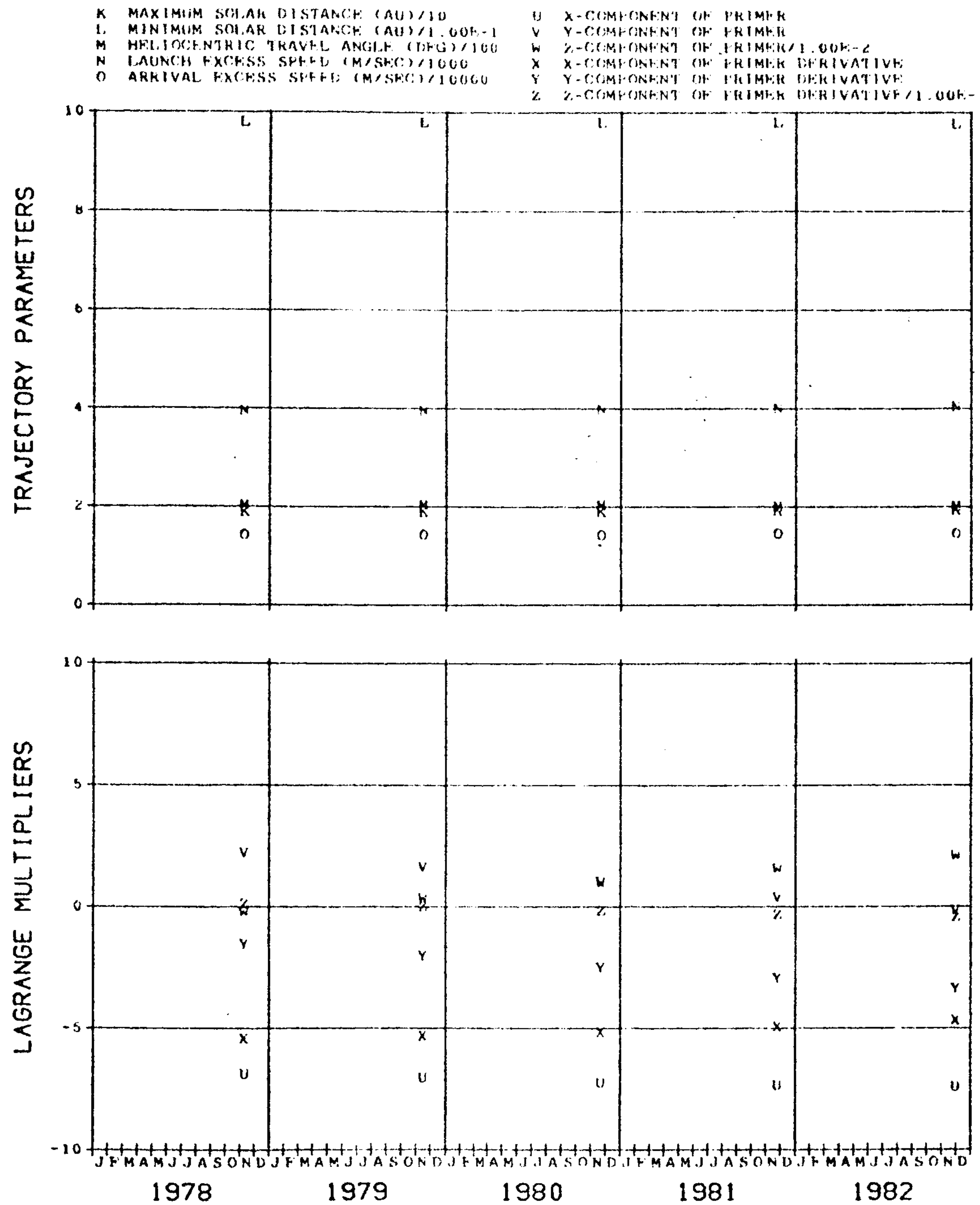

FIG. 25B. (CONCLUDED)

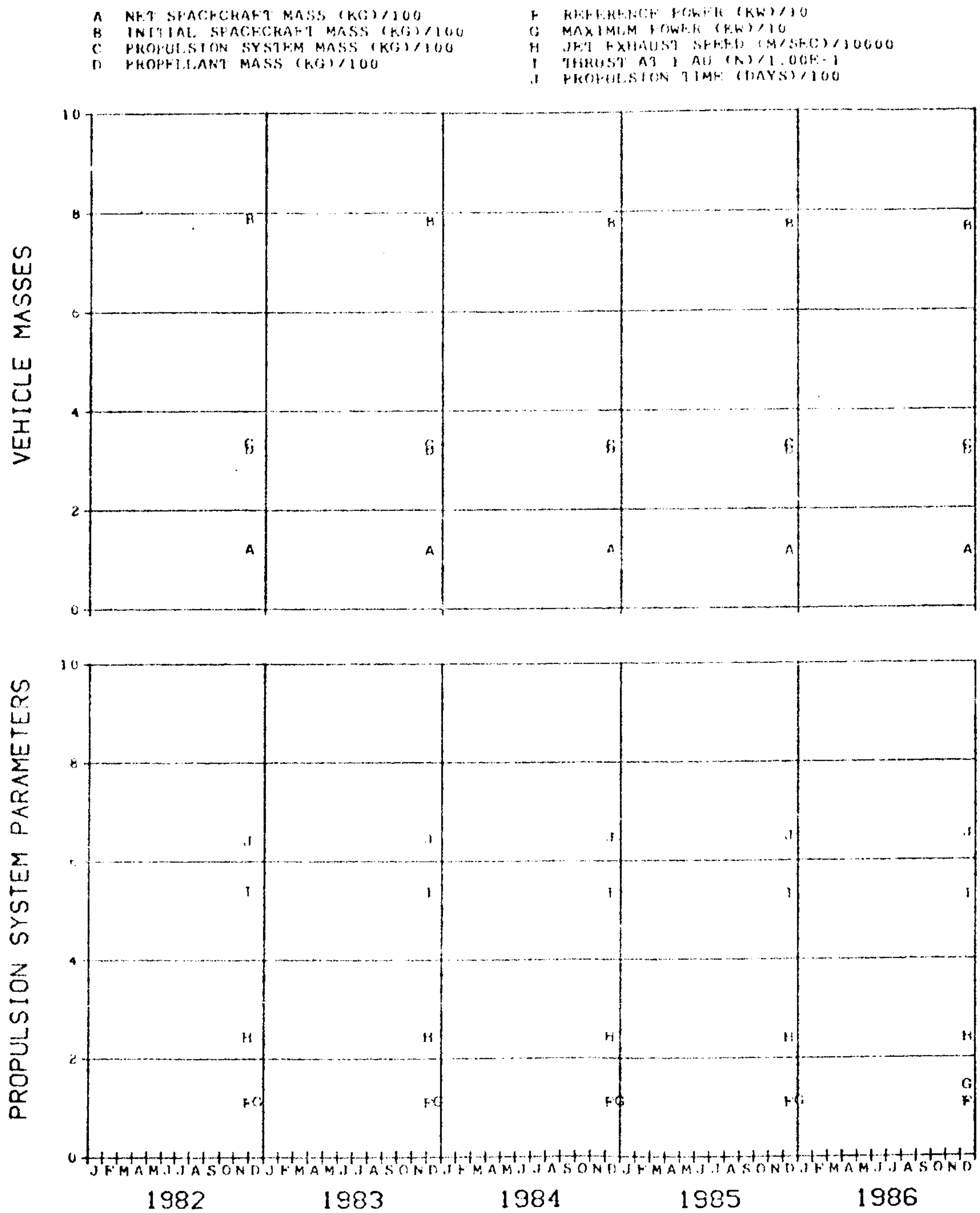

FIG. 25C. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

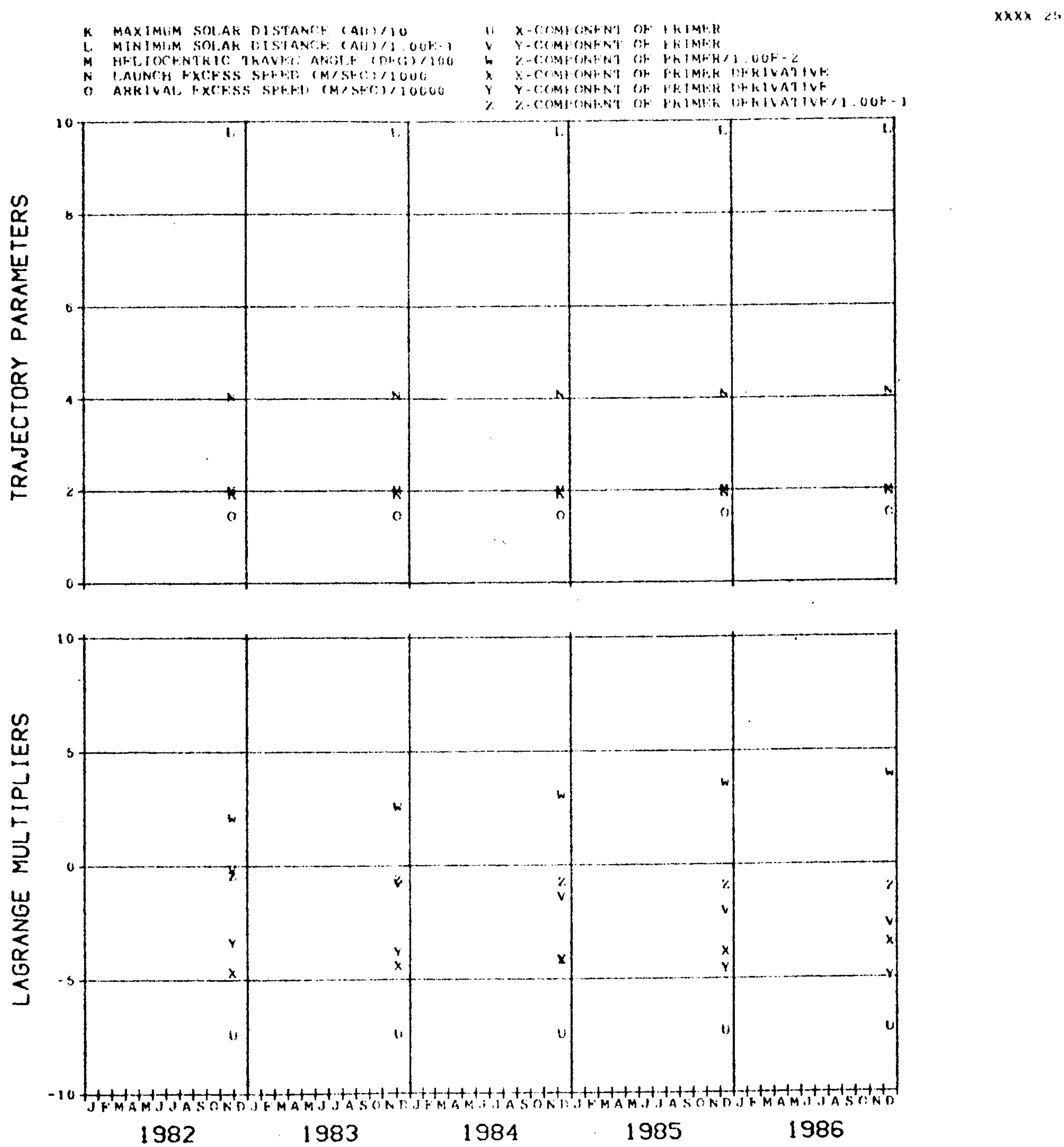

FIG. 25C. (CONCLUDED)

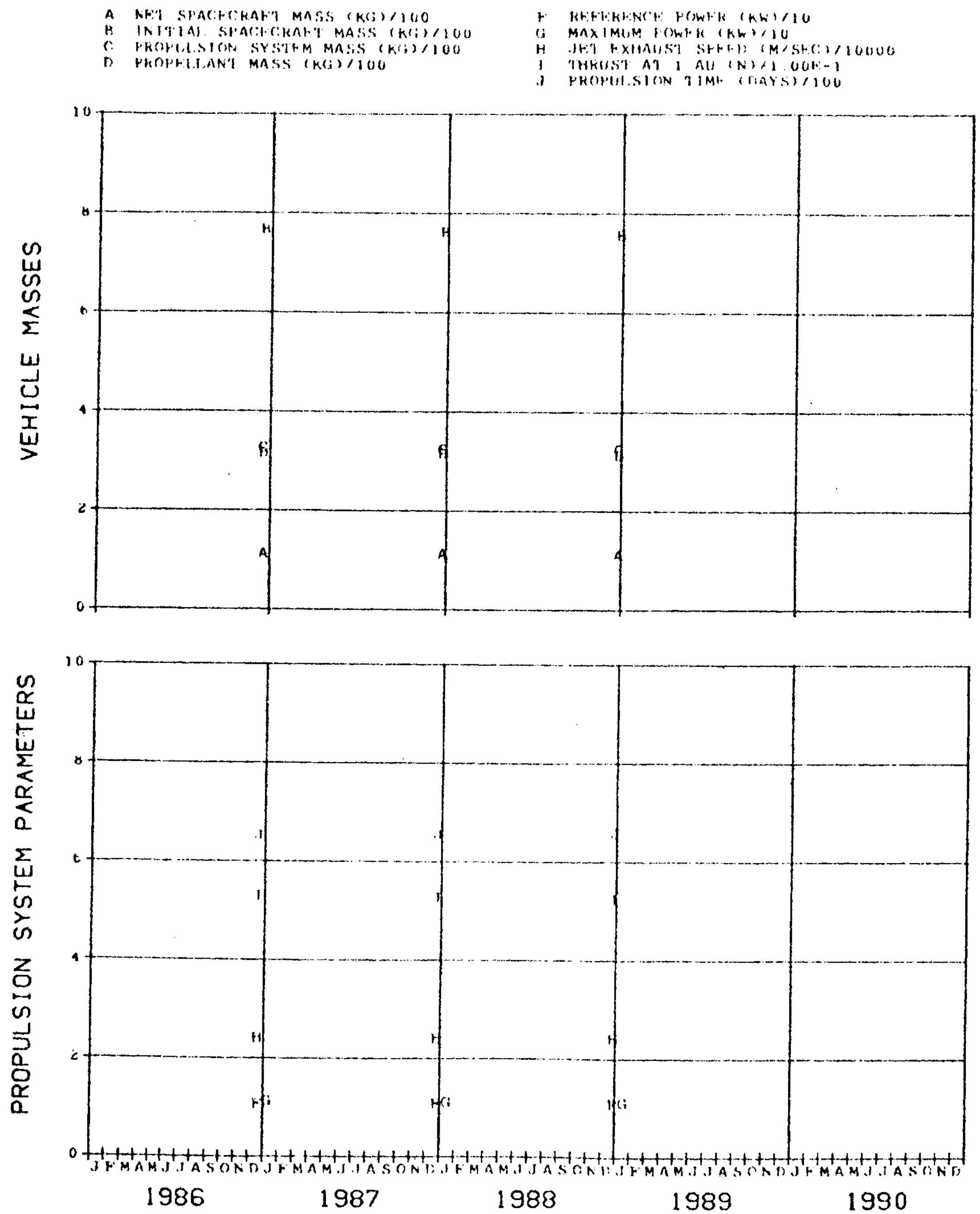

FIG. 25D. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

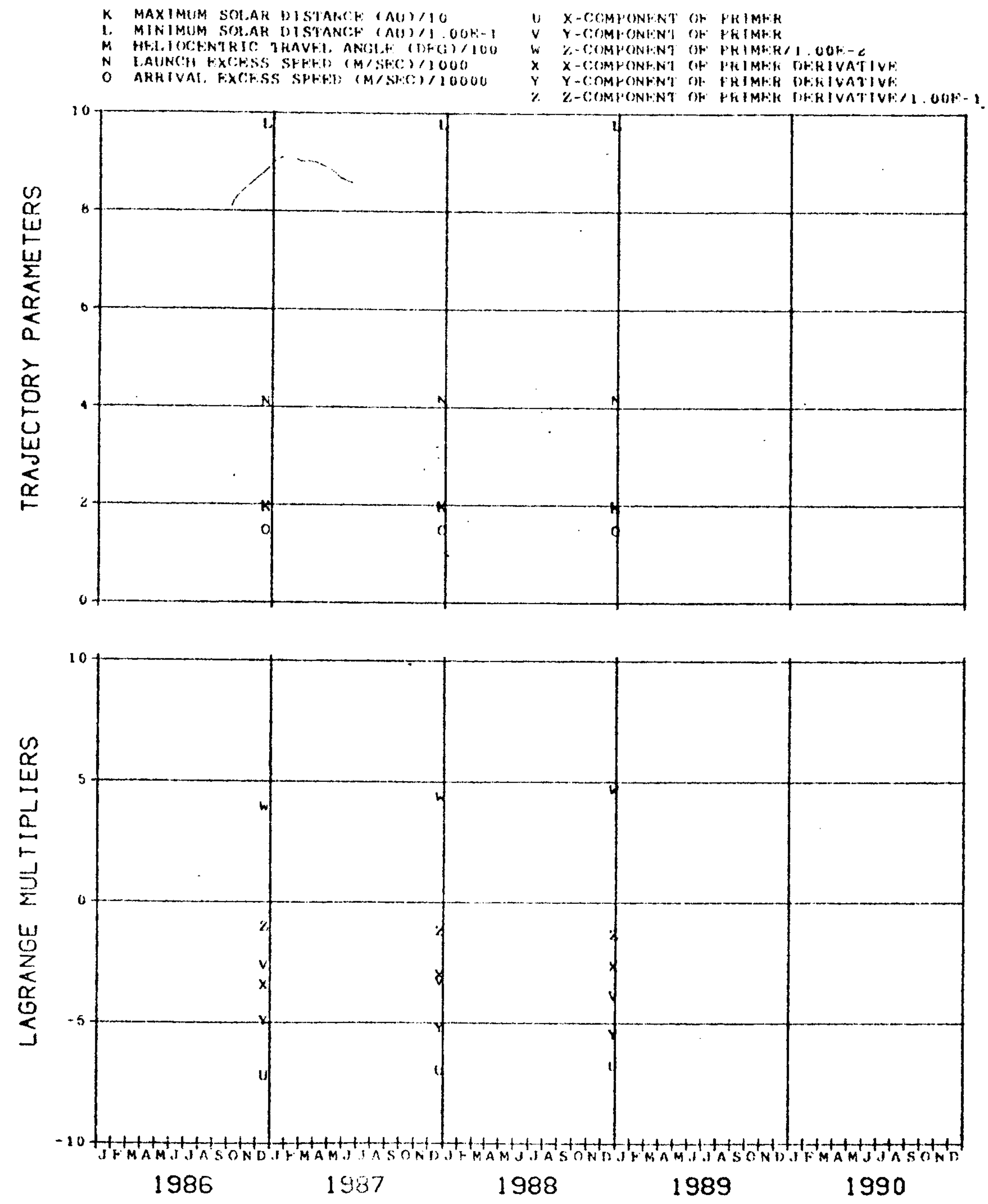

FIG. 25D. (CONCLUDED)

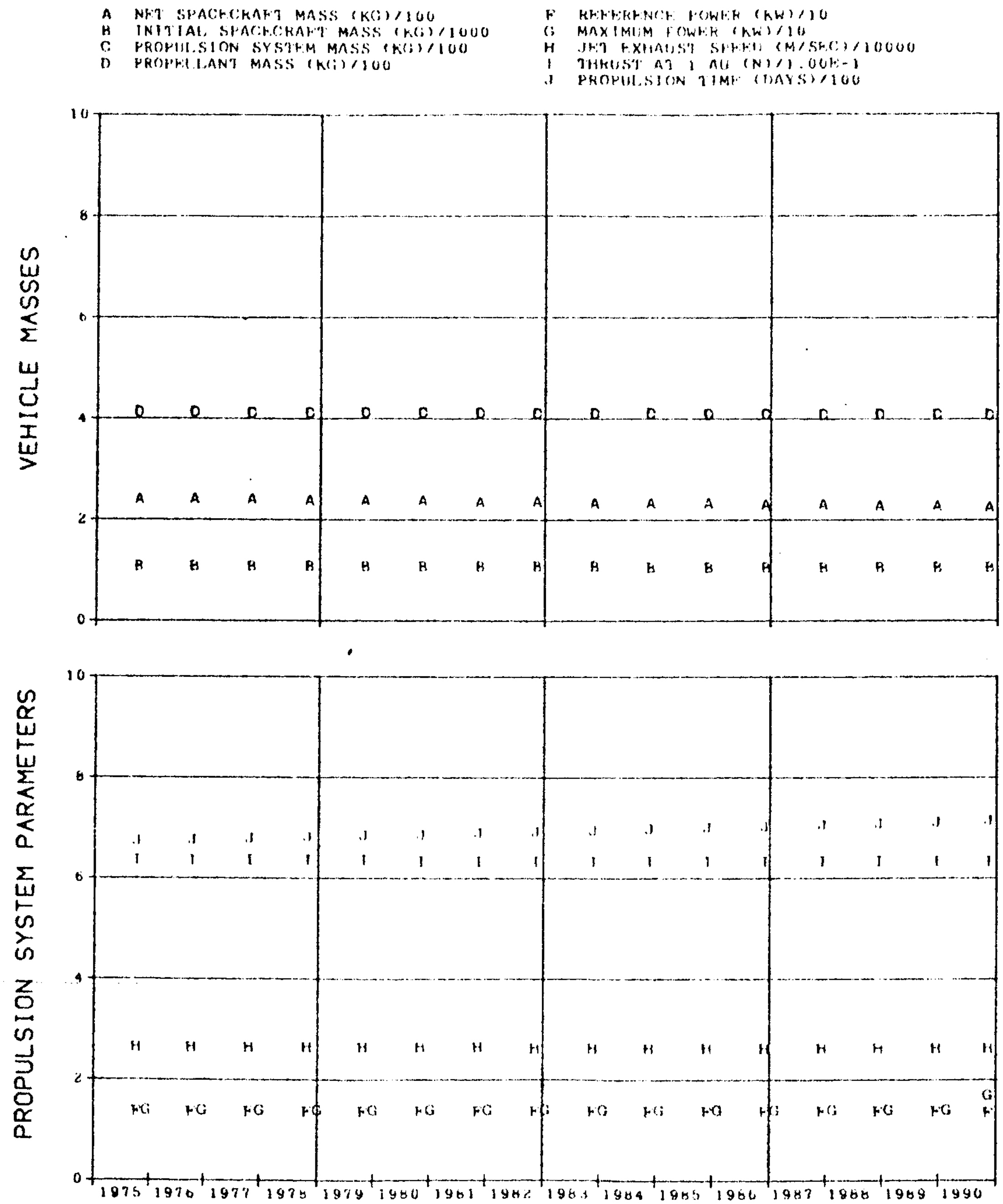

FIG. 26. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

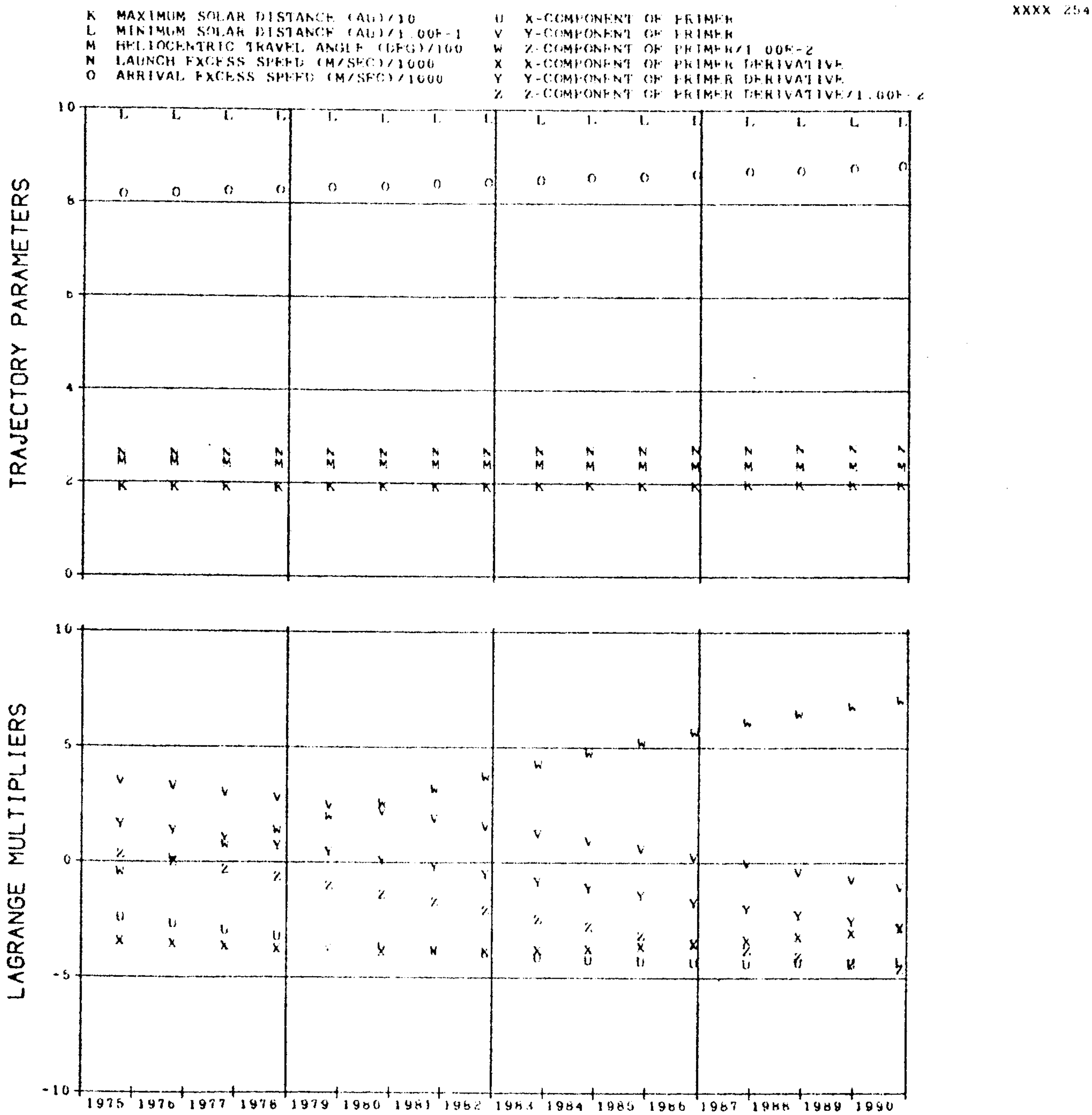

FIG. 26. (CONCLUDED)

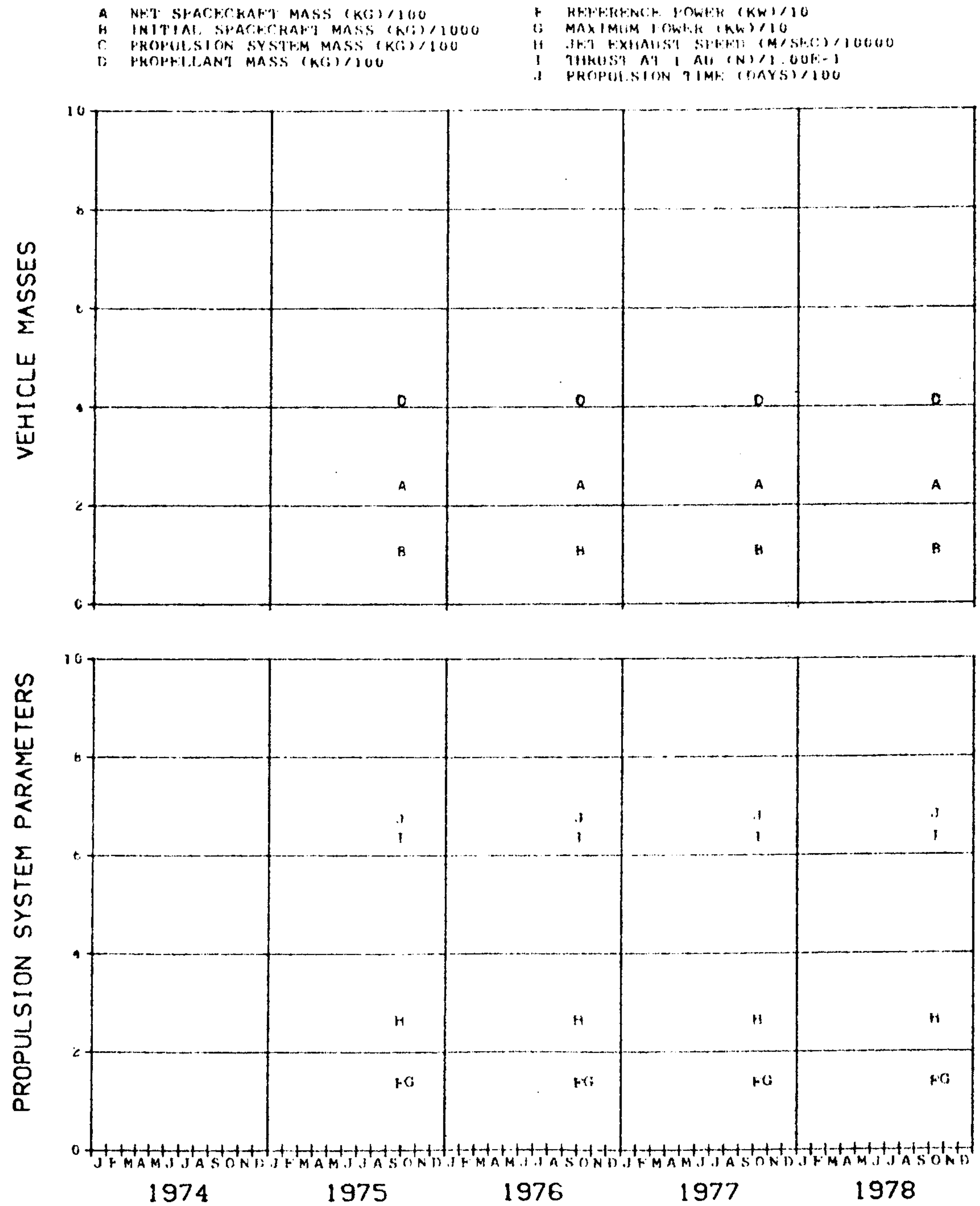

FIG. 26A. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

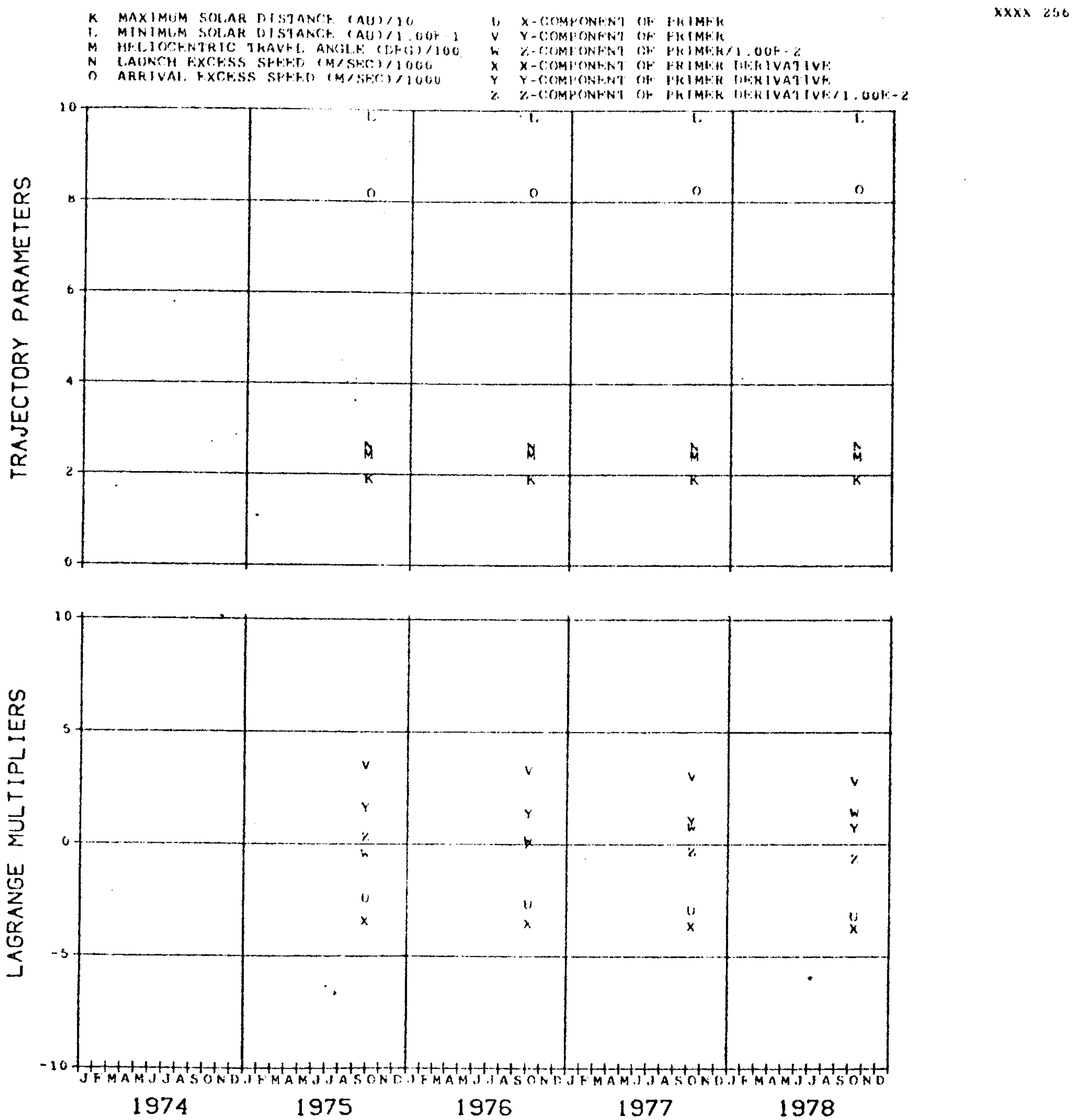

FIG. 26A. (CONCLUDED)

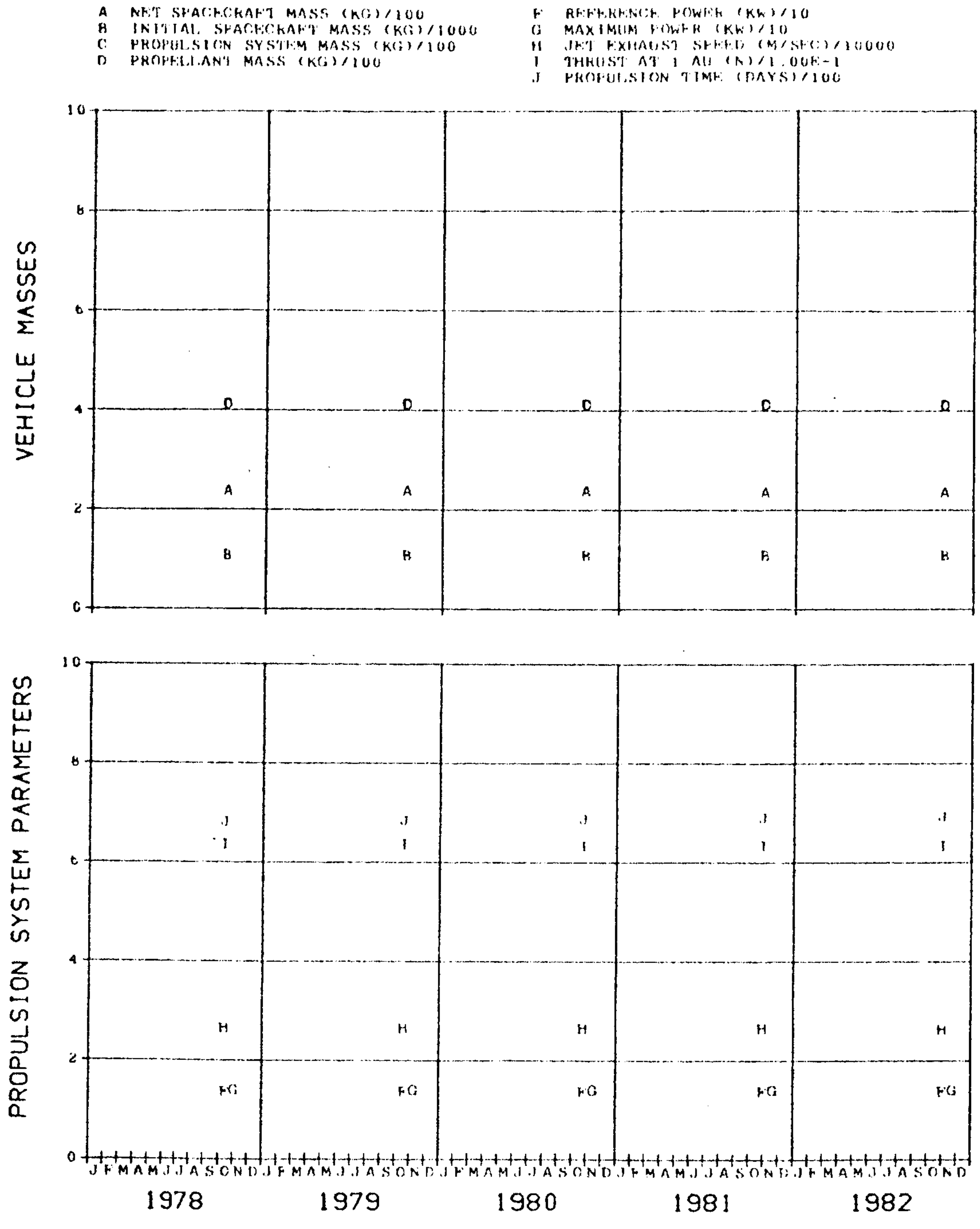

FIG. 26B. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

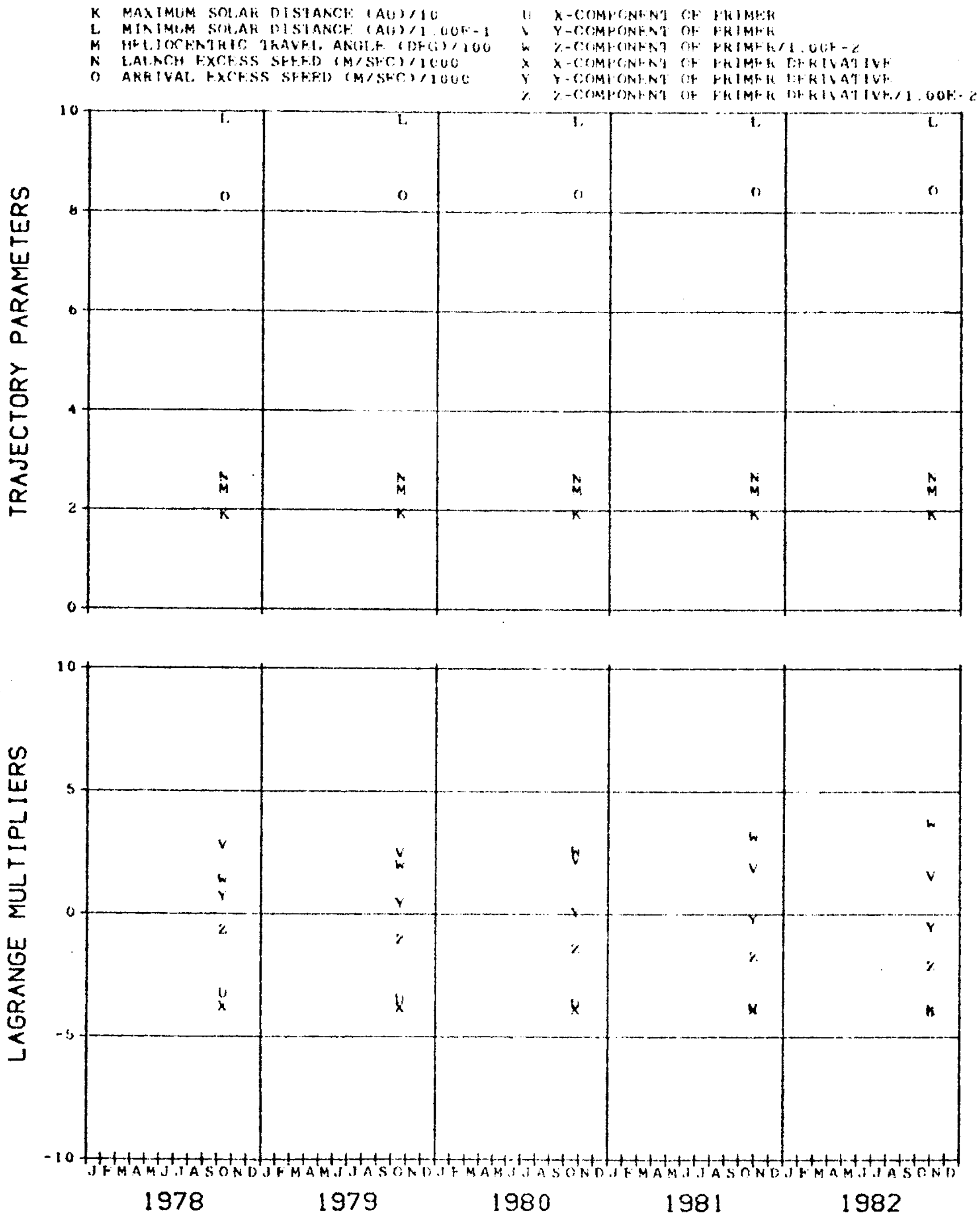

FIG. 26B. (CONCLUDED)

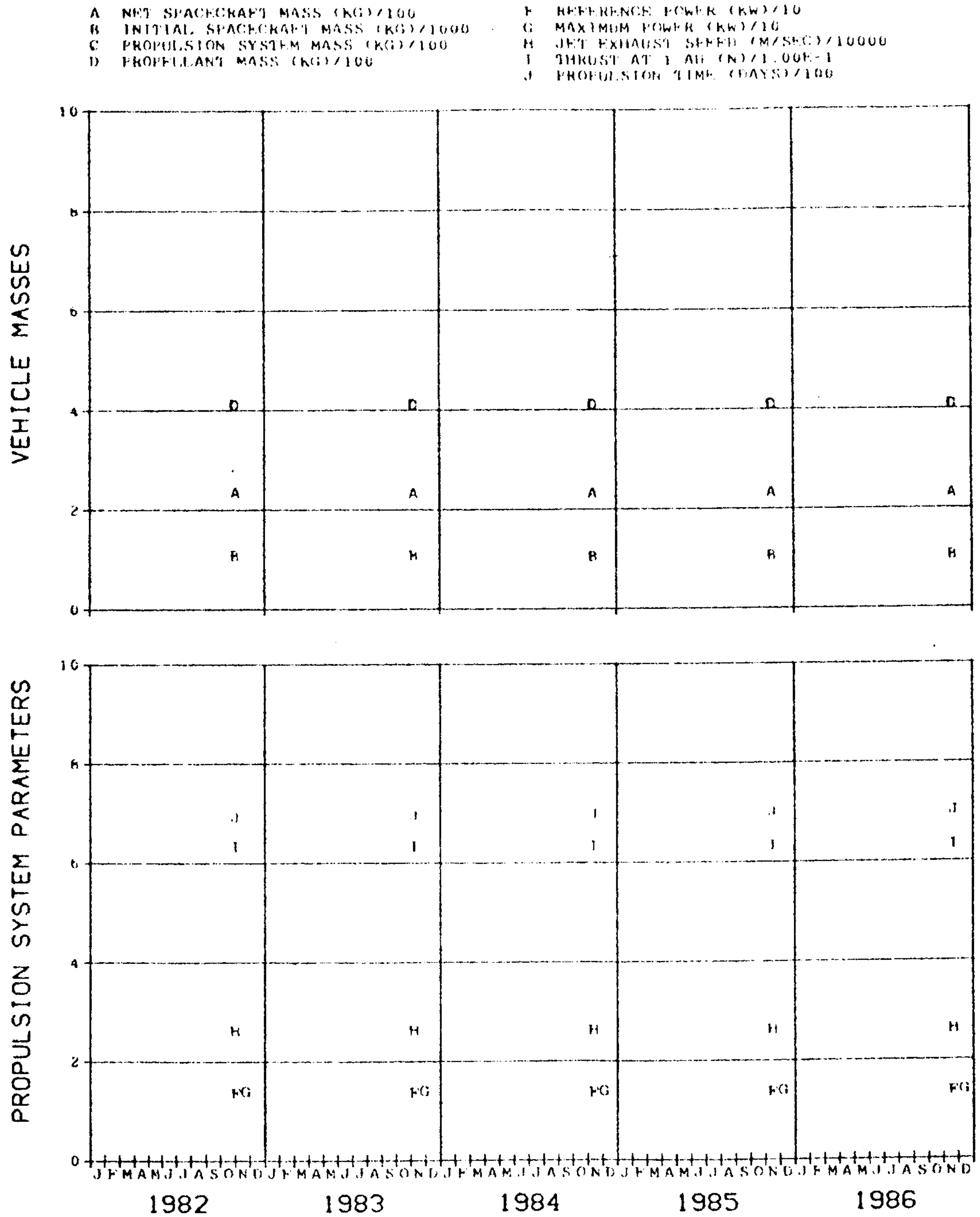

FIG. 26C. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

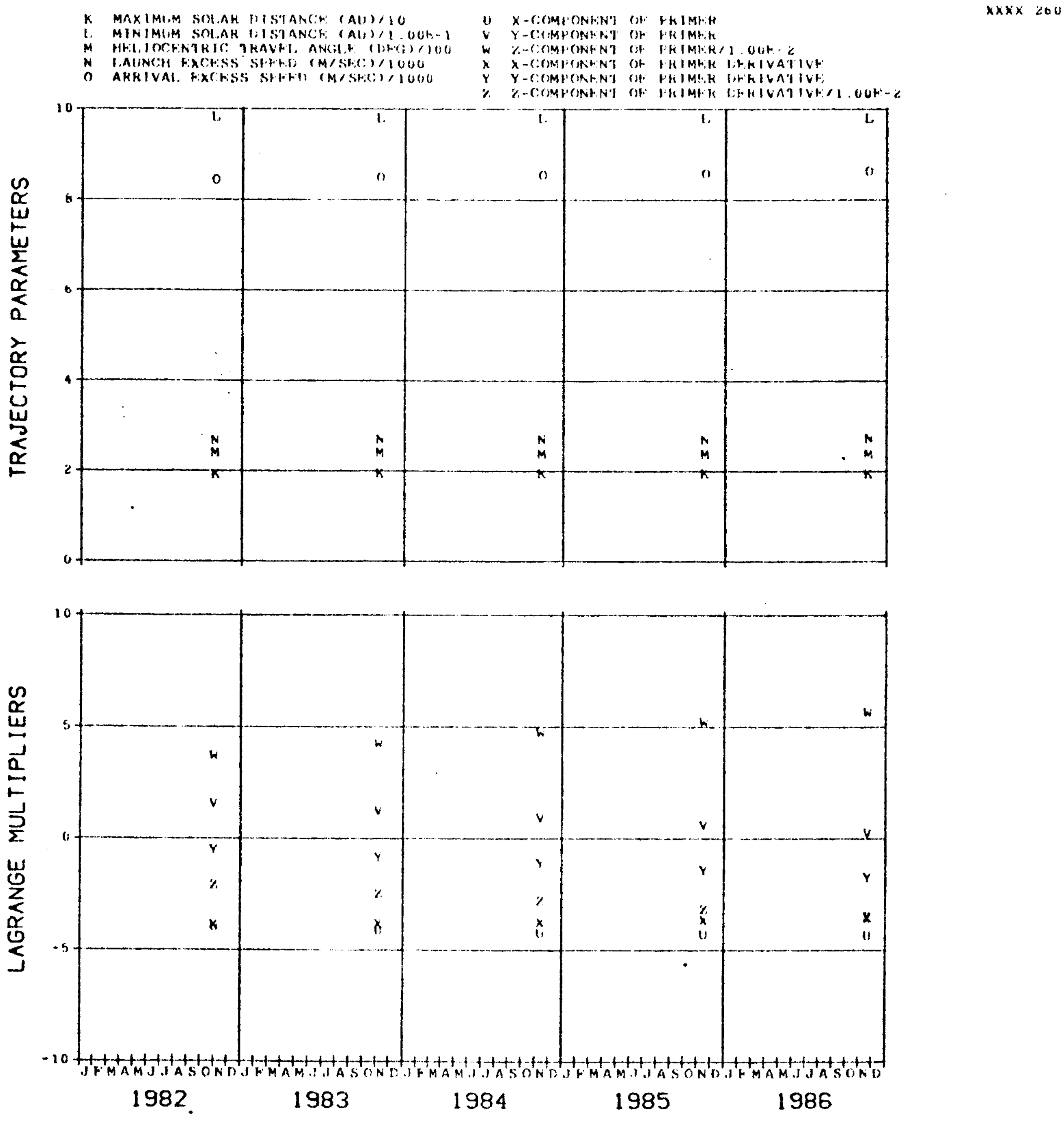

FIG. 26C. (CONCLUDED)

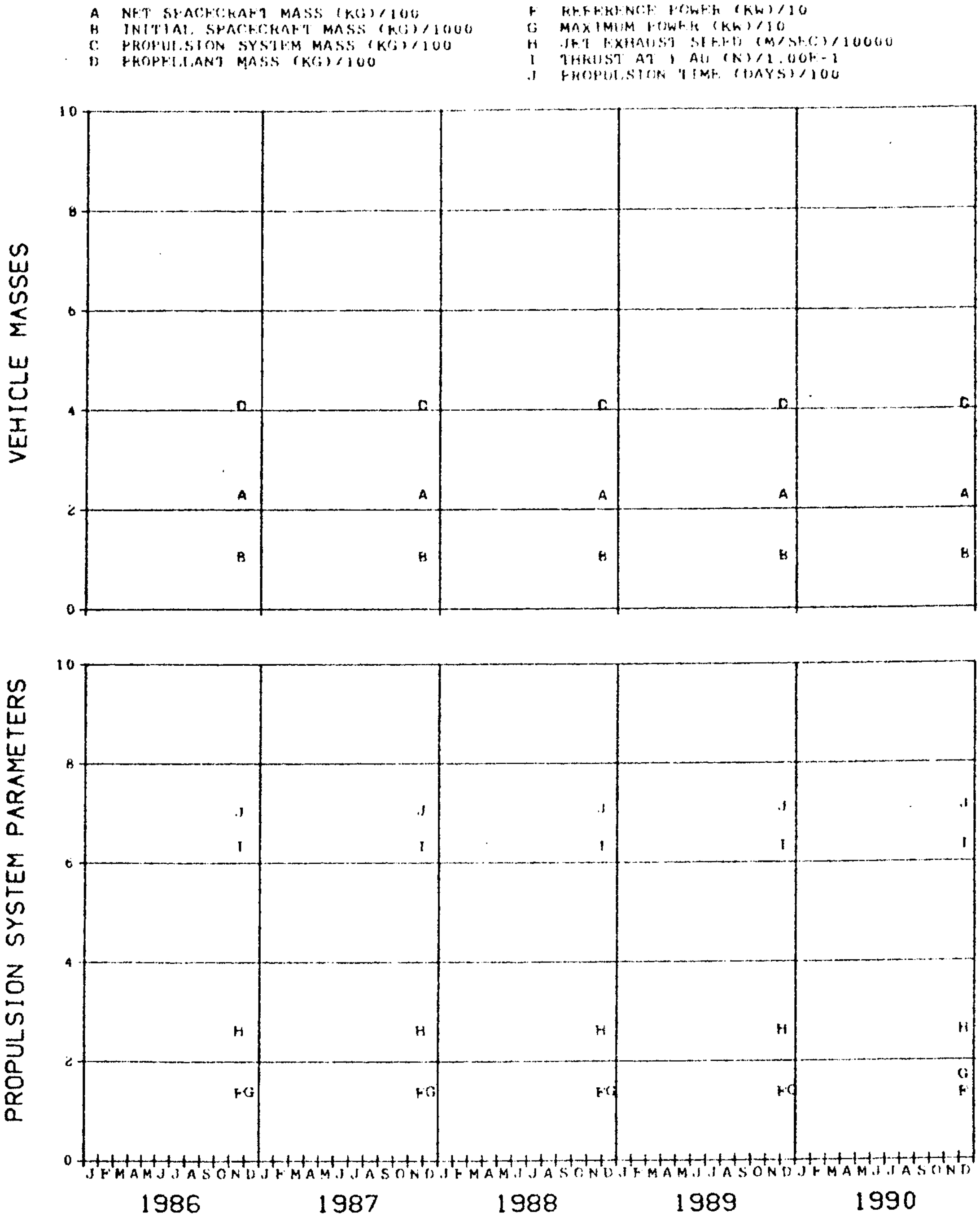

FIG. 26D. URANUS MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

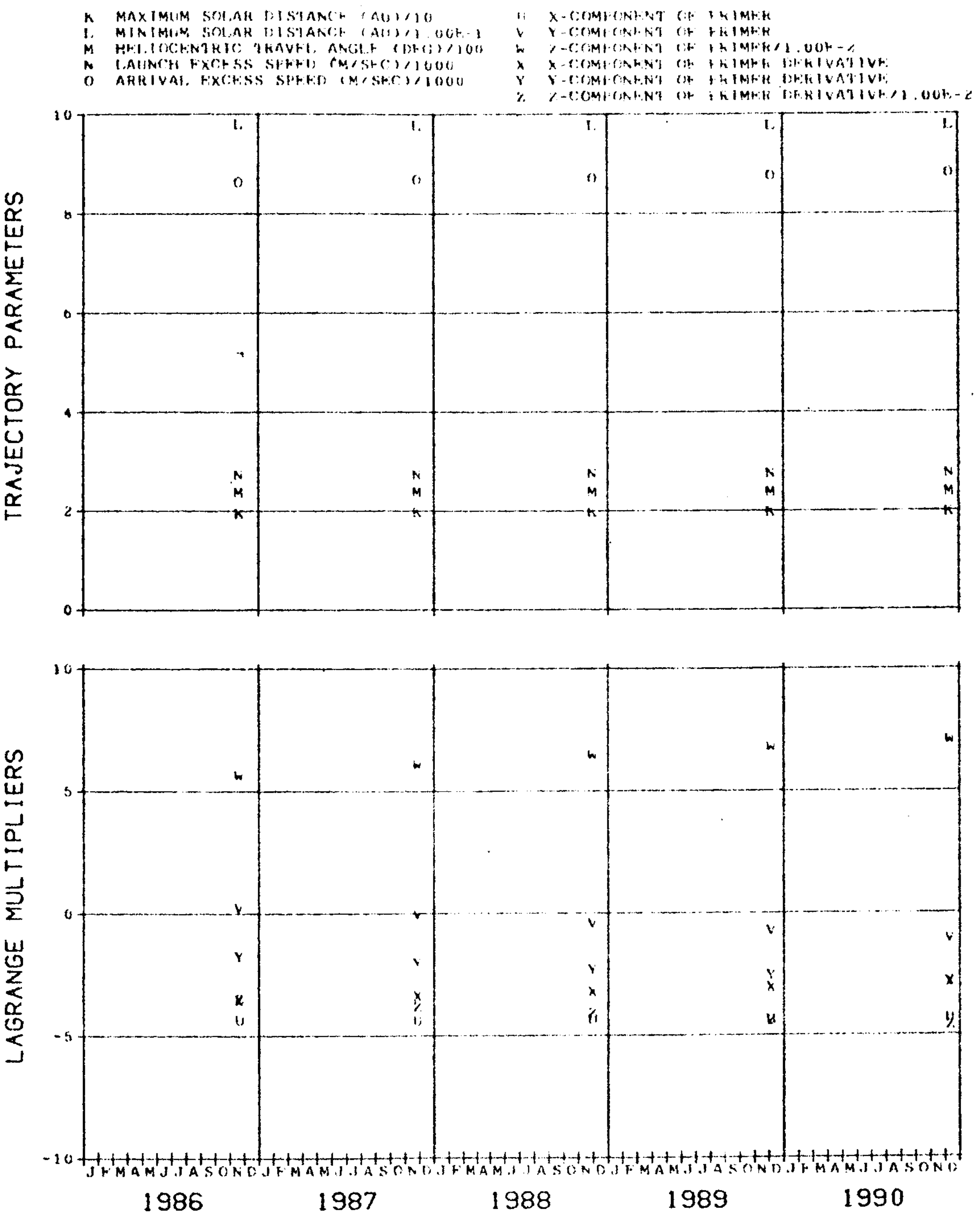

FIG. 26D. (CONCLUDED)

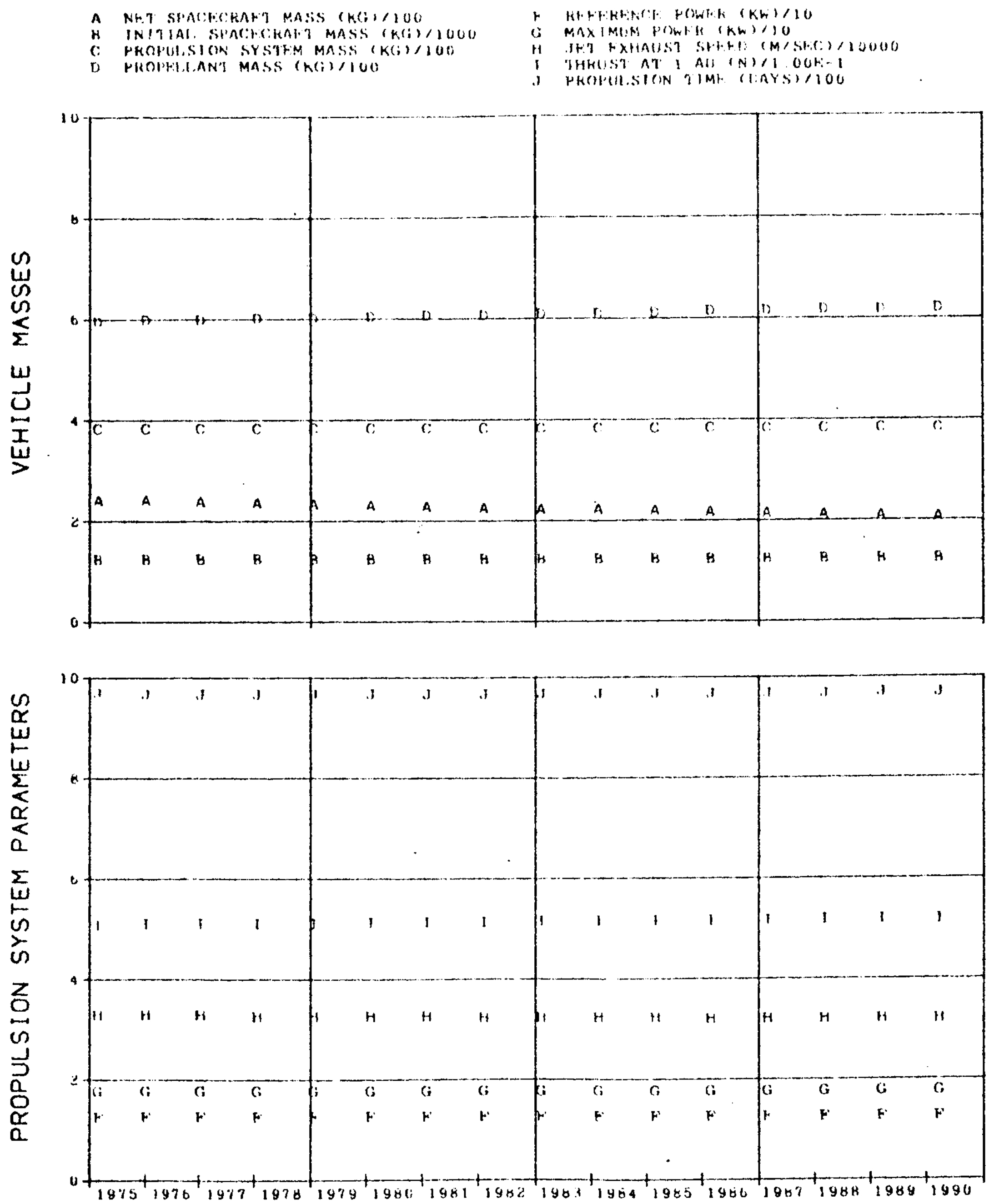

FIG. 27. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

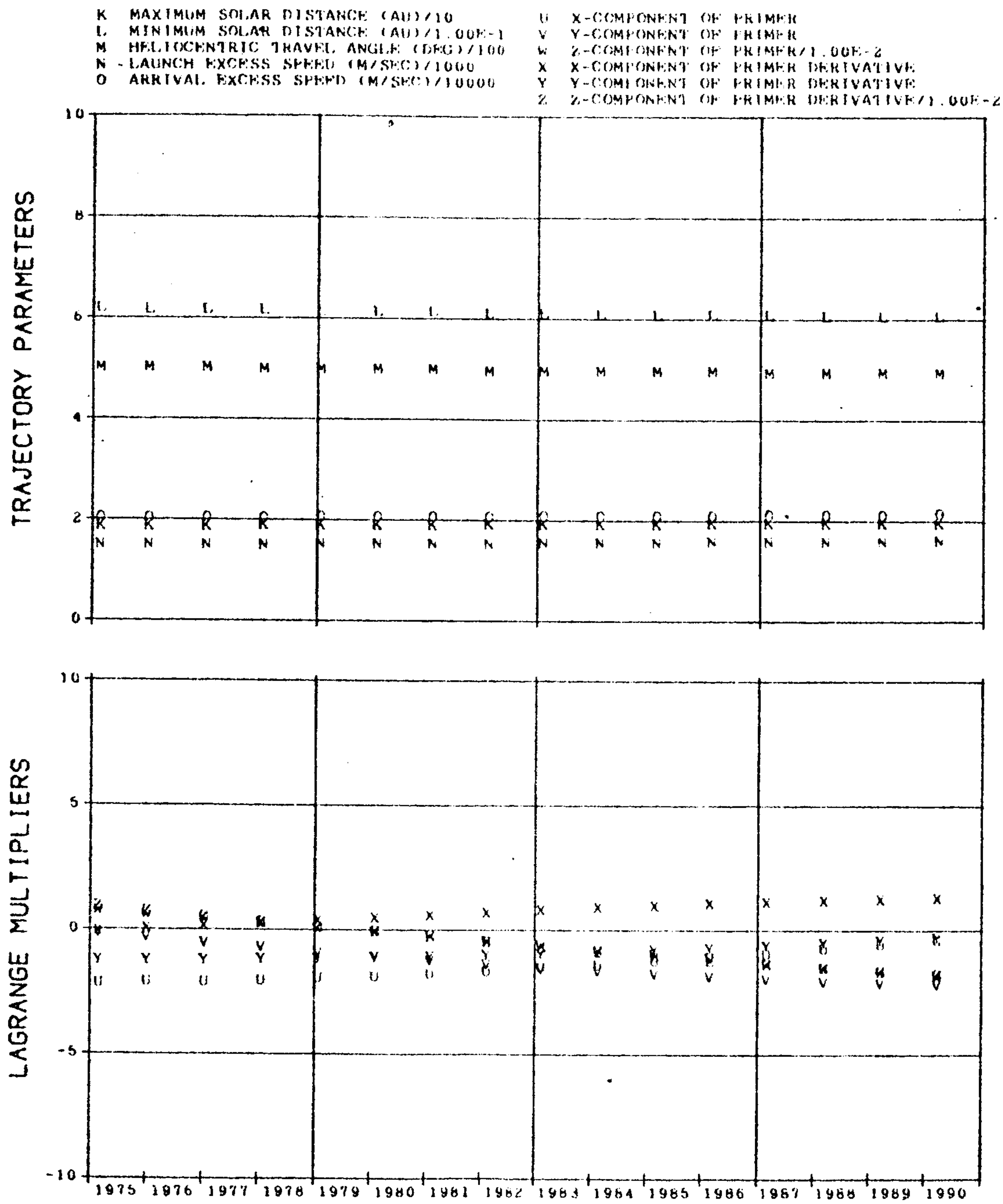

FIG. 27. (CONCLUDED)

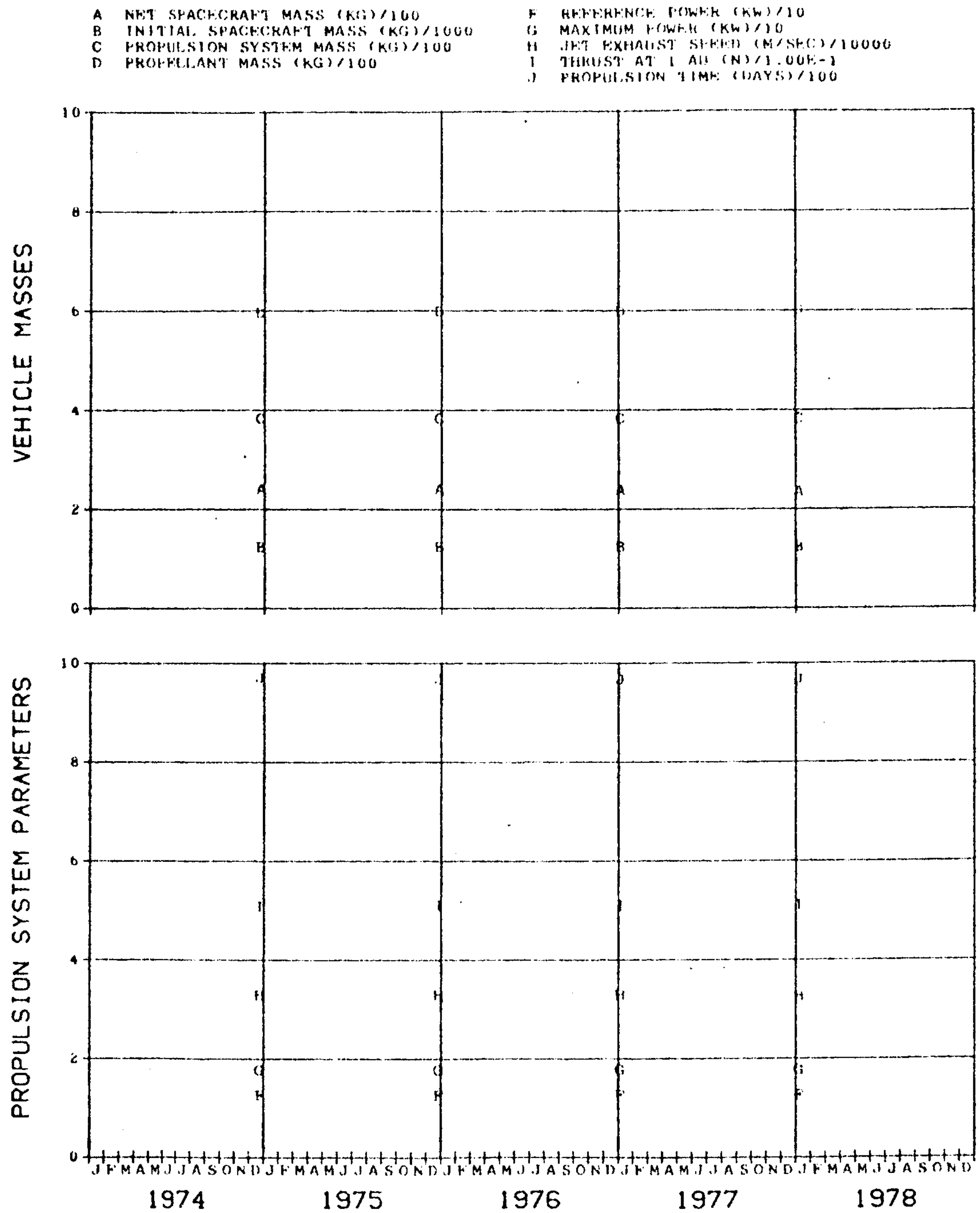

FIG. 27A. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

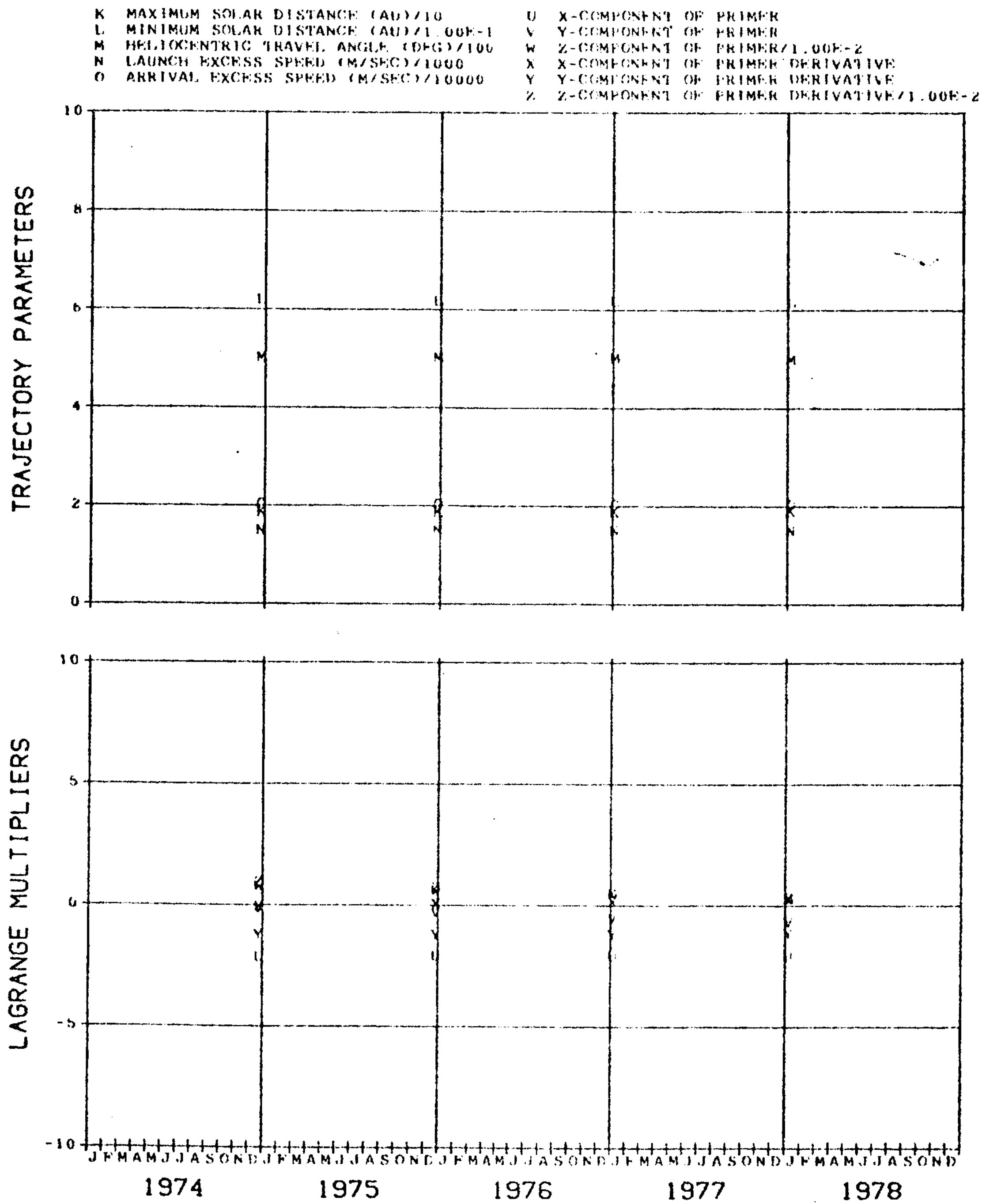

FIG. 27A. (CONCLUDED)

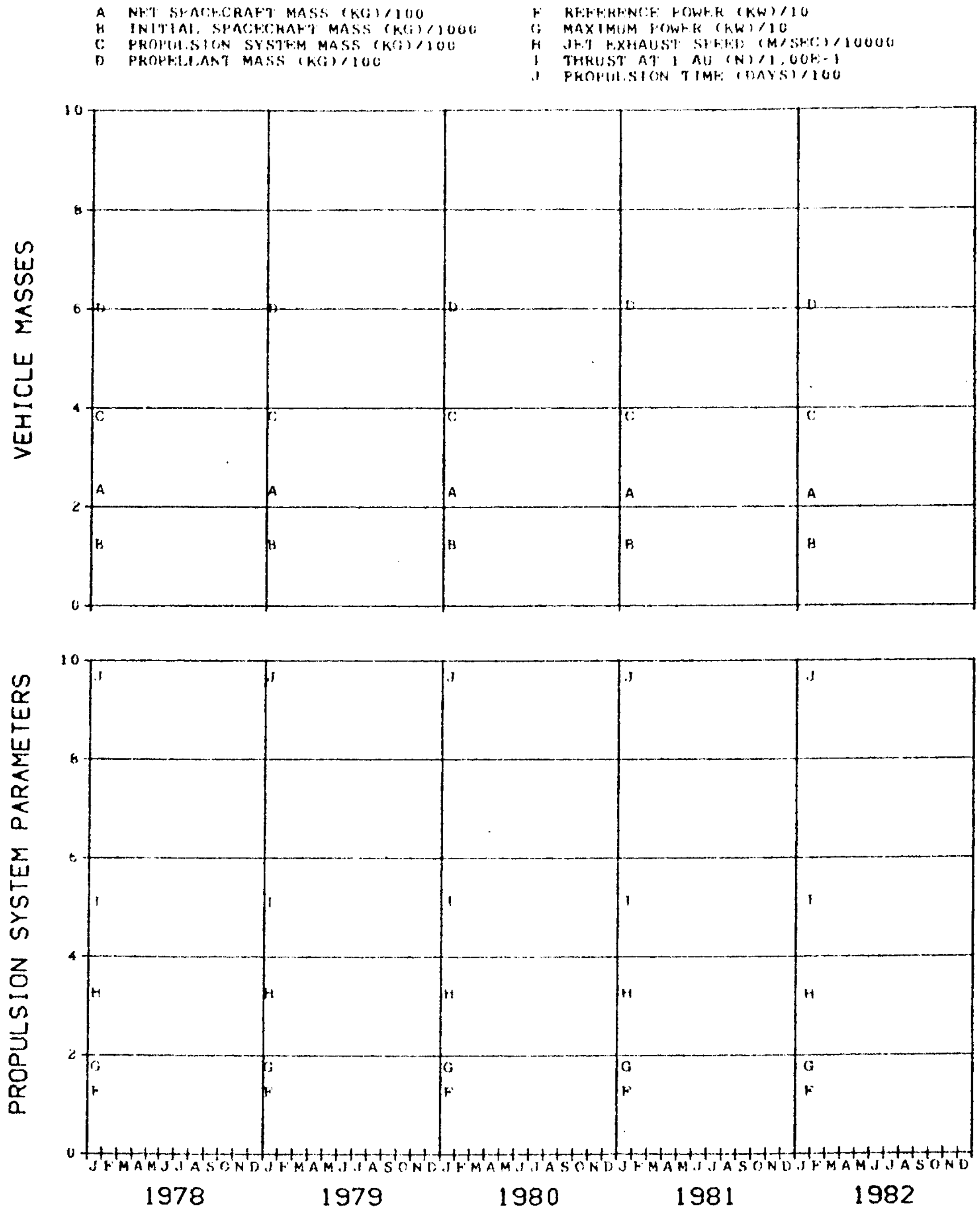

FIG. 27B. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

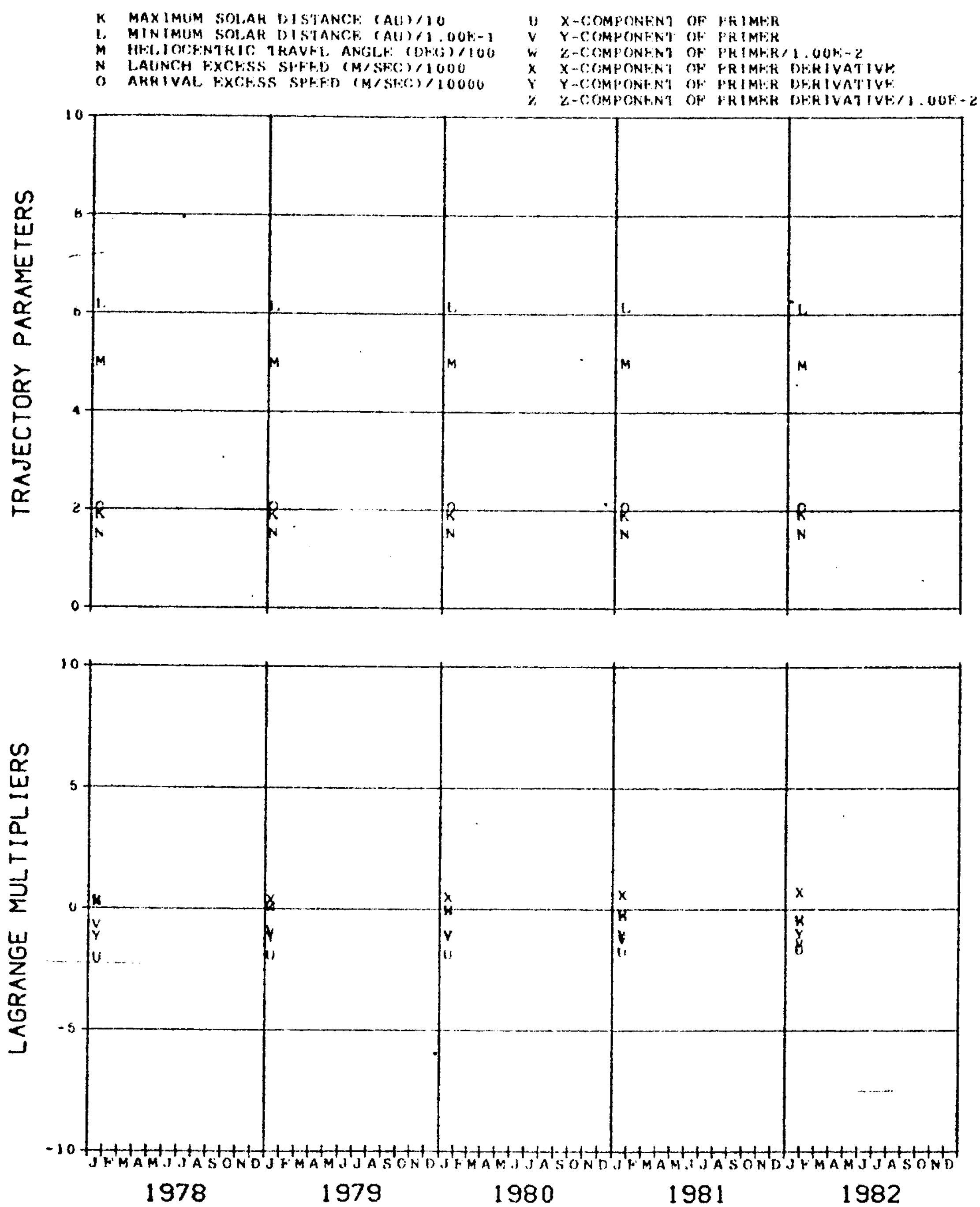

FIG. 27B. (CONCLUDED)

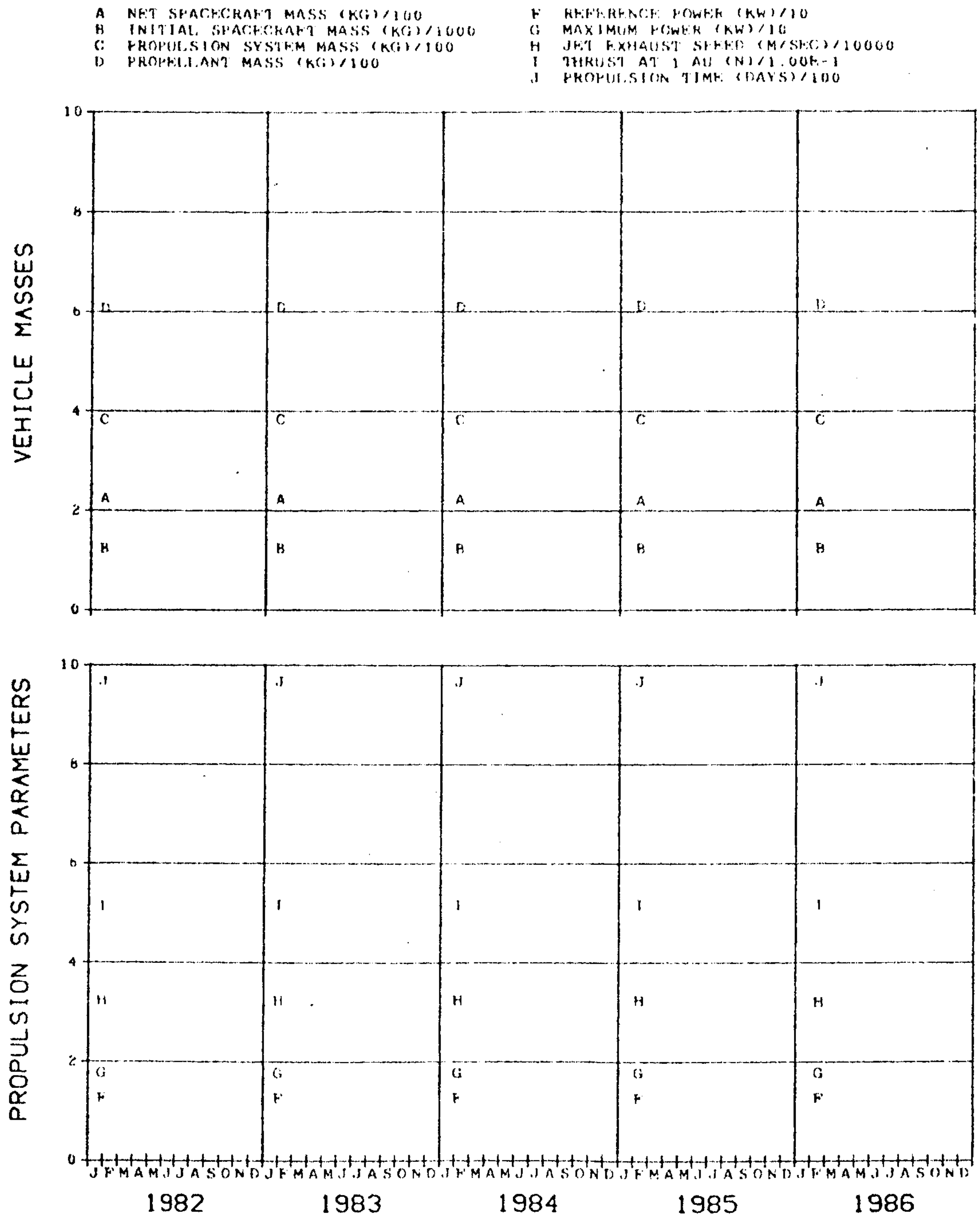

FIG. 27C. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

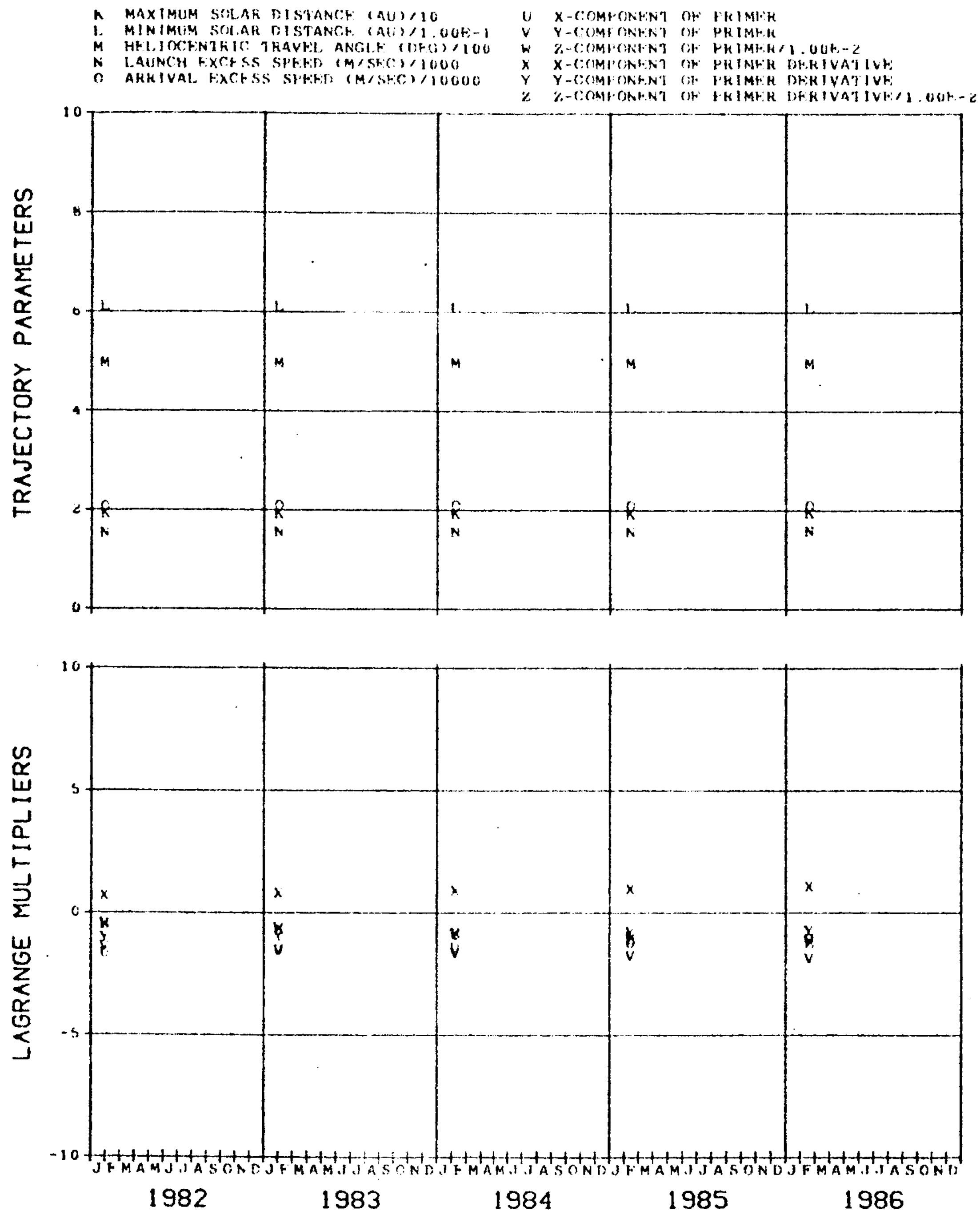

FIG. 27C. (CONCLUDED)

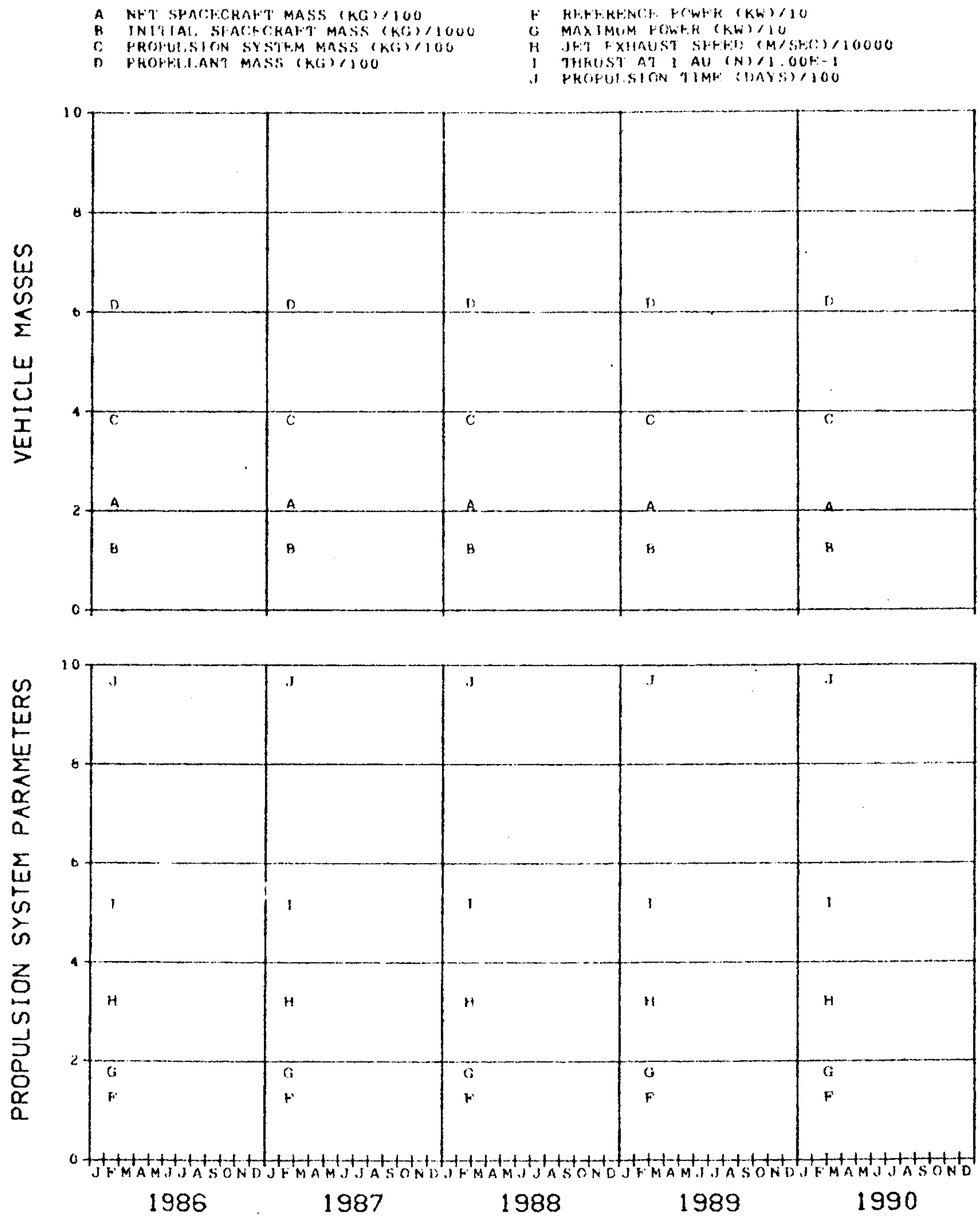

FIG. 27D. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2000 DAYS

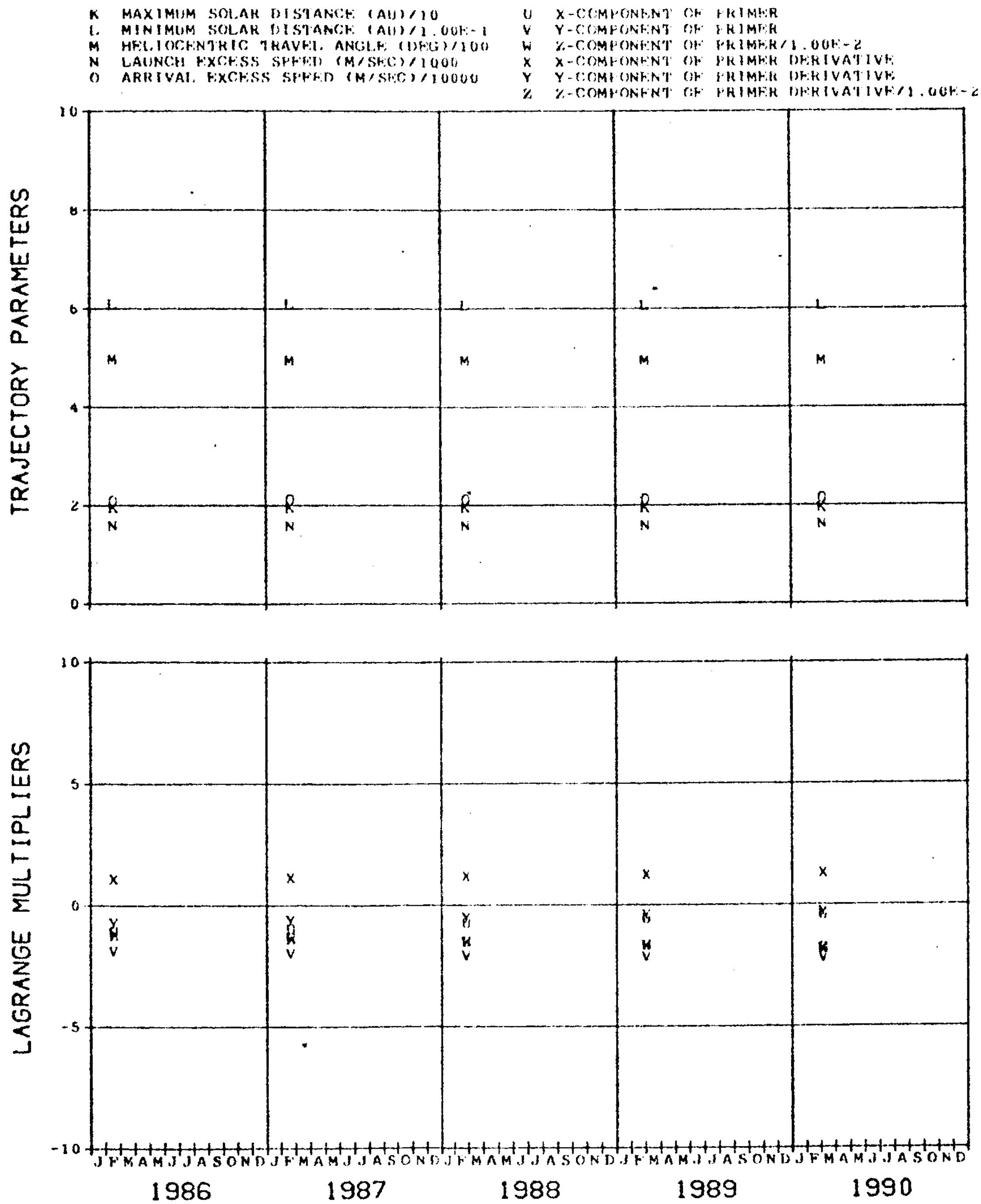

FIG. 27D. (CONCLUDED)

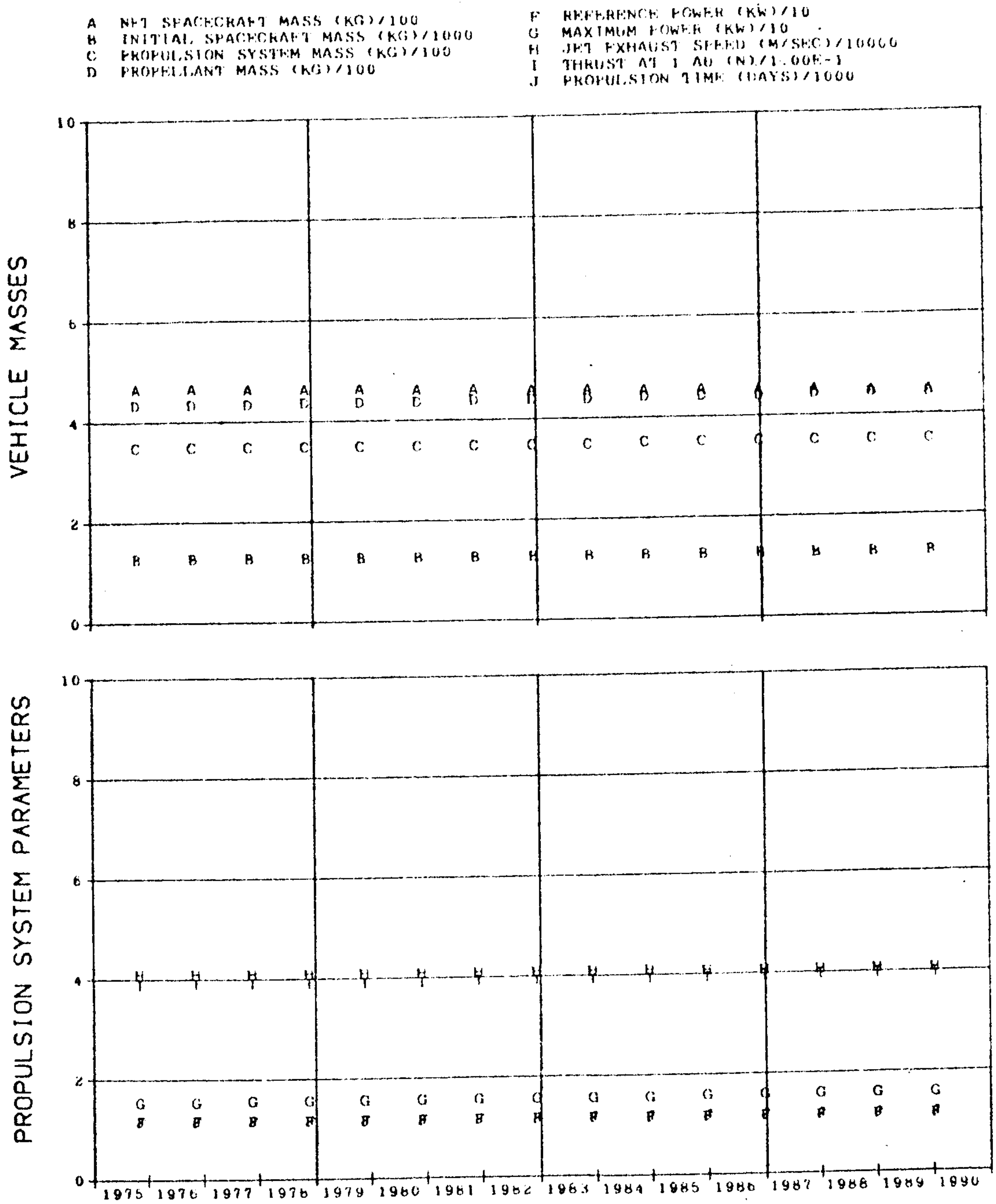

FIG. 28. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

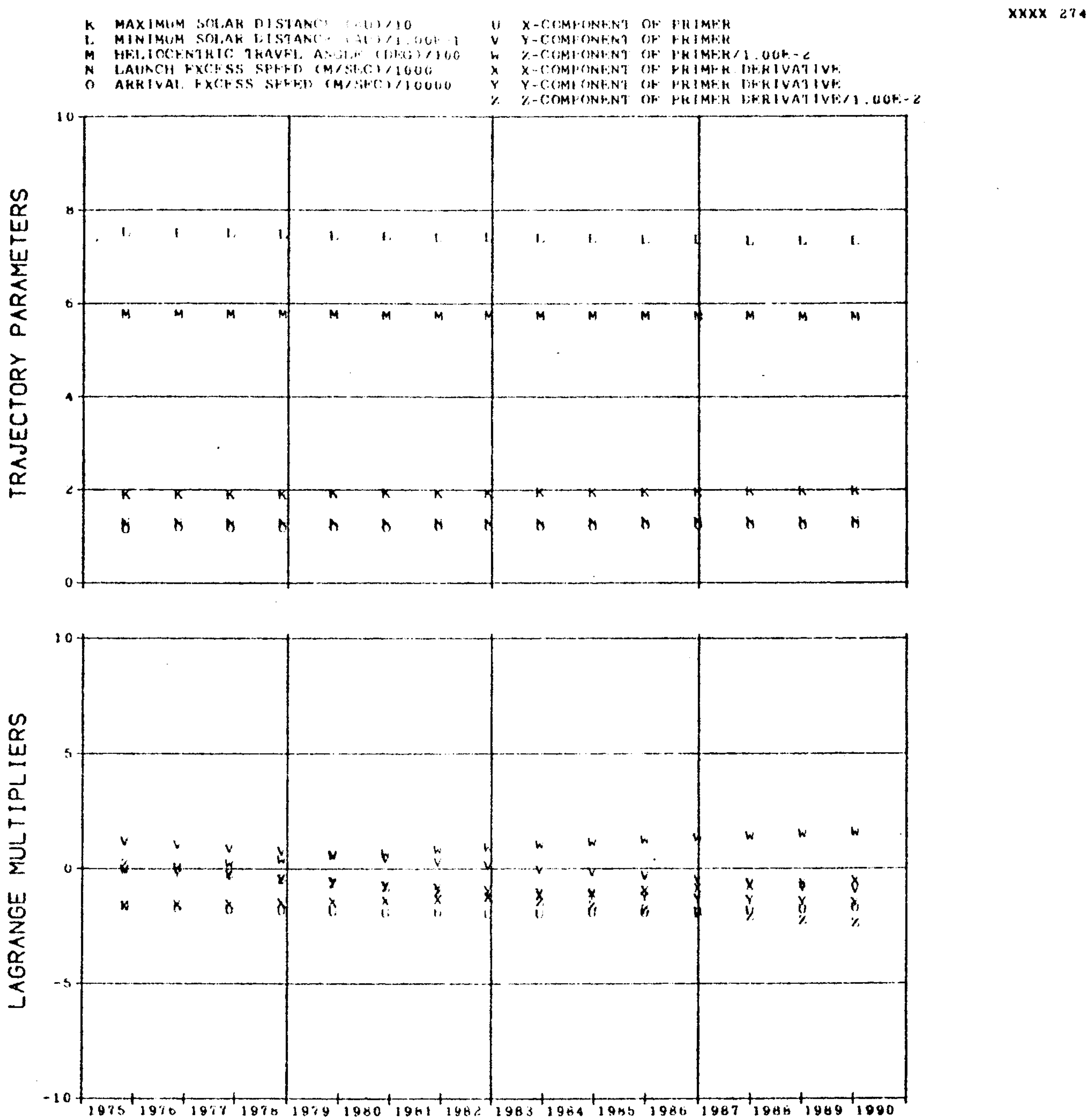

FIG. 28. (CONCLUDED)

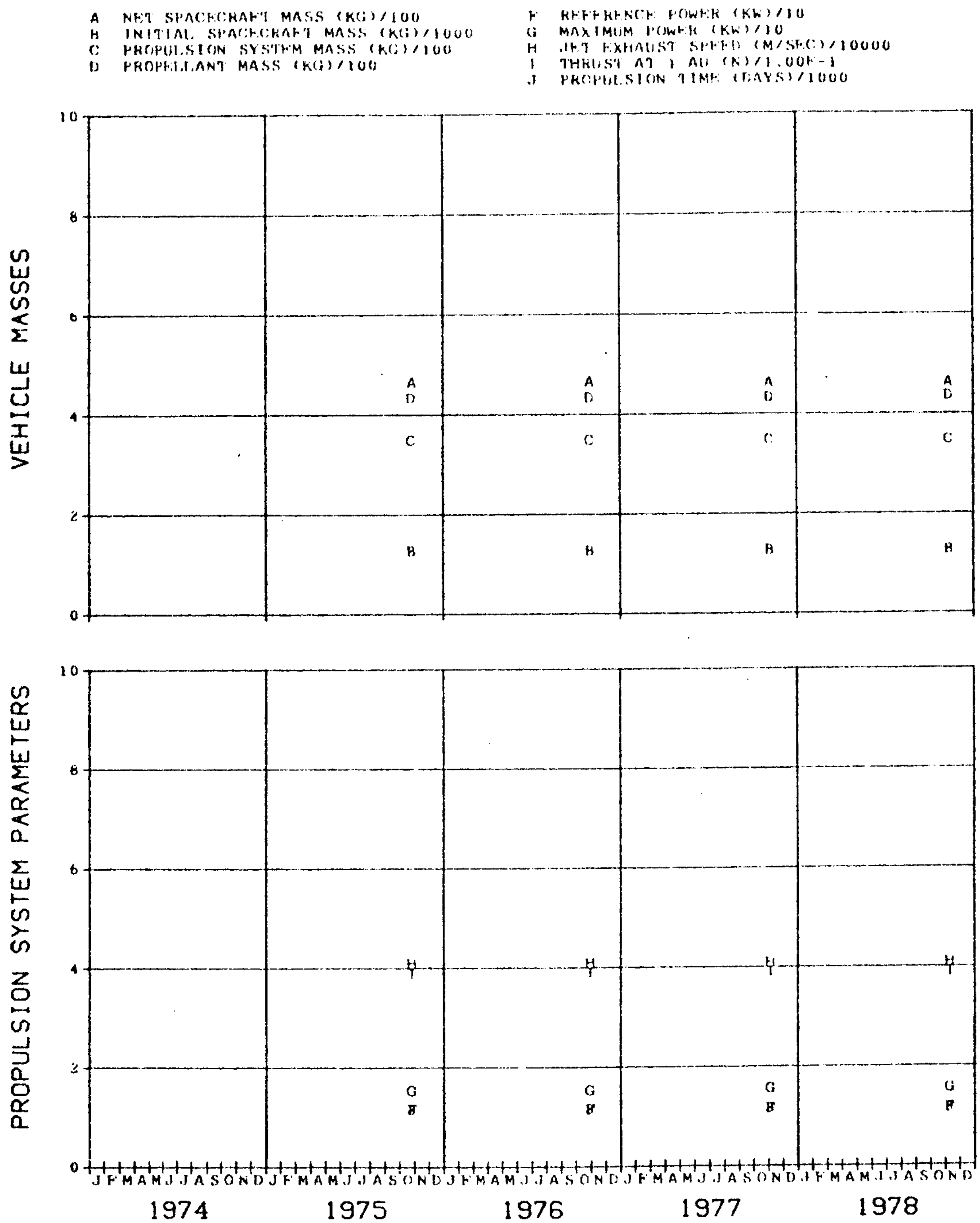

FIG. 28A. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

XXXX 276

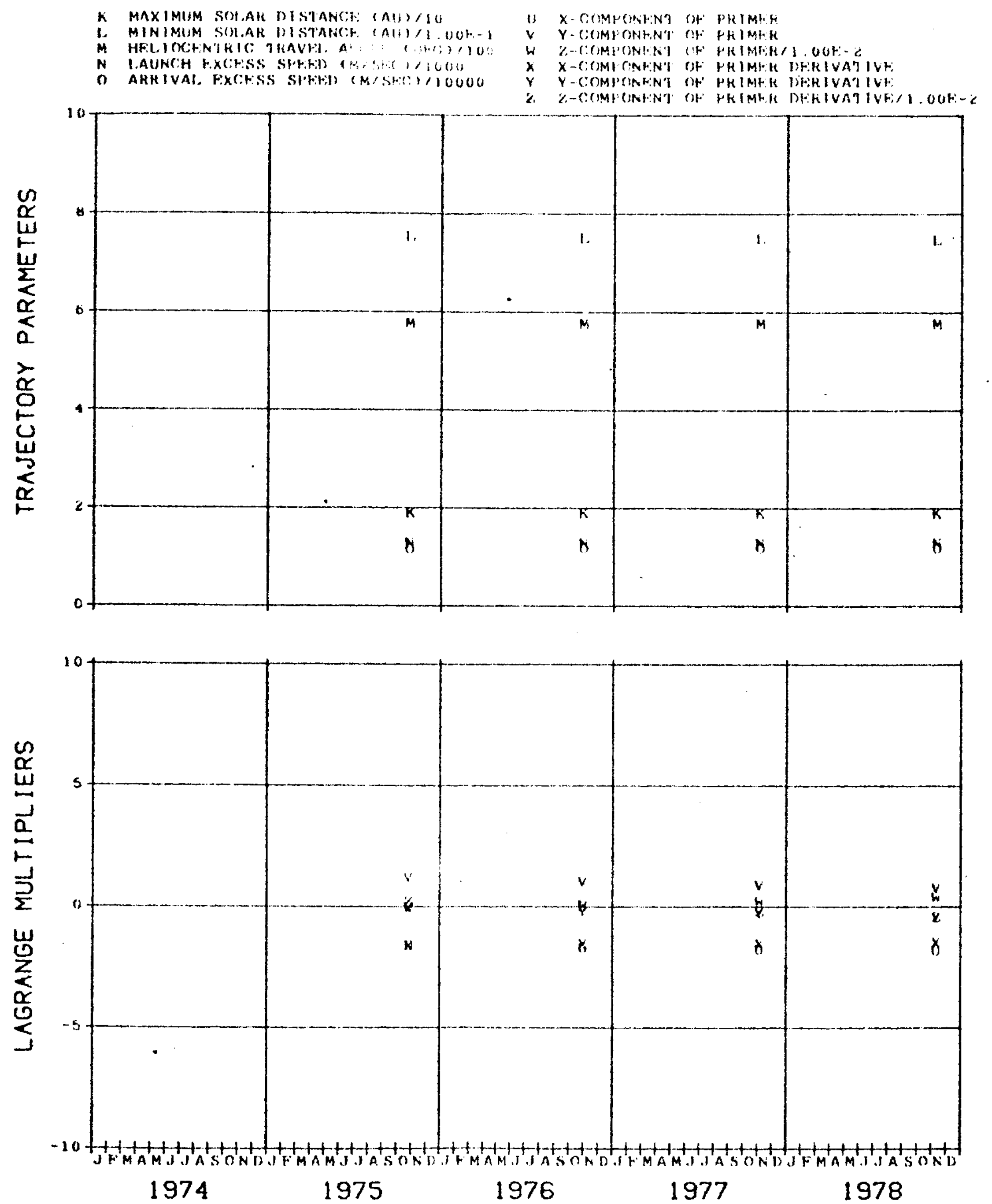

FIG. 28A. (CONCLUDED)

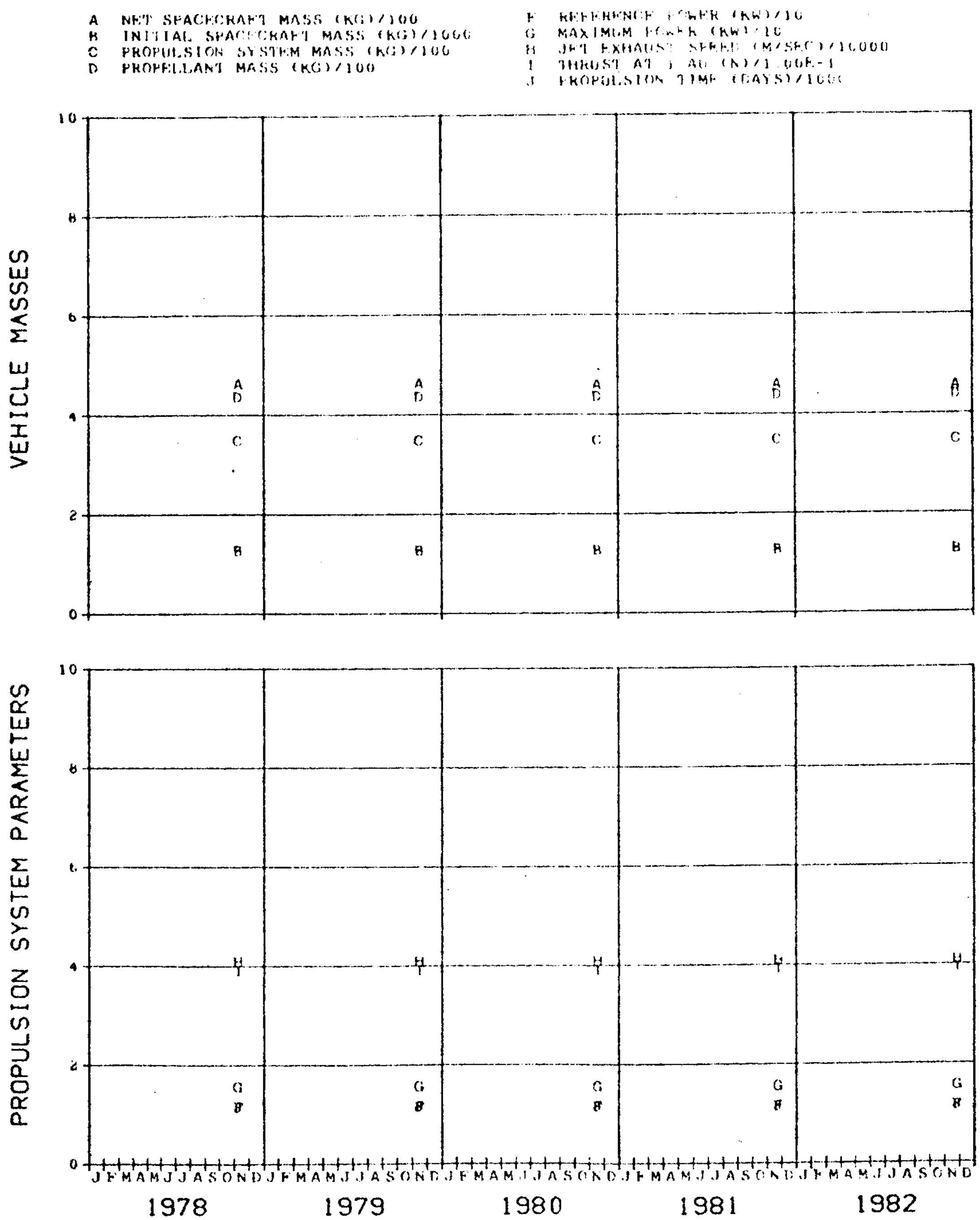

FIG. 28B. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

XXXX 278

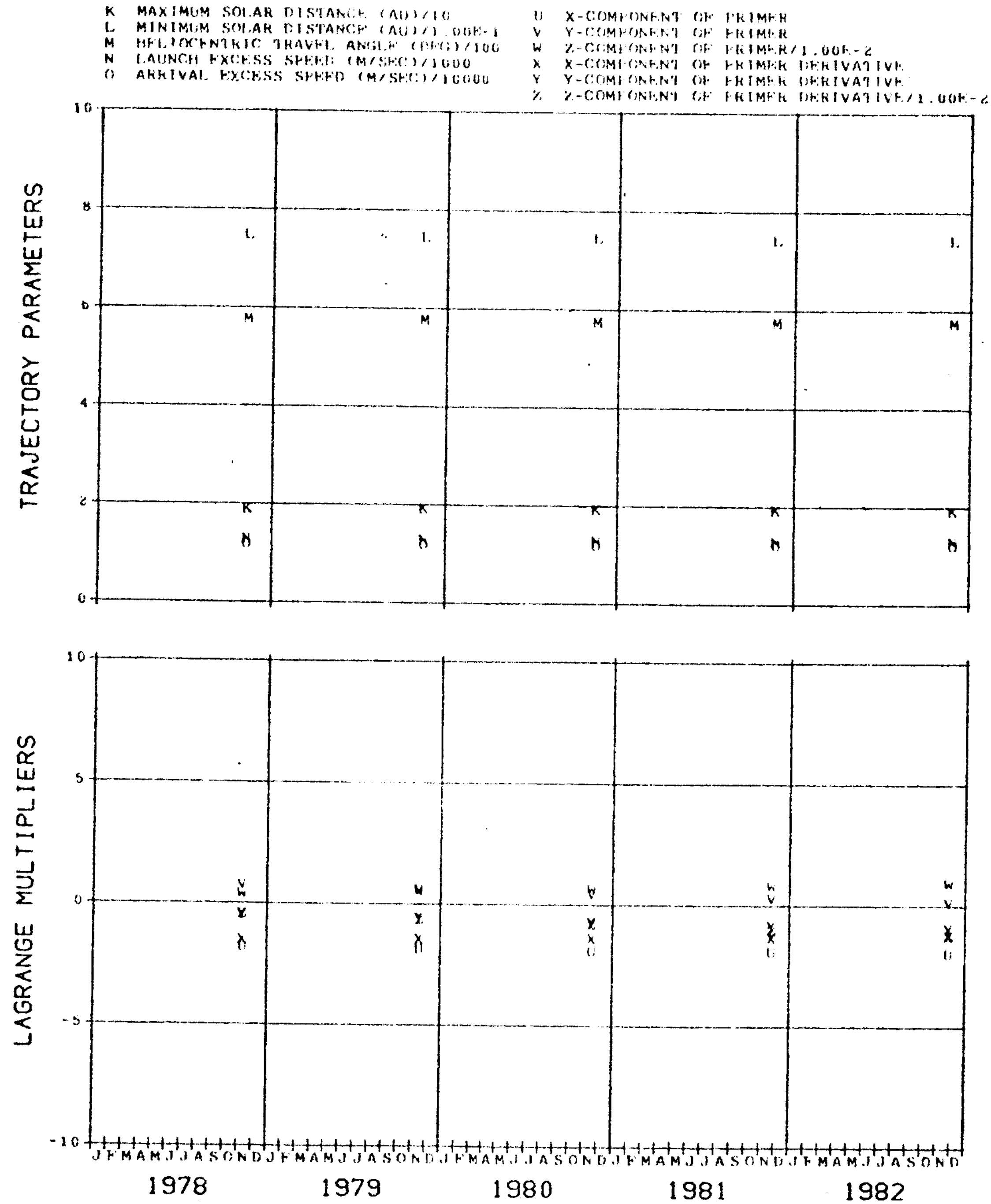

FIG. 28B. (CONCLUDED)

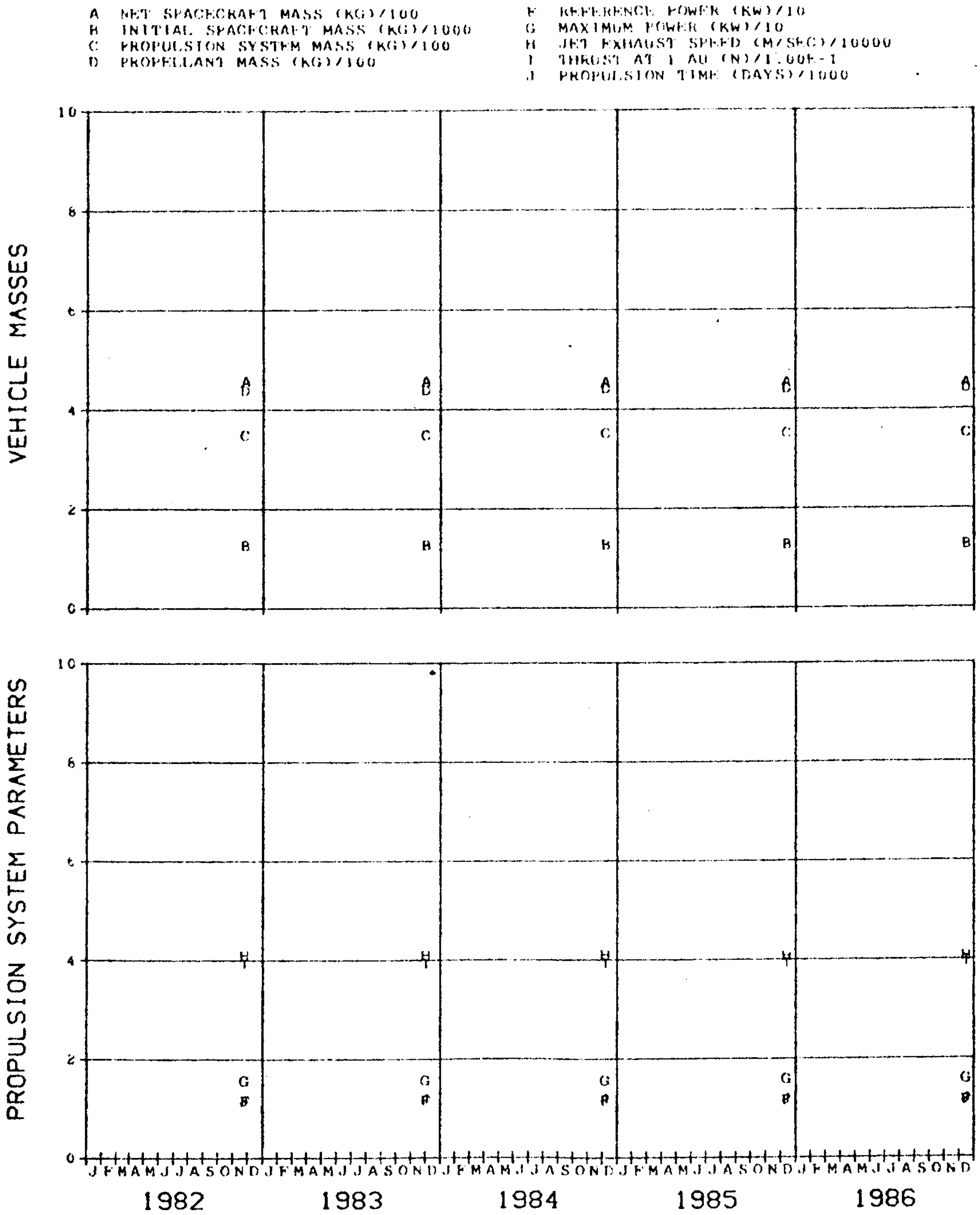

FIG. 28C. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

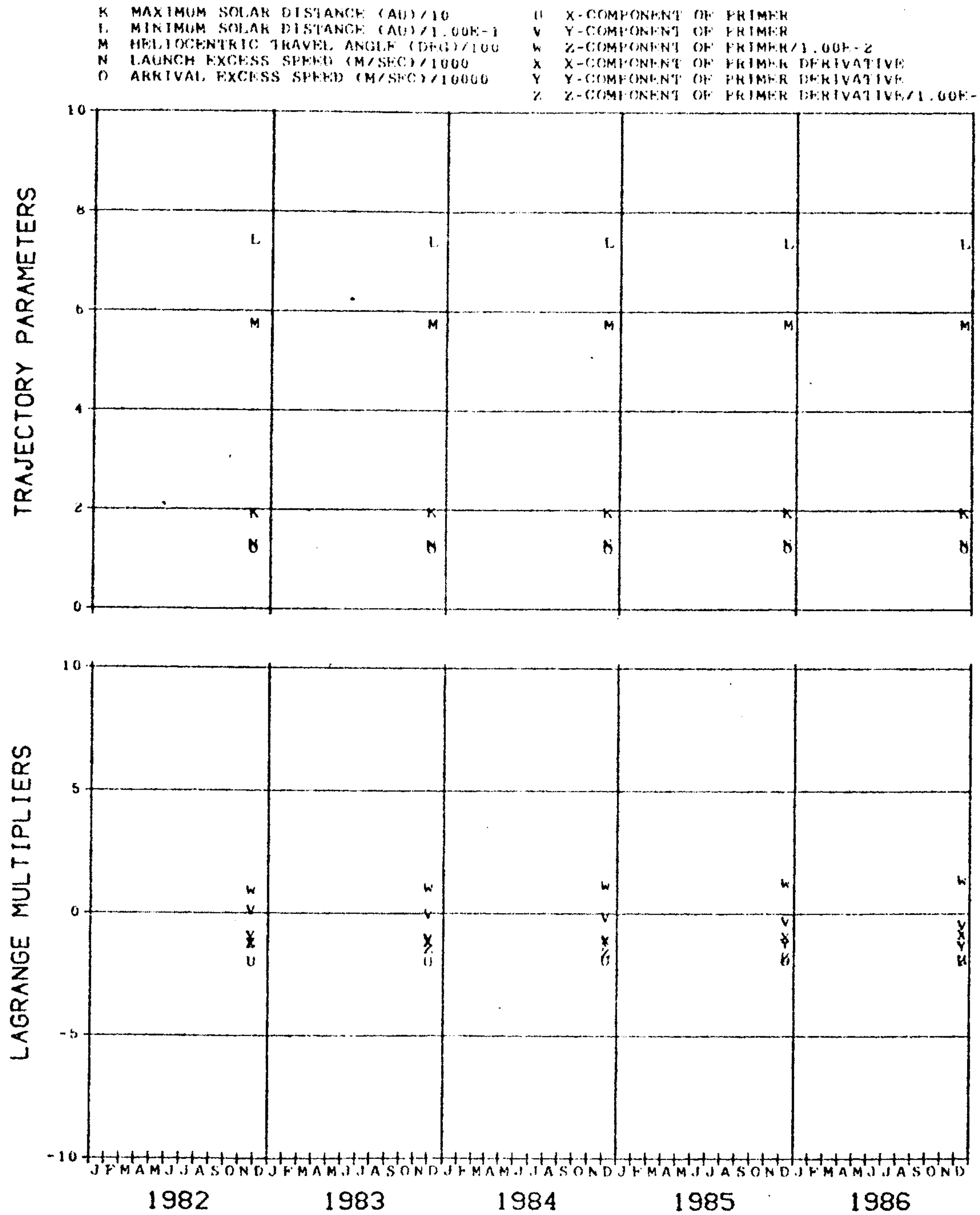

FIG. 28C. (CONCLUDED)

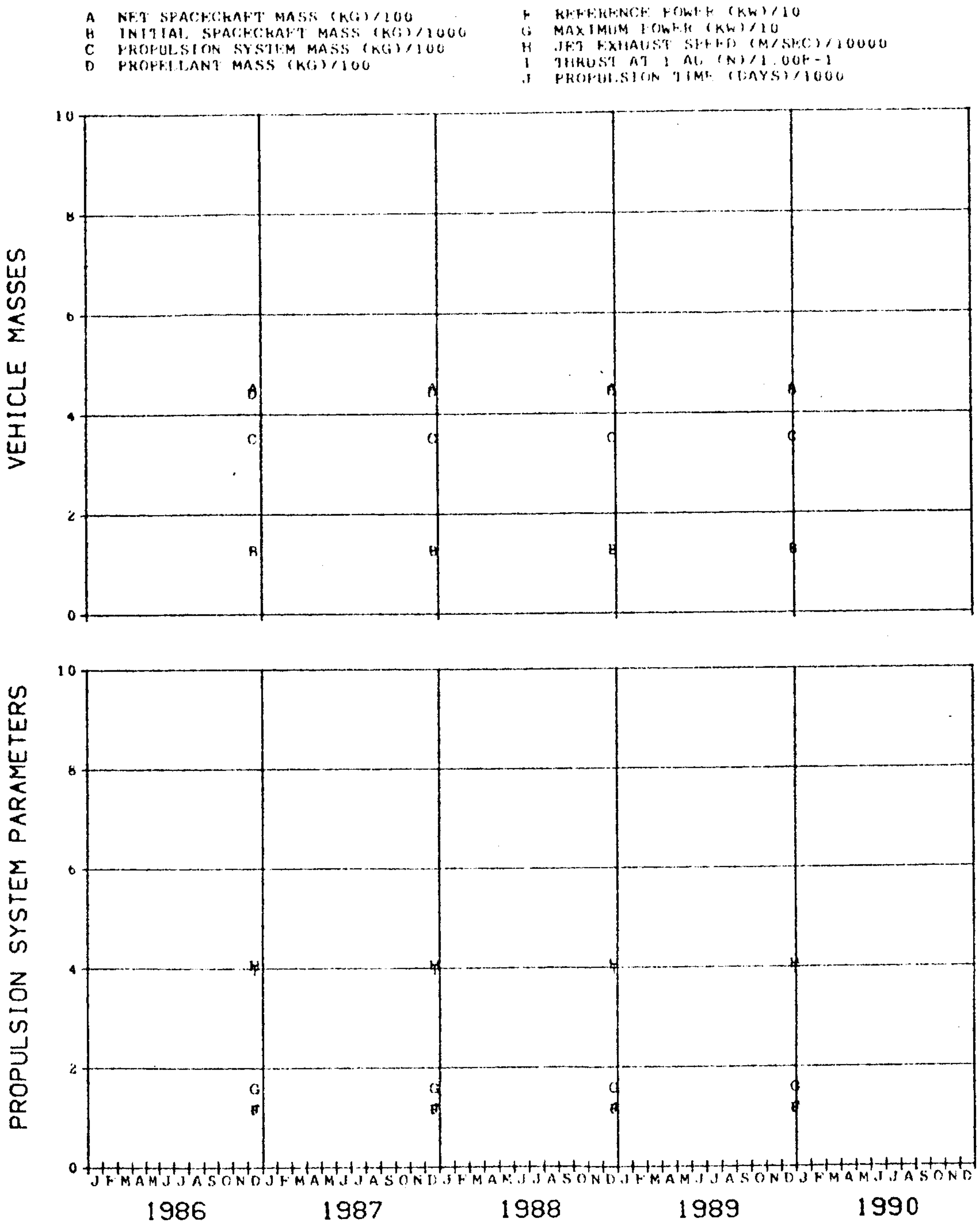

FIG. 28D. URANUS MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

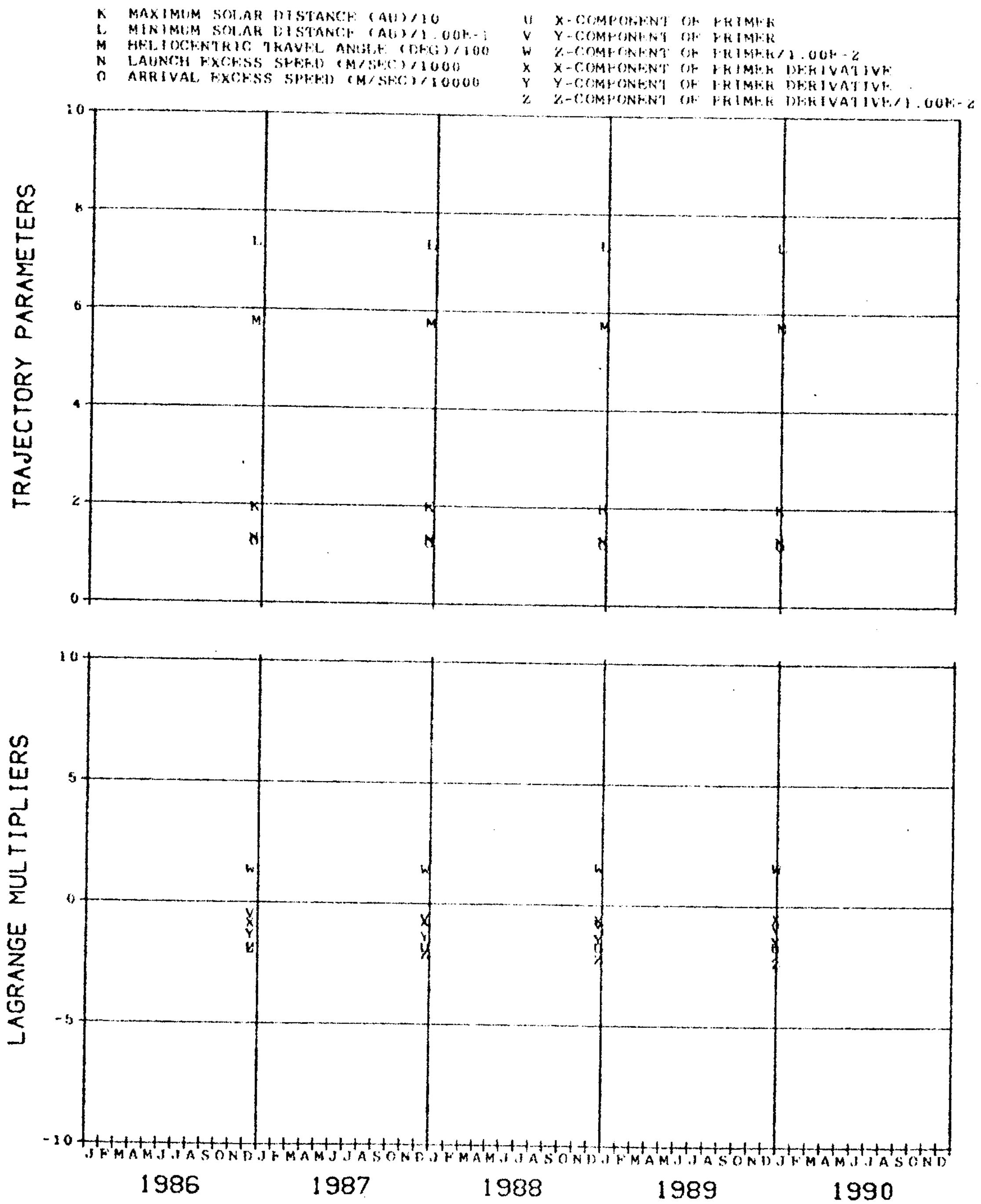

FIG. 28D. (CONCLUDED)

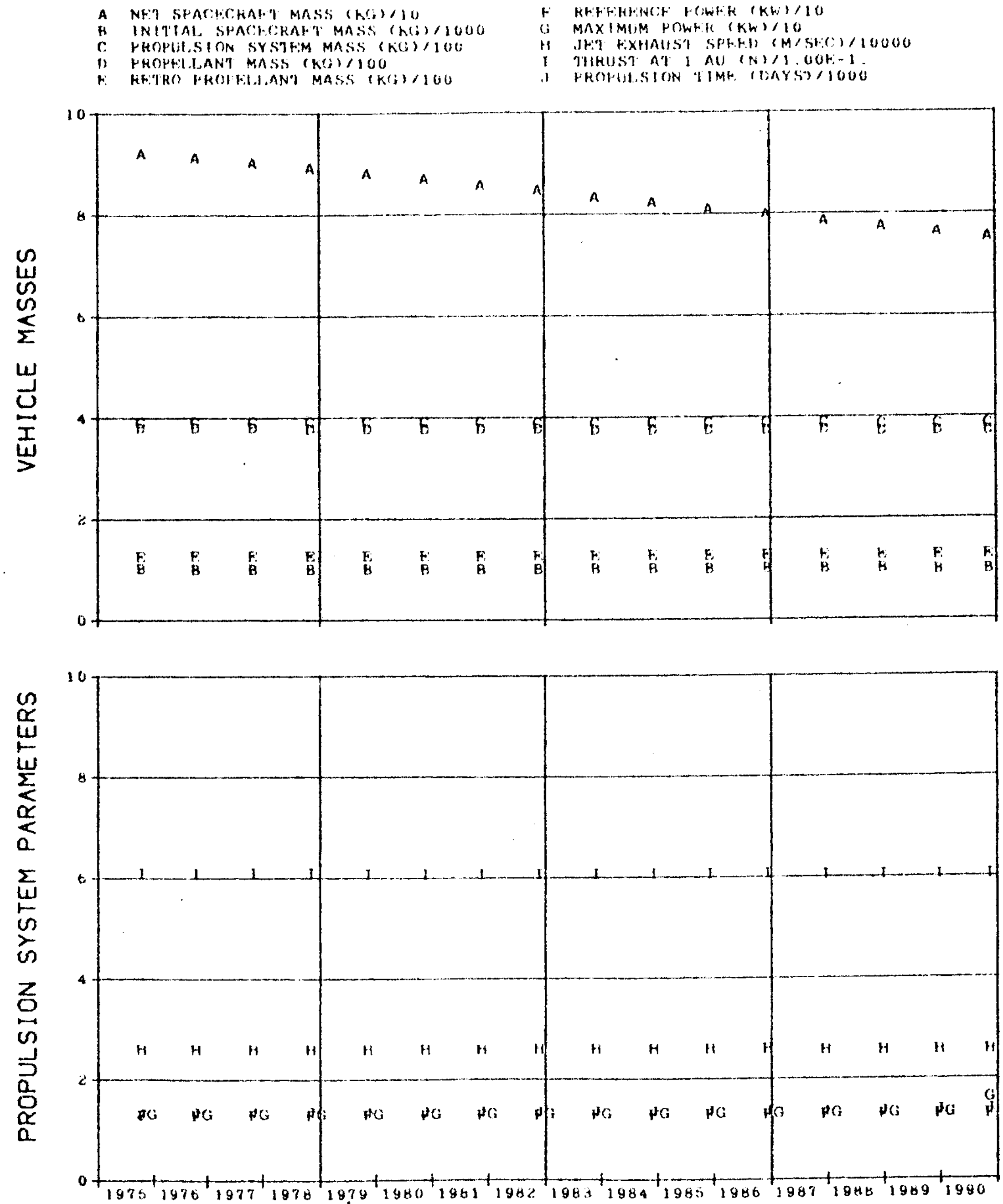

FIG. 29. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

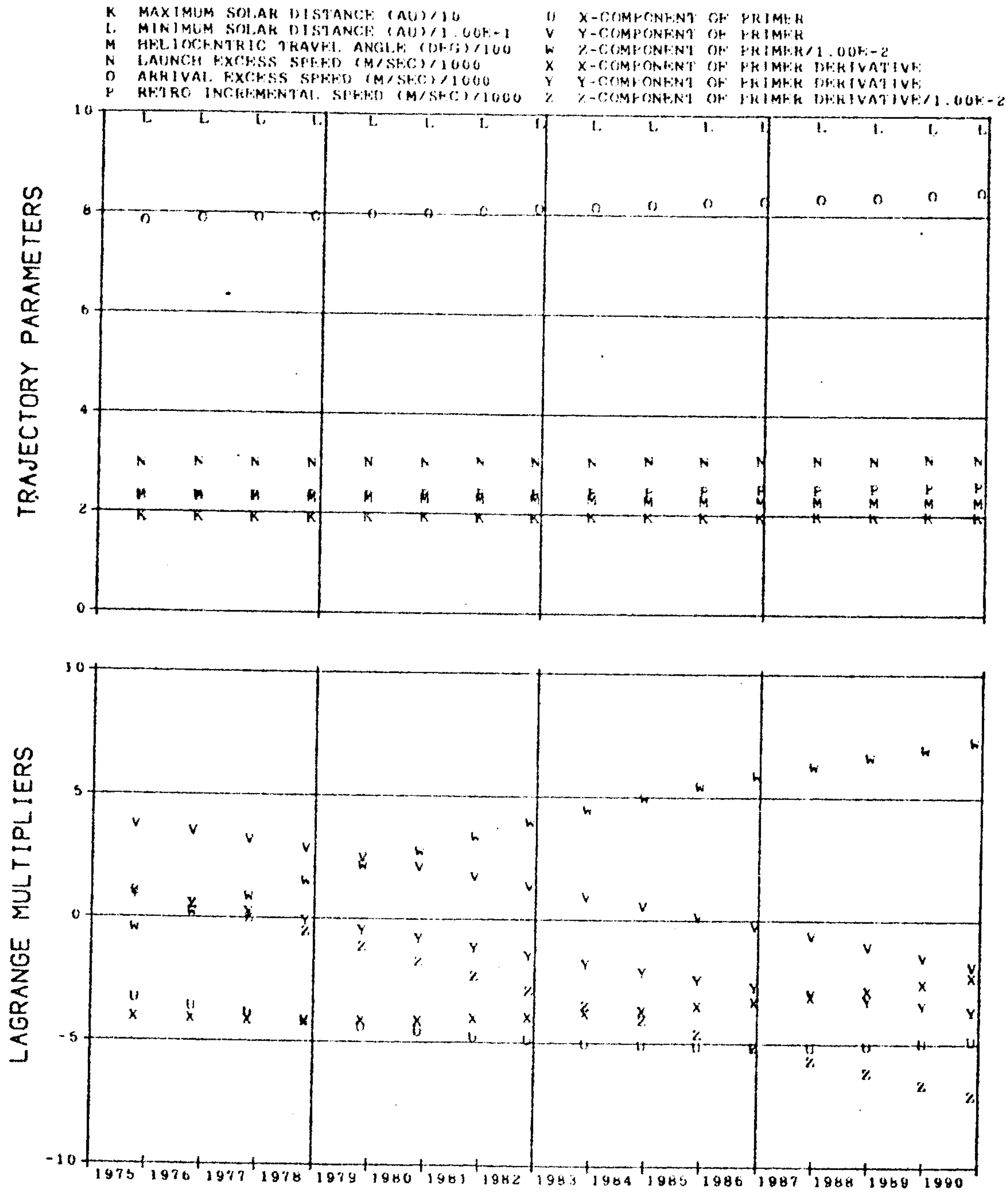

FIG. 29. (CONCLUDED)

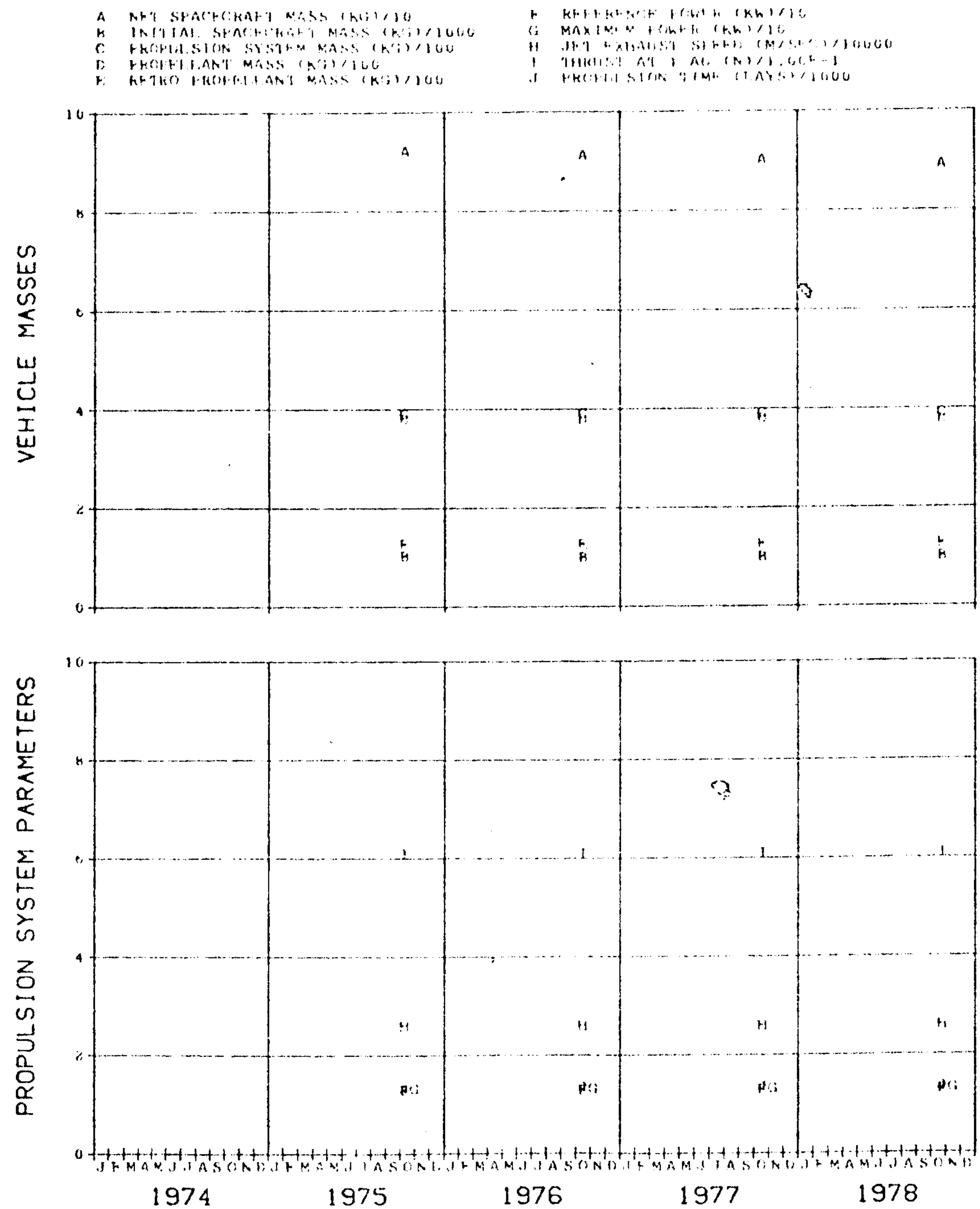

FIG. 29A. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

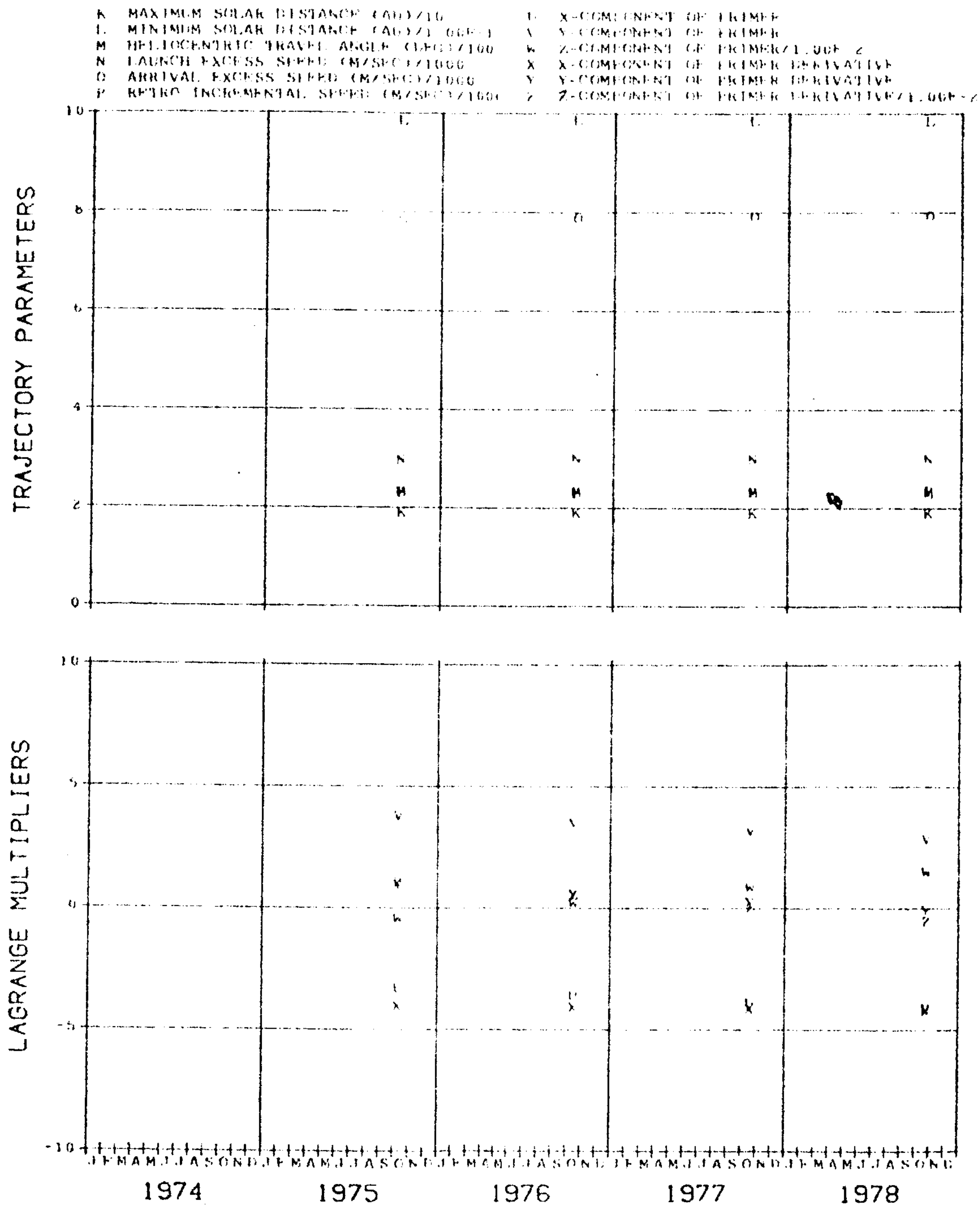

FIG. 29A. (CONCLUDED)

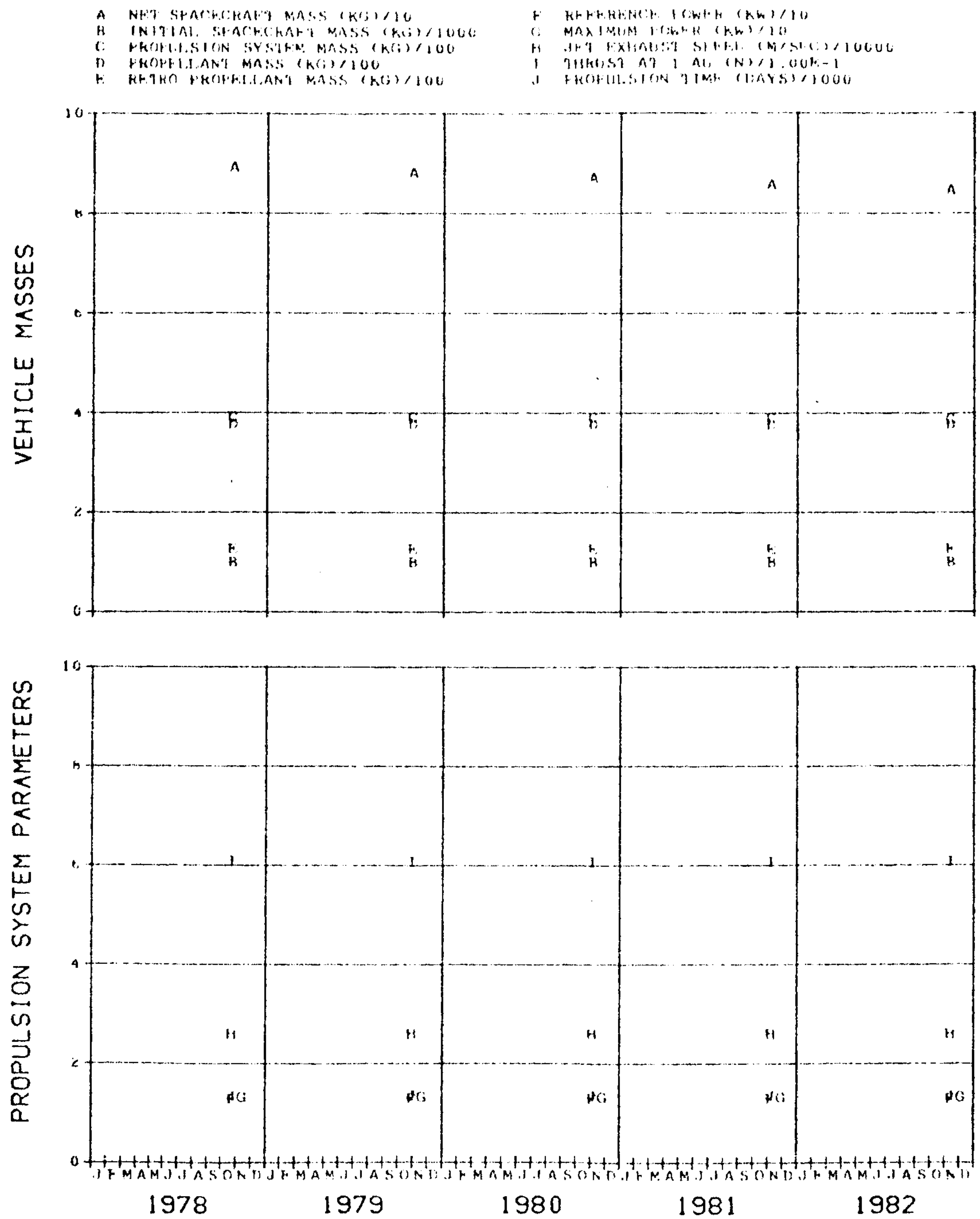

FIG. 29B. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

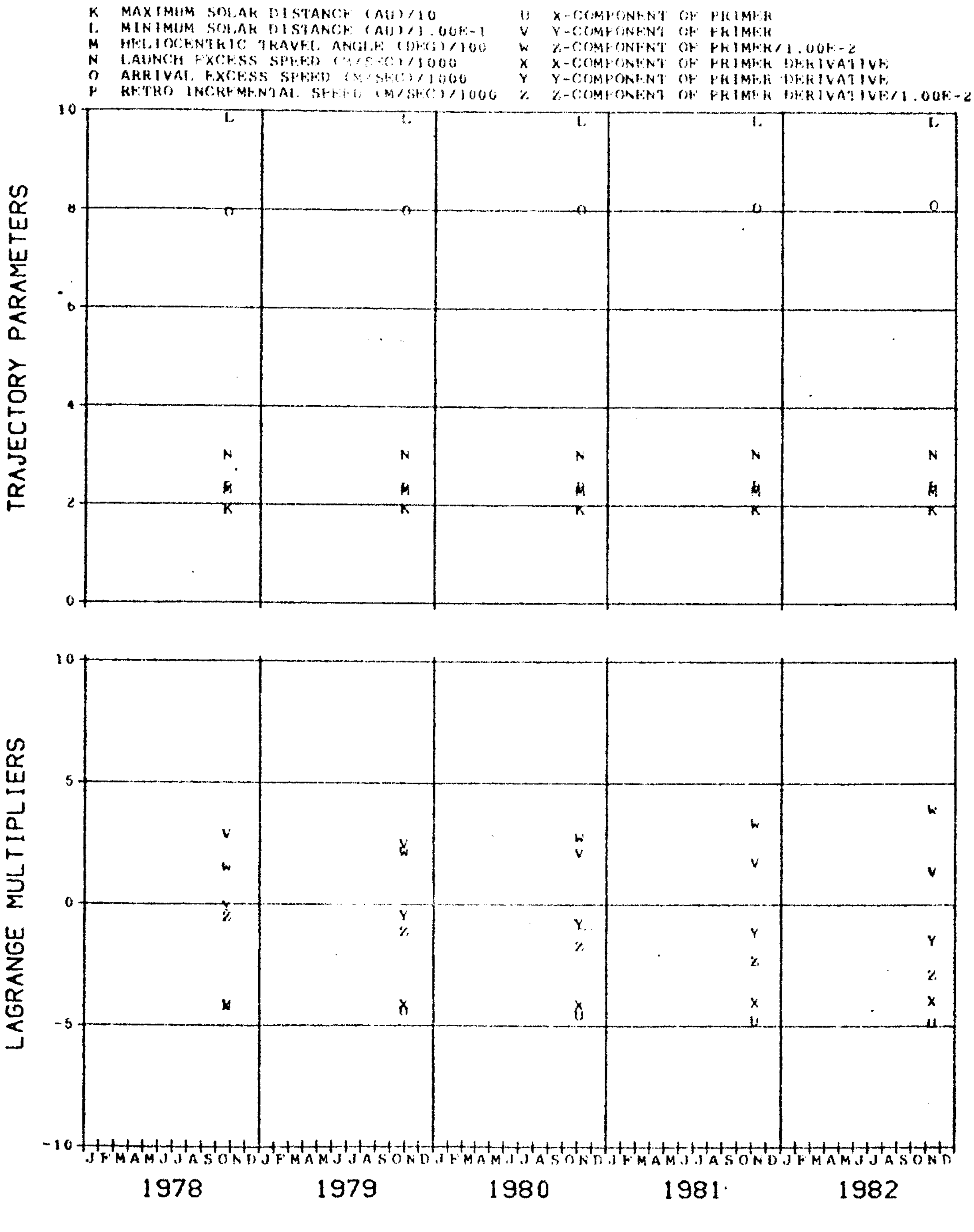

FIG. 29B. (CONCLUDED)

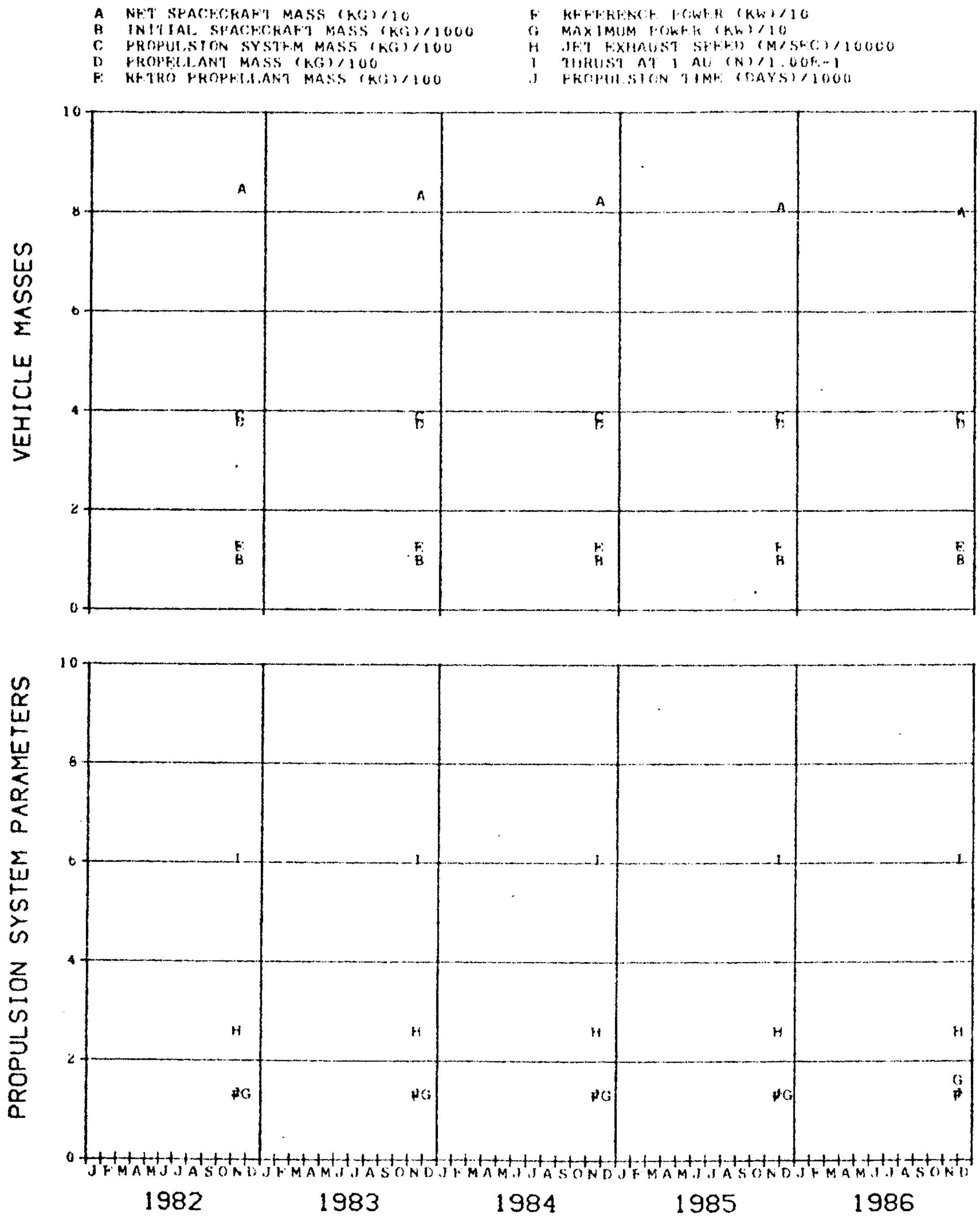

FIG. 29C. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

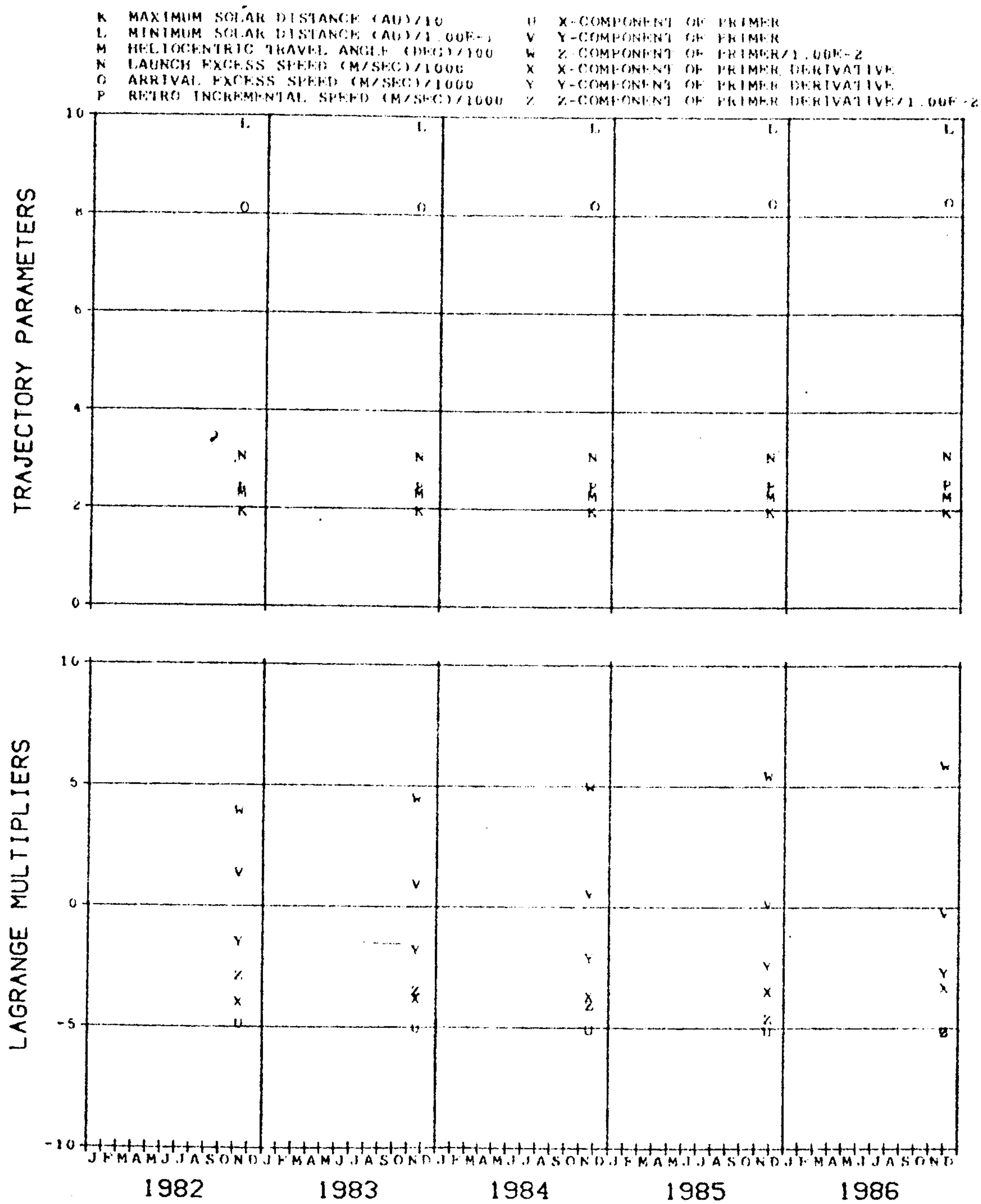

FIG. 29C. (CONCLUDED)

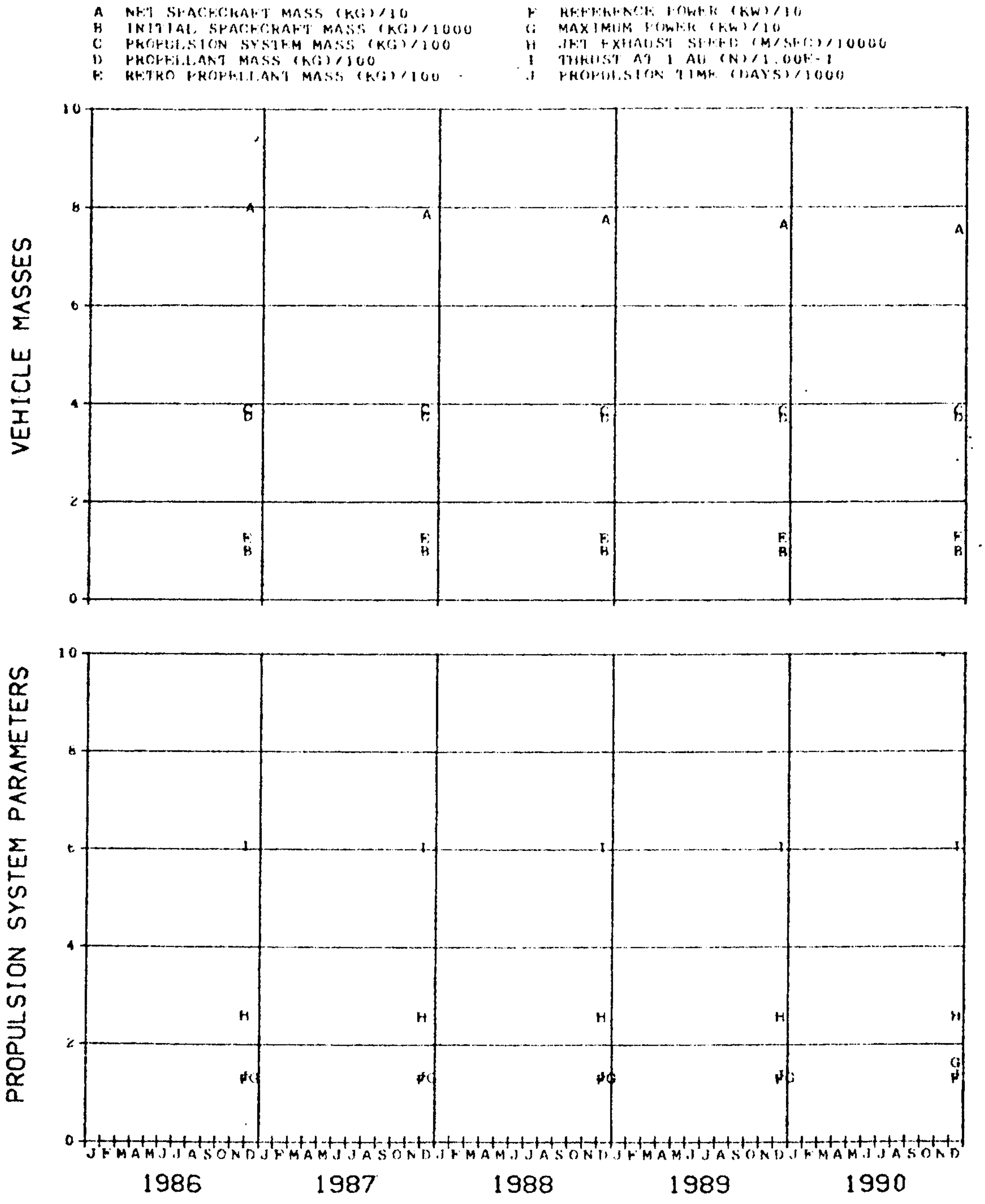

FIG. 29D. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

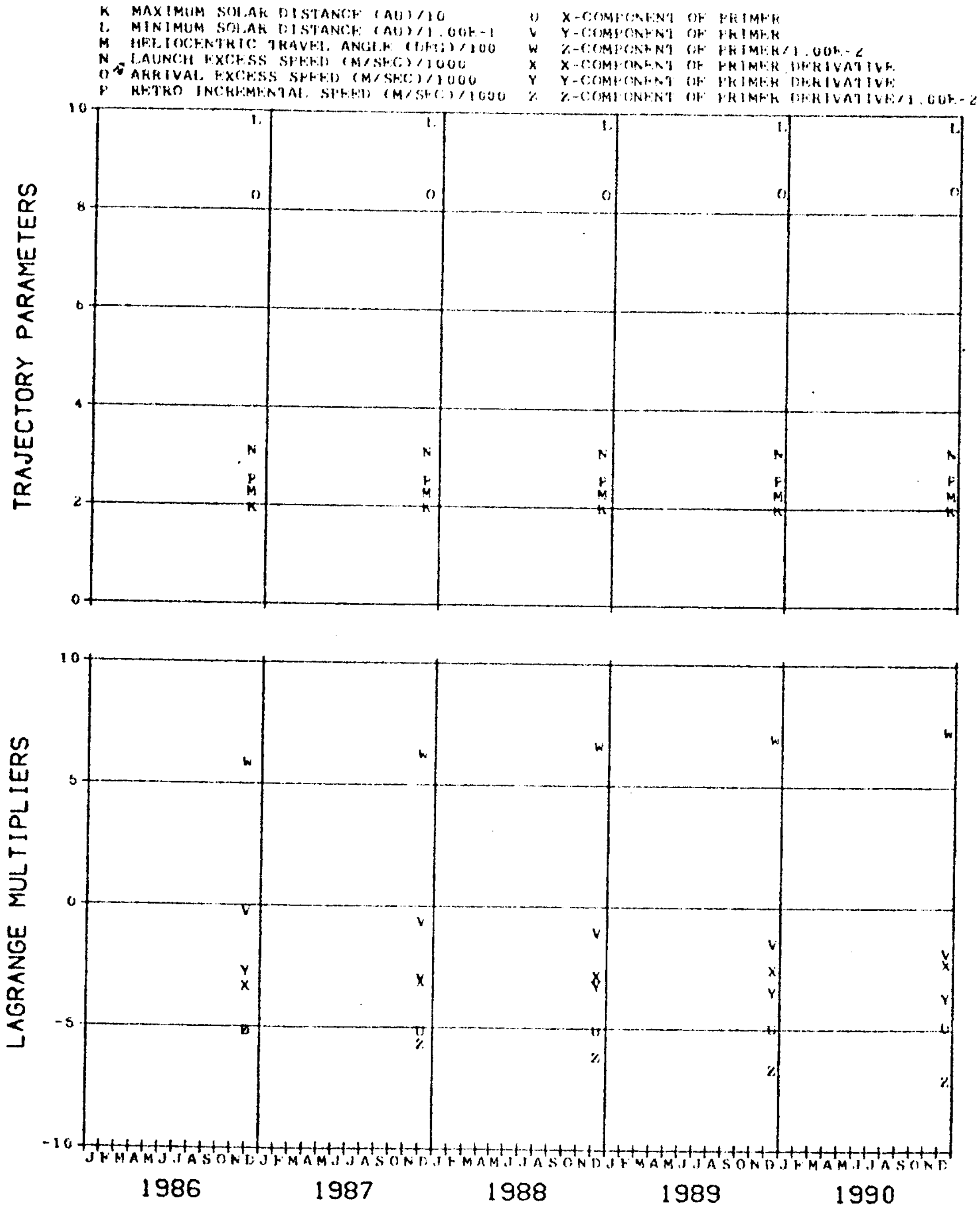

FIG. 29D. (CONCLUDED)

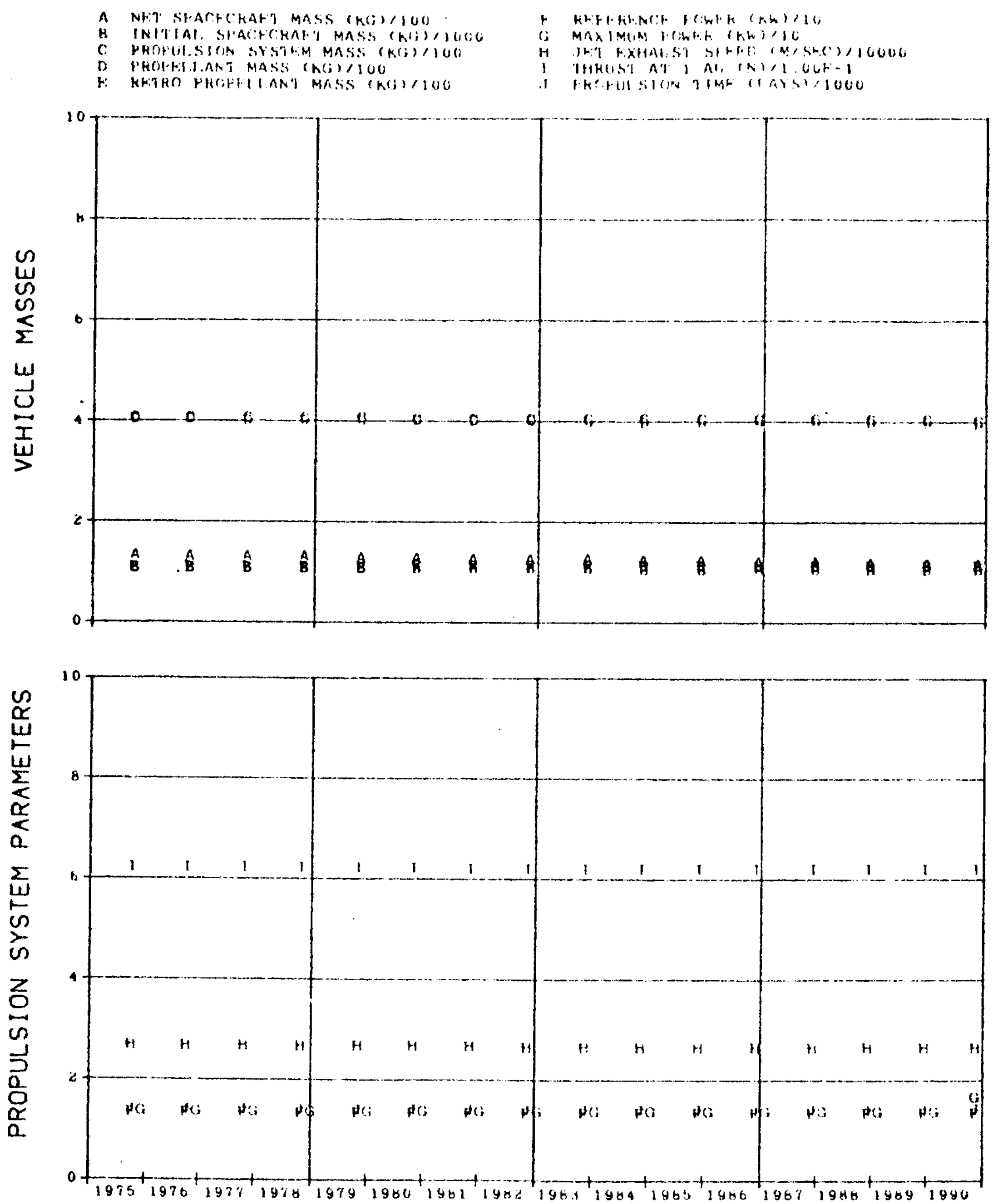

FIG. 30. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3500 DAYS

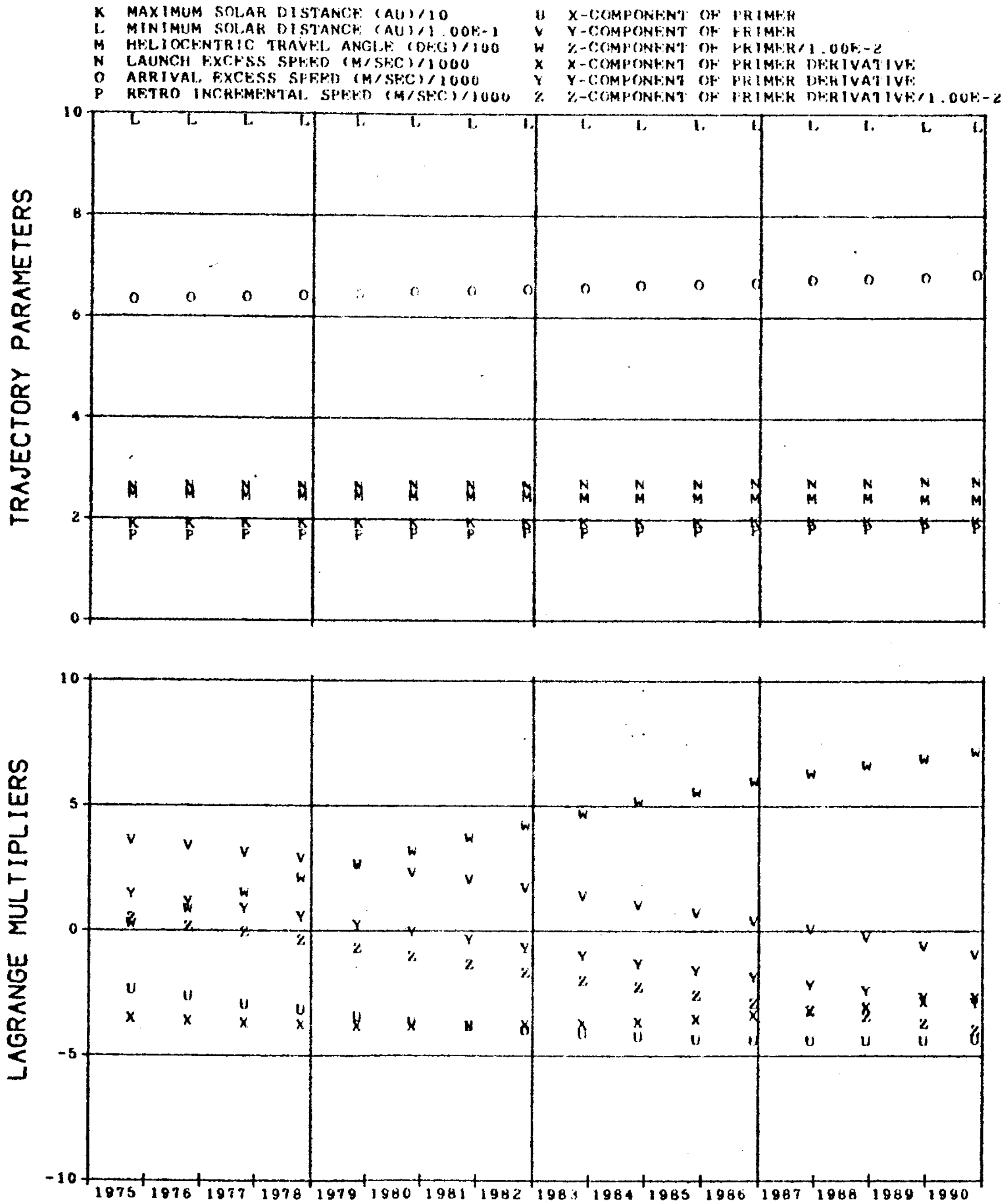

FIG. 30. (CONCLUDED)

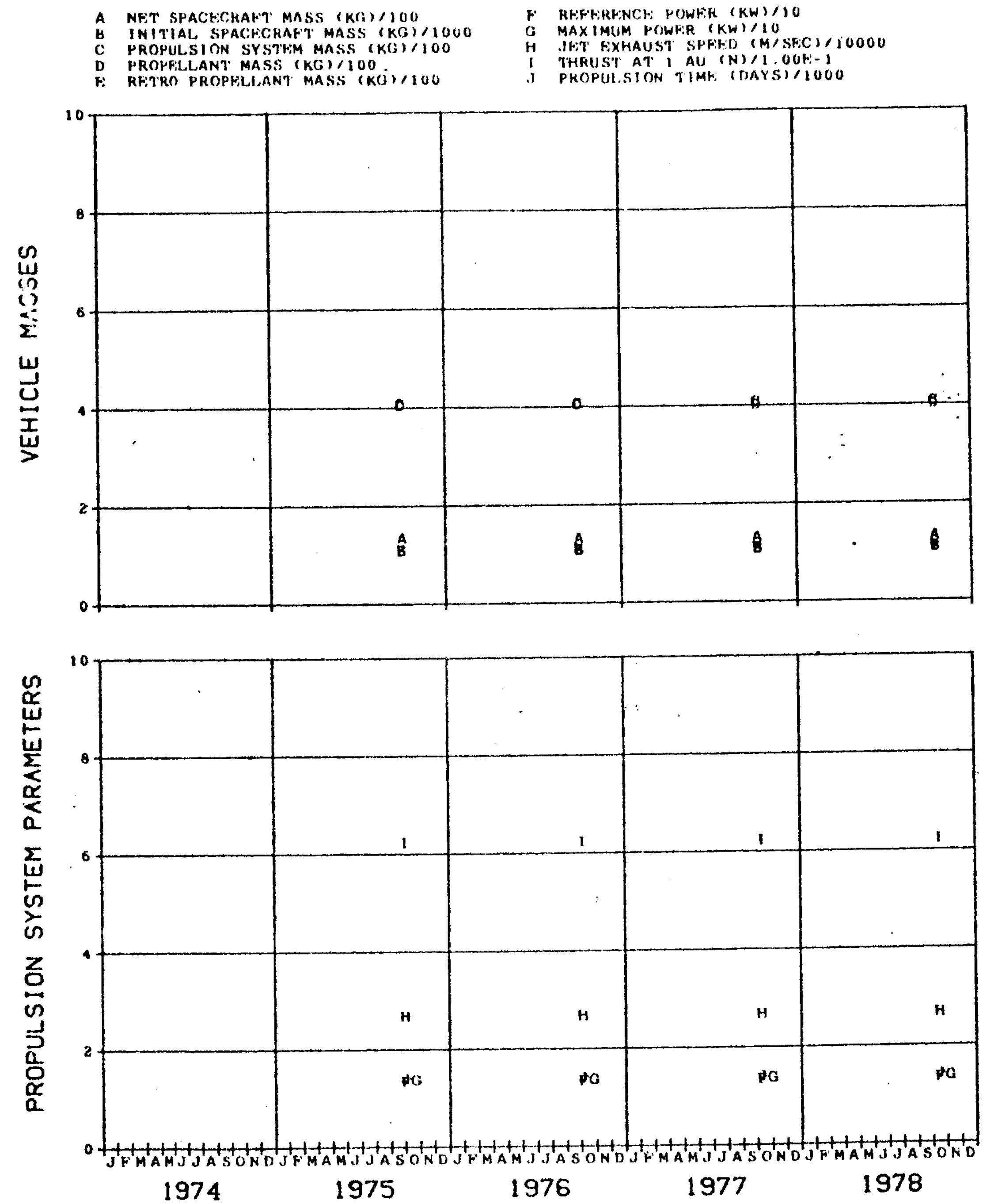

FIG. 30A. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3500 DAYS

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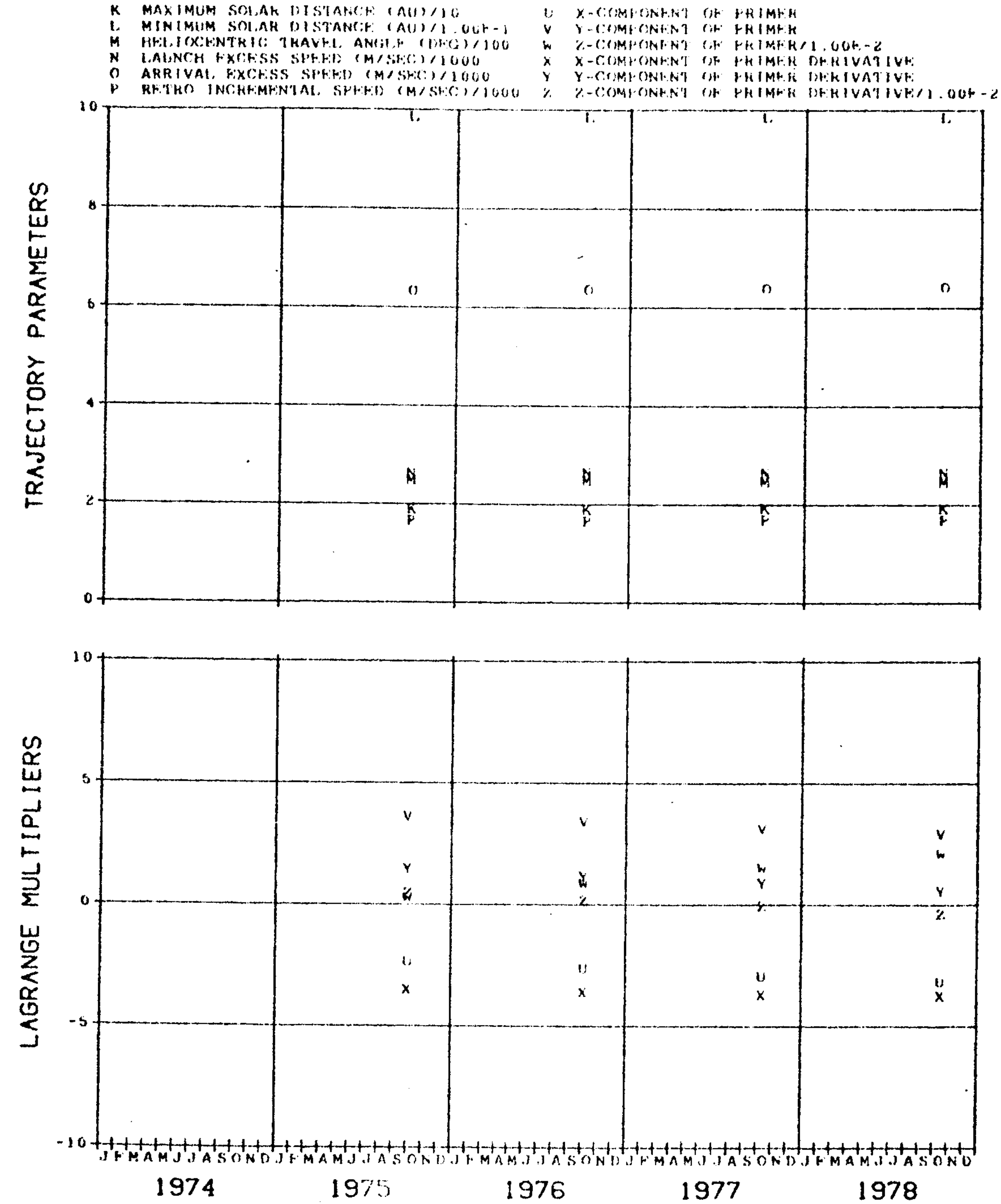

FIG. 30A. (CONCLUDED)

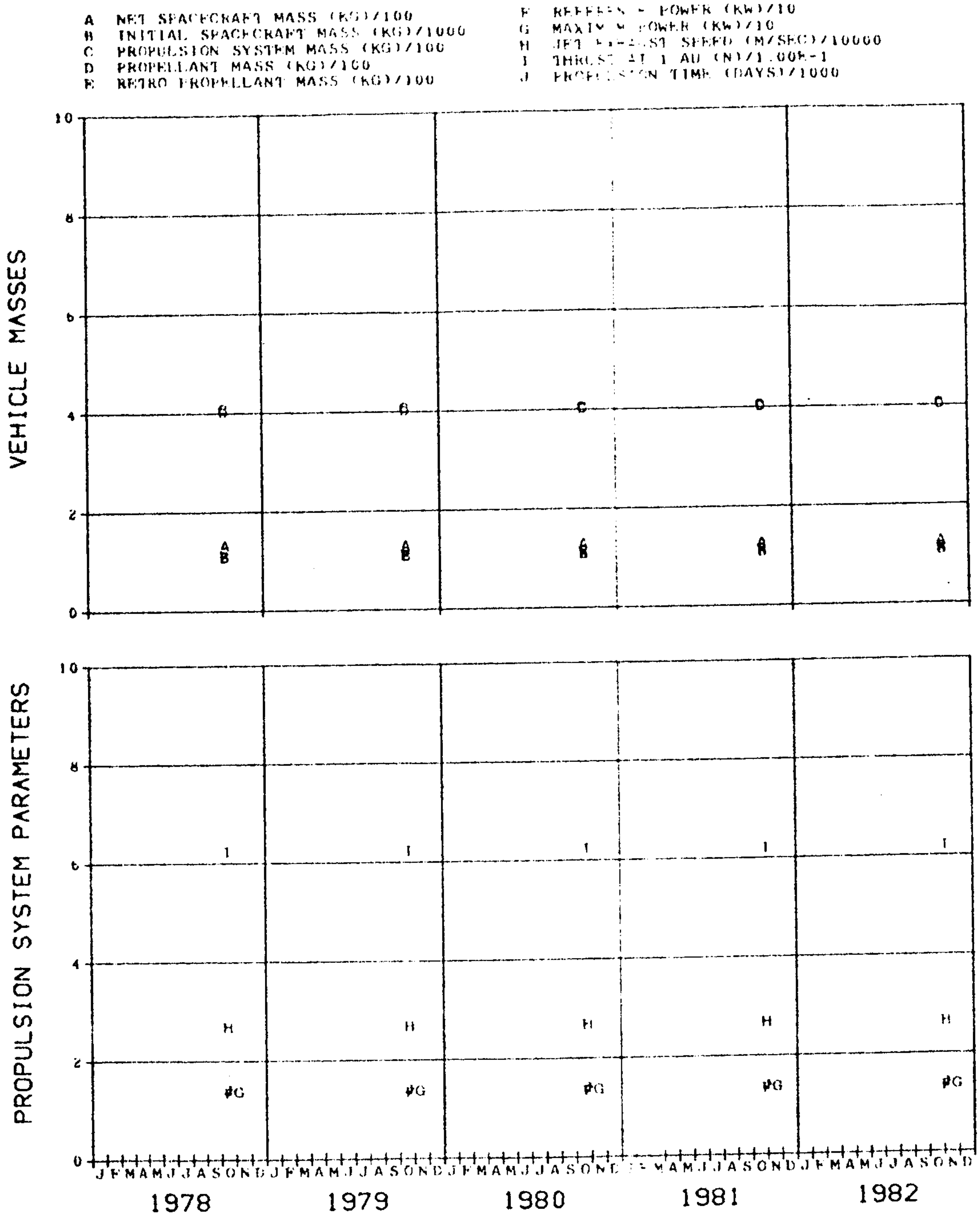

FIG. 30B. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3500 DAYS

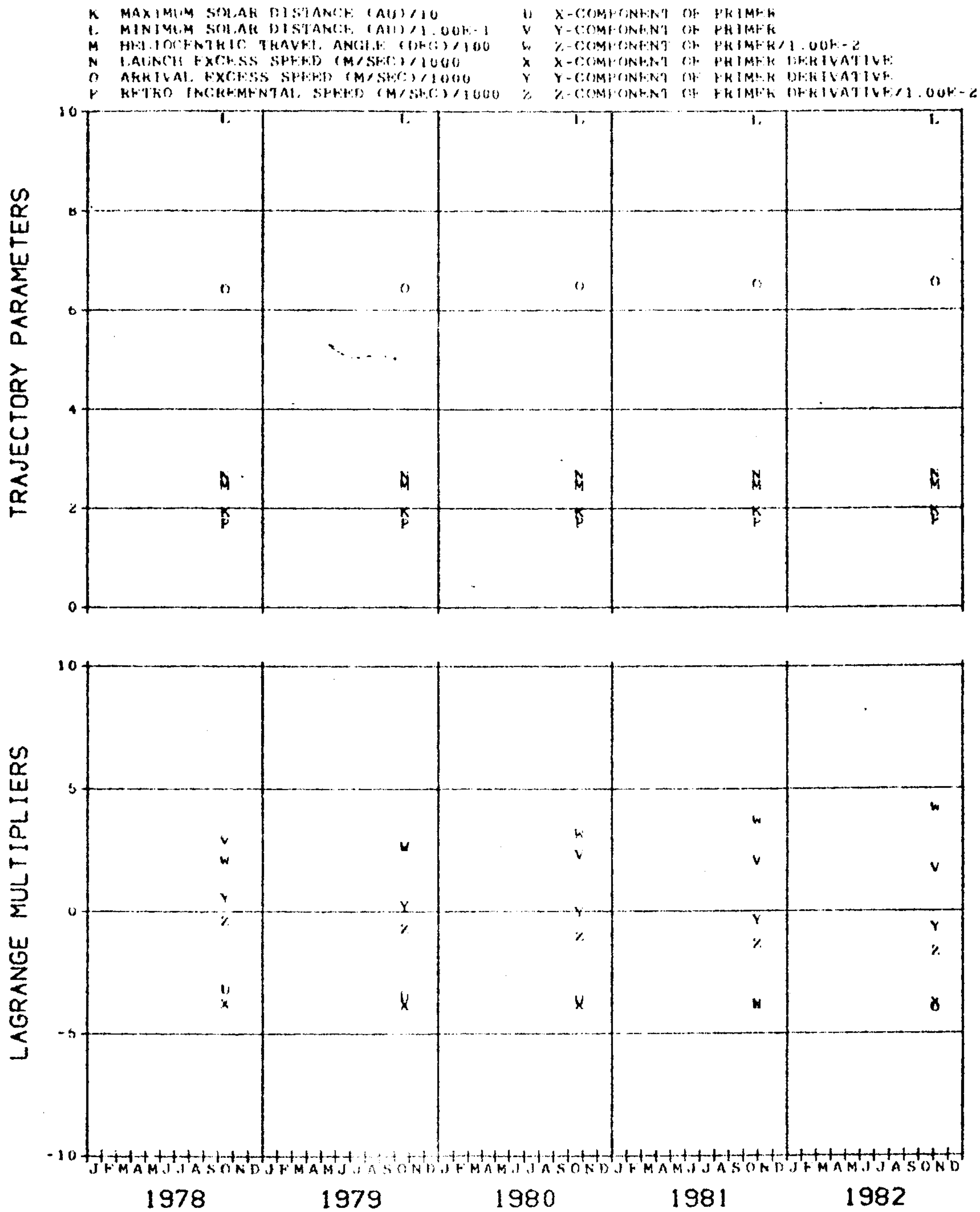

FIG. 30B. (CONCLUDED)

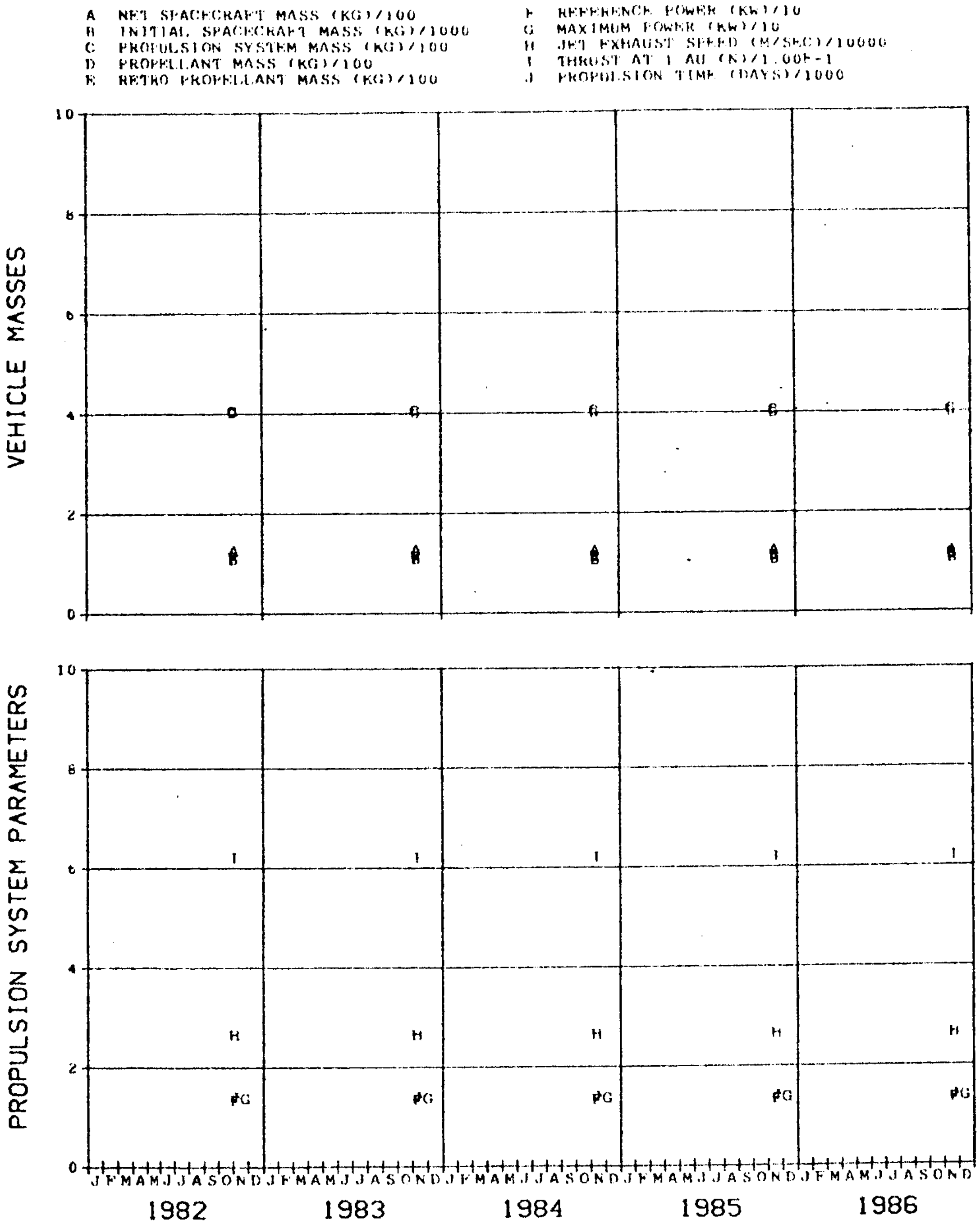

FIG. 30C. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3500 DAYS

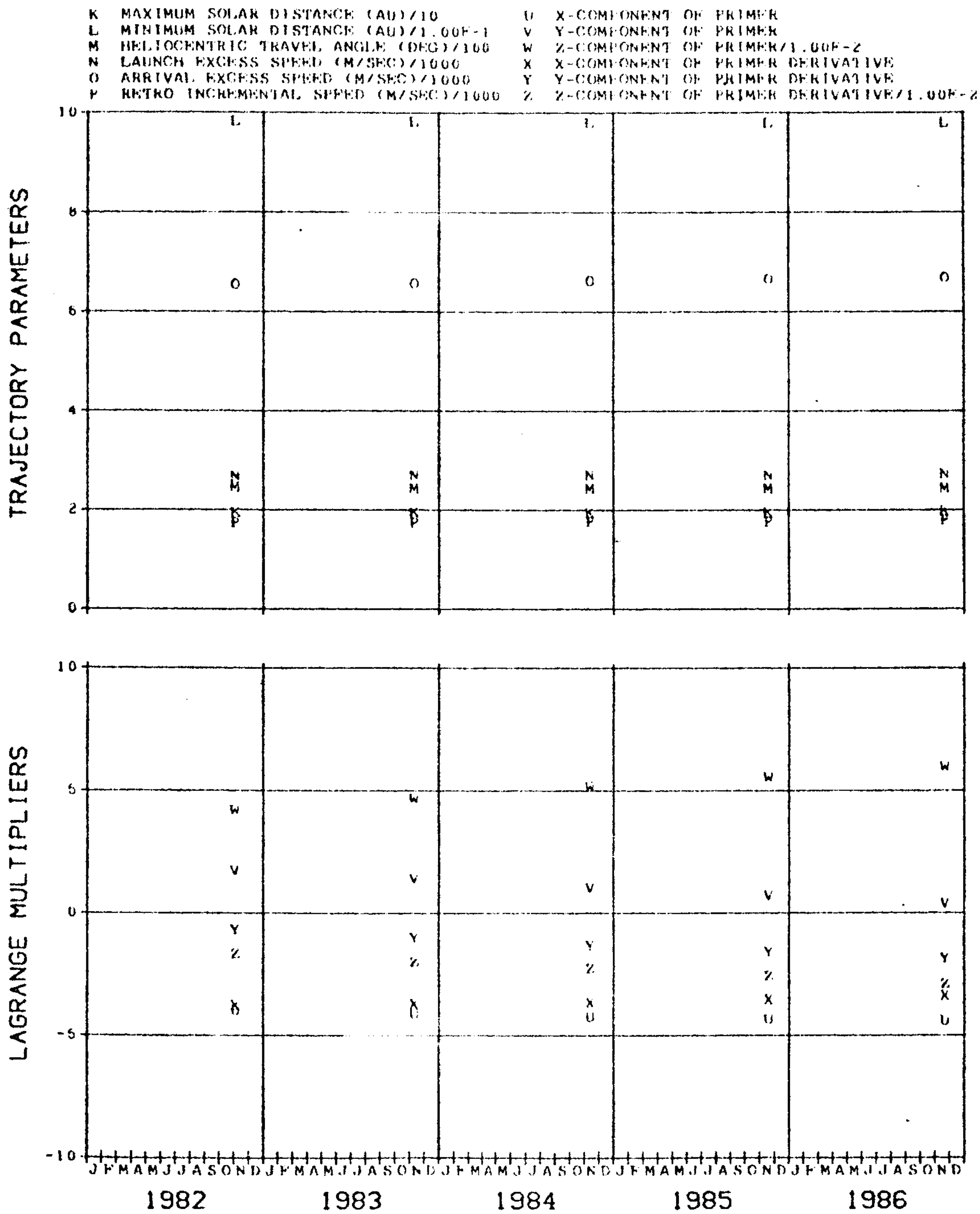

FIG. 30C. (CONCLUDED)

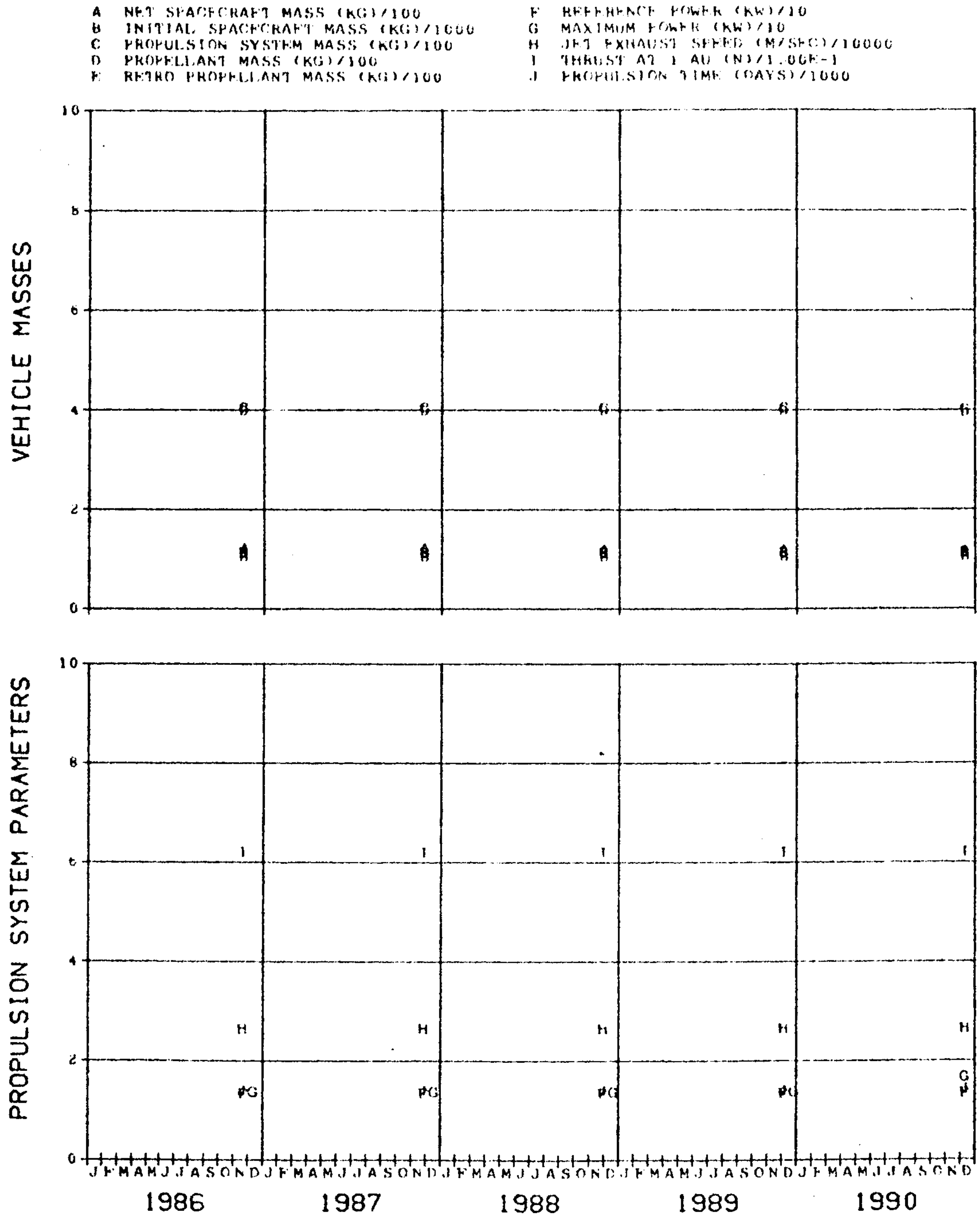

FIG. 30D. URANUS MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 3500 DAYS

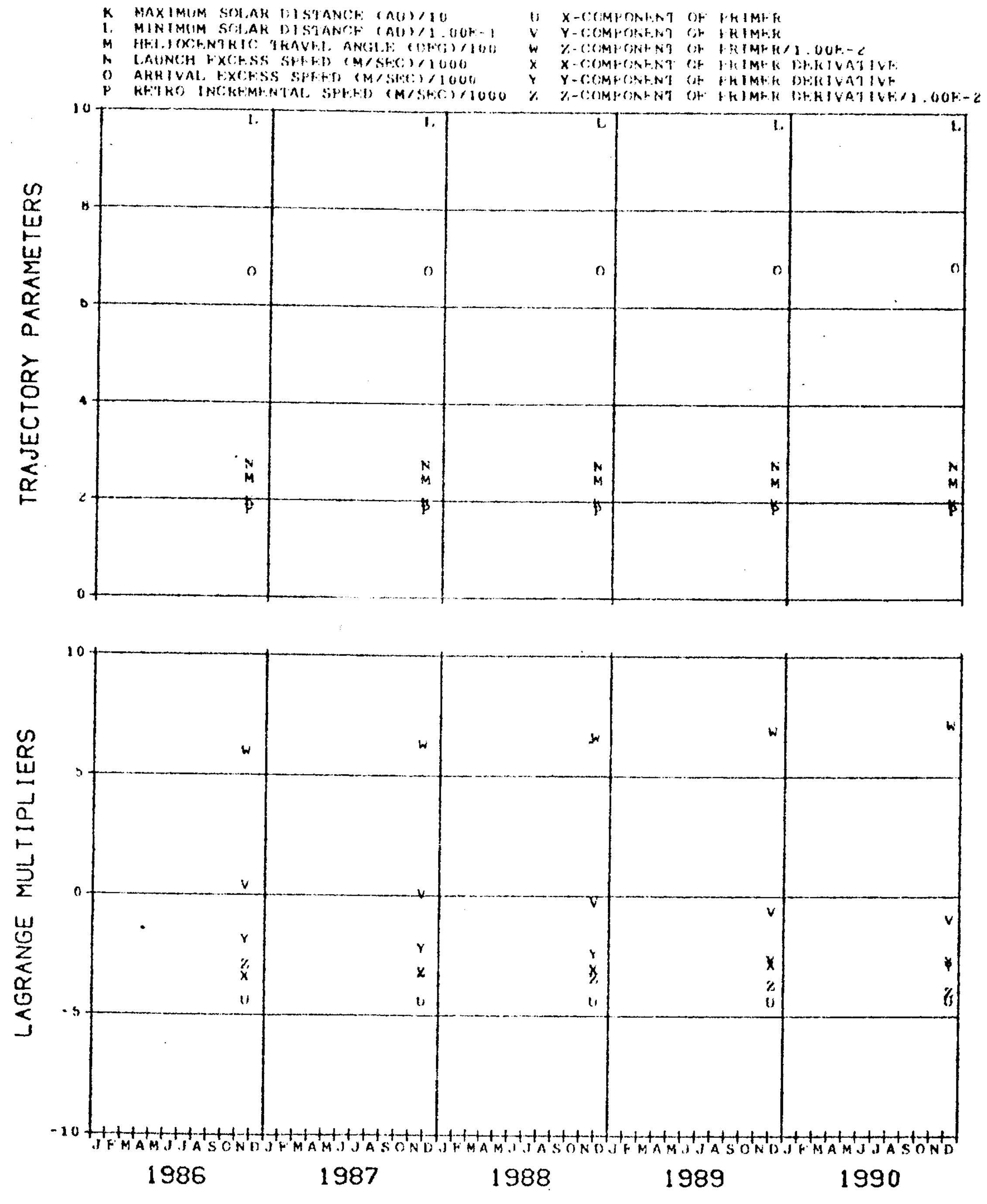

FIG. 30D. (CONCLUDED)

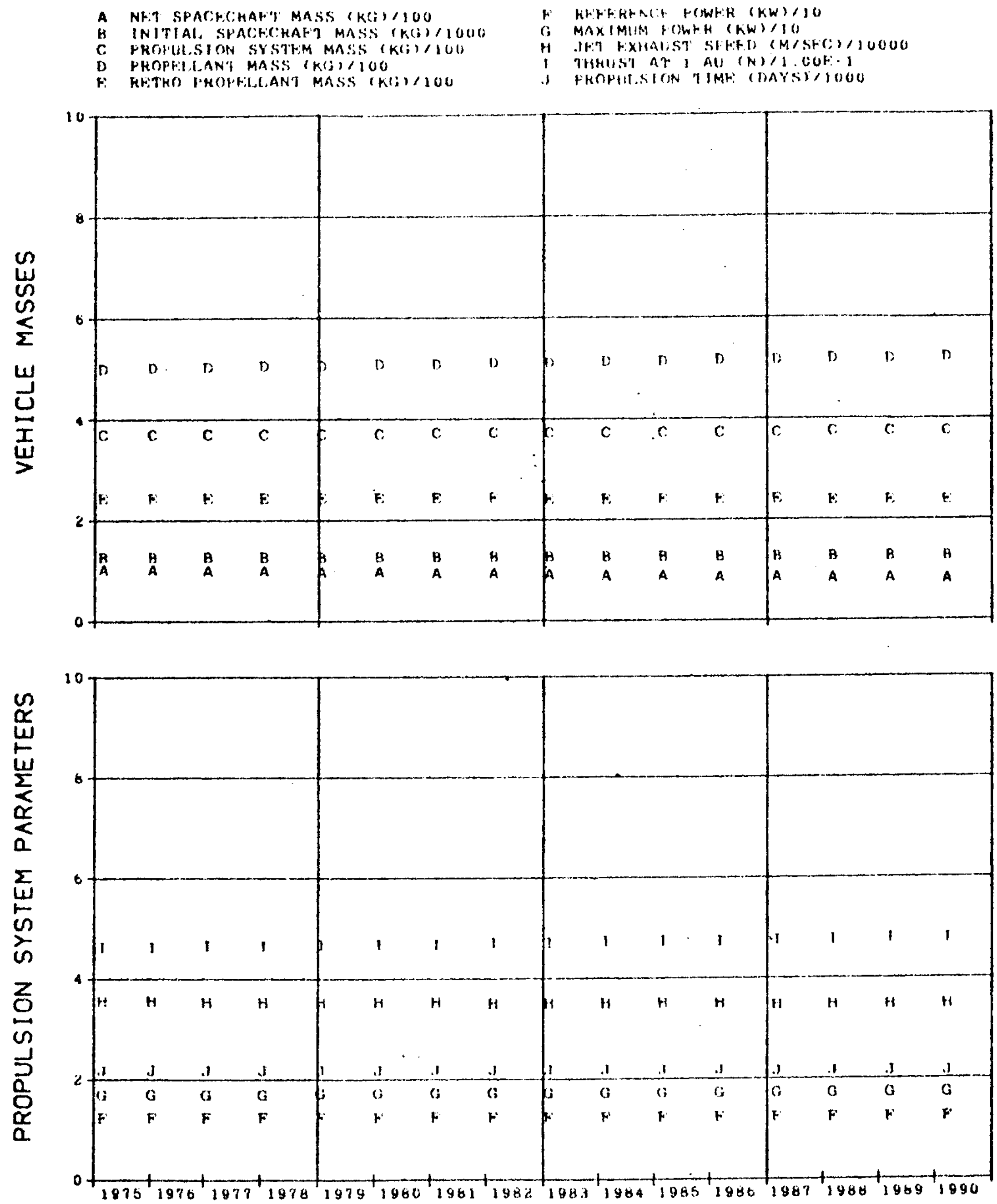

FIG. 31. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

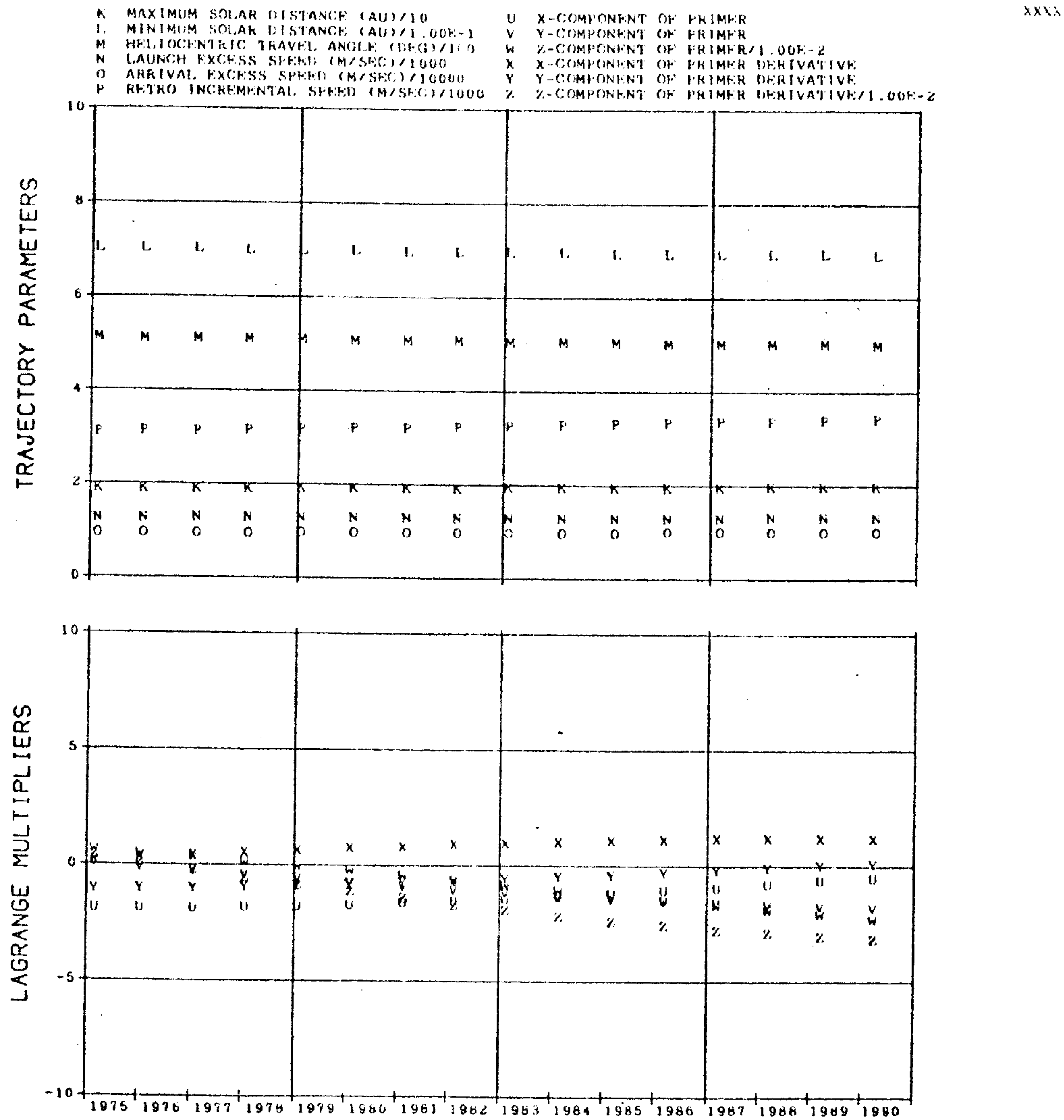

FIG. 31. (CONCLUDED)

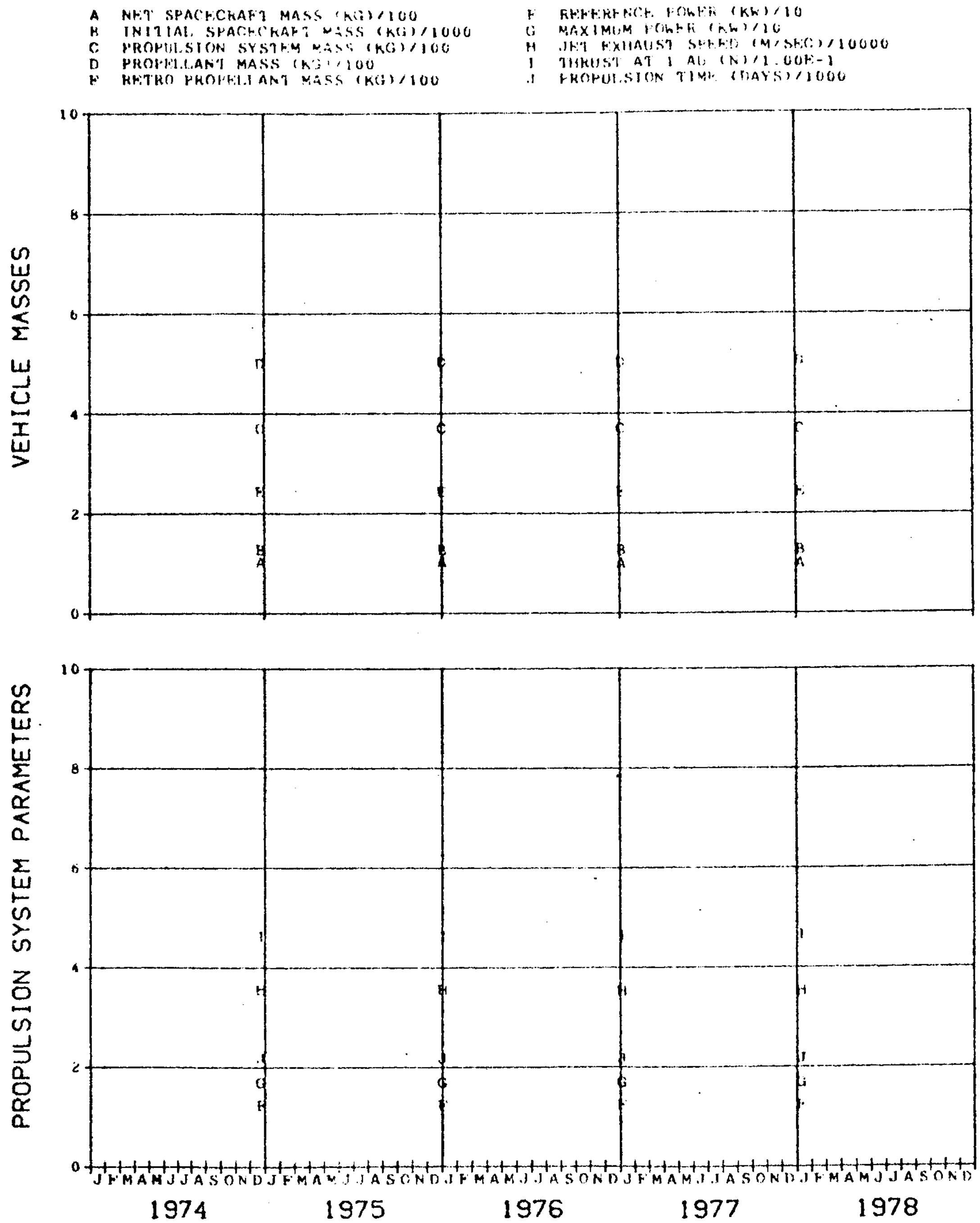

FIG. 31A. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

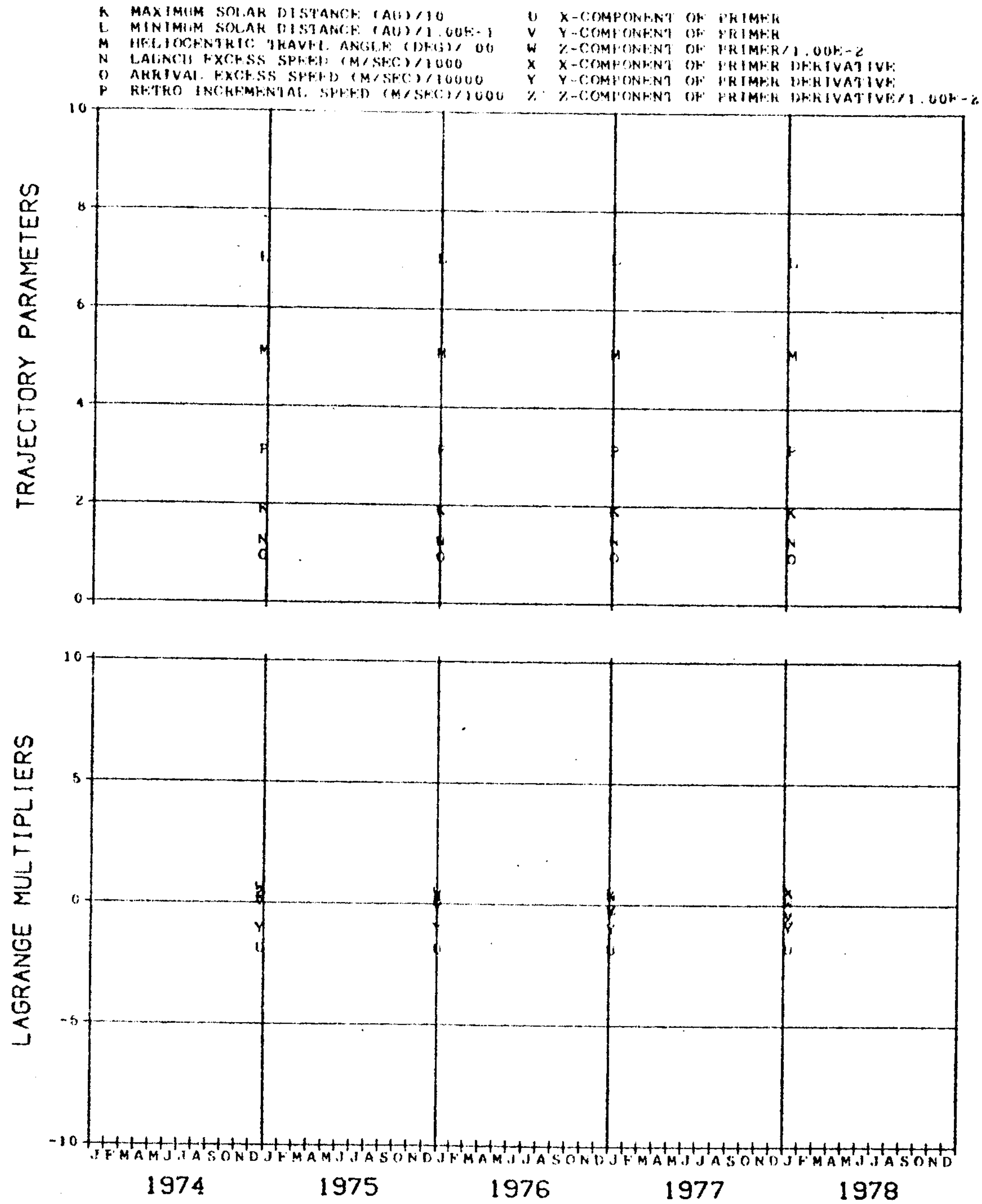

FIG. 31A. (CONCLUDED)

XXX)

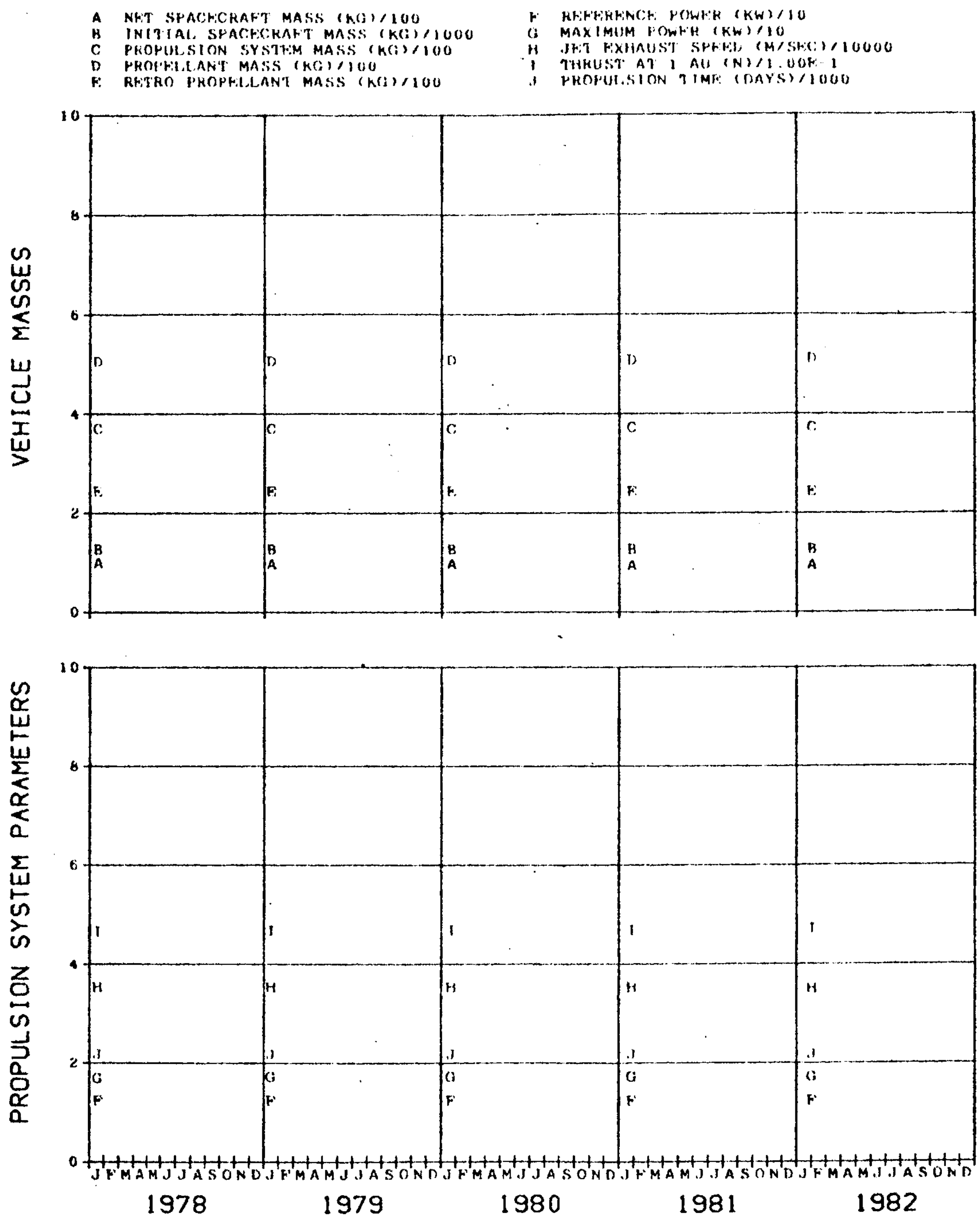

FIG. 31B. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

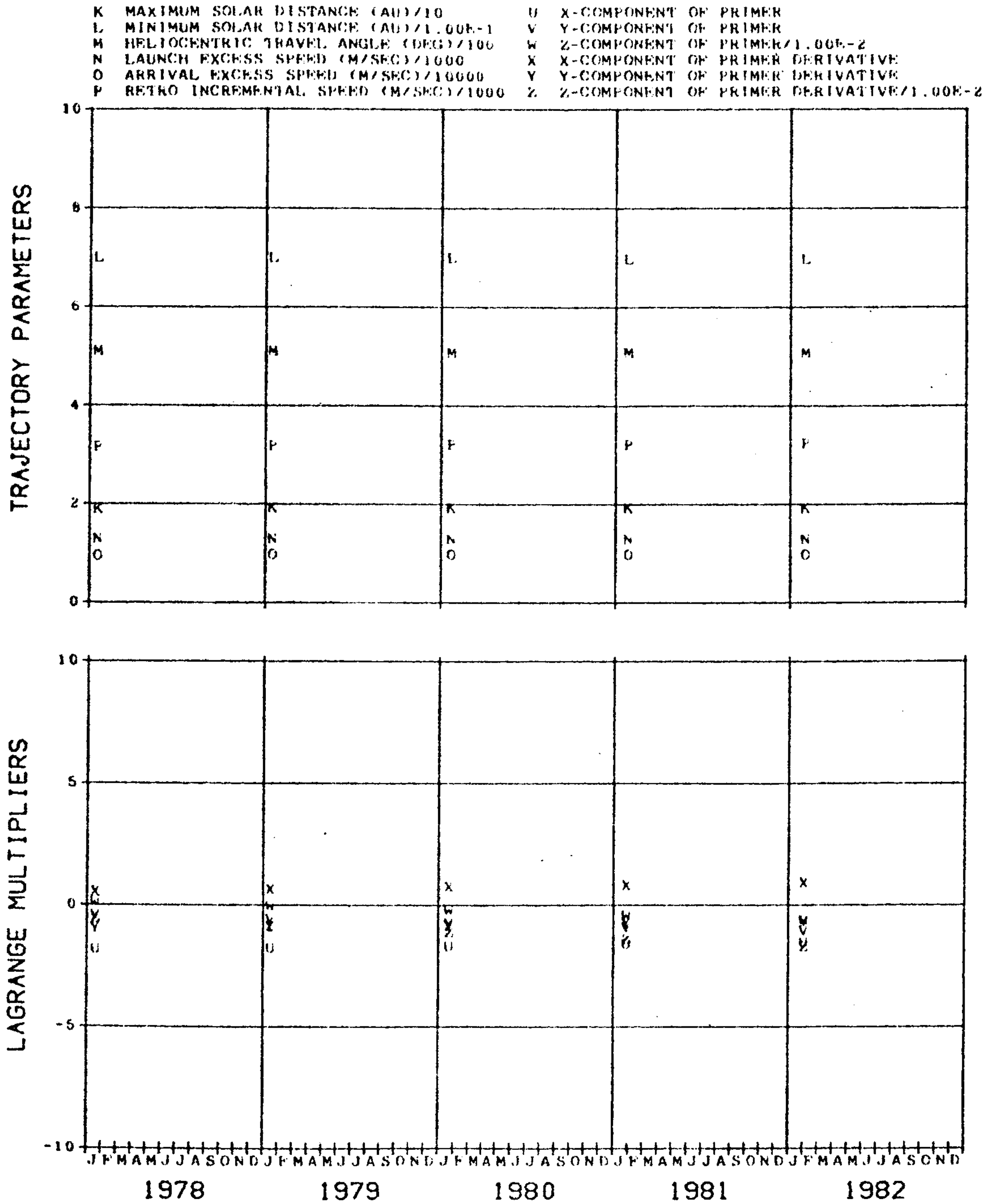

FIG. 31B. (CONCLUDED)

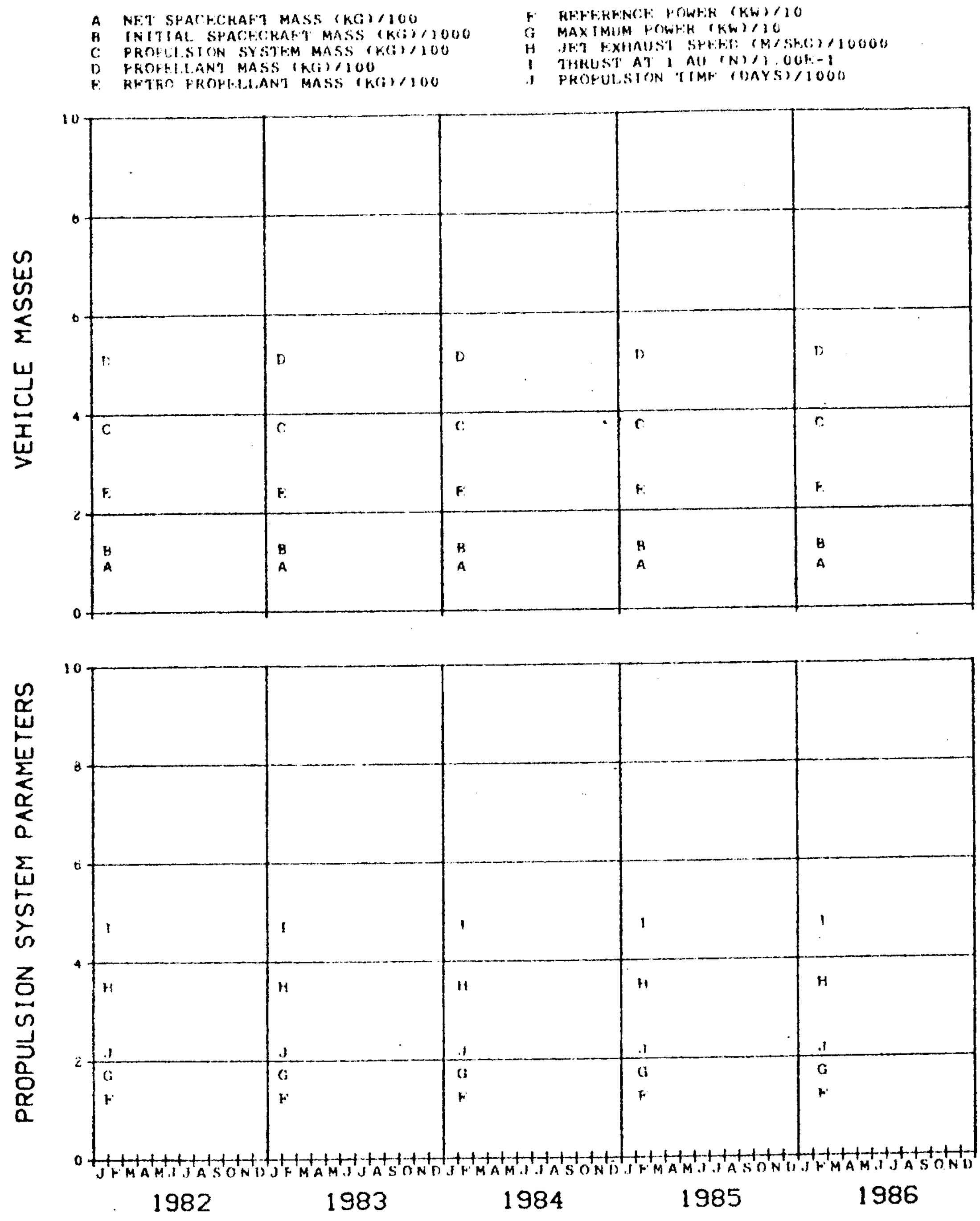

FIG. 31C. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

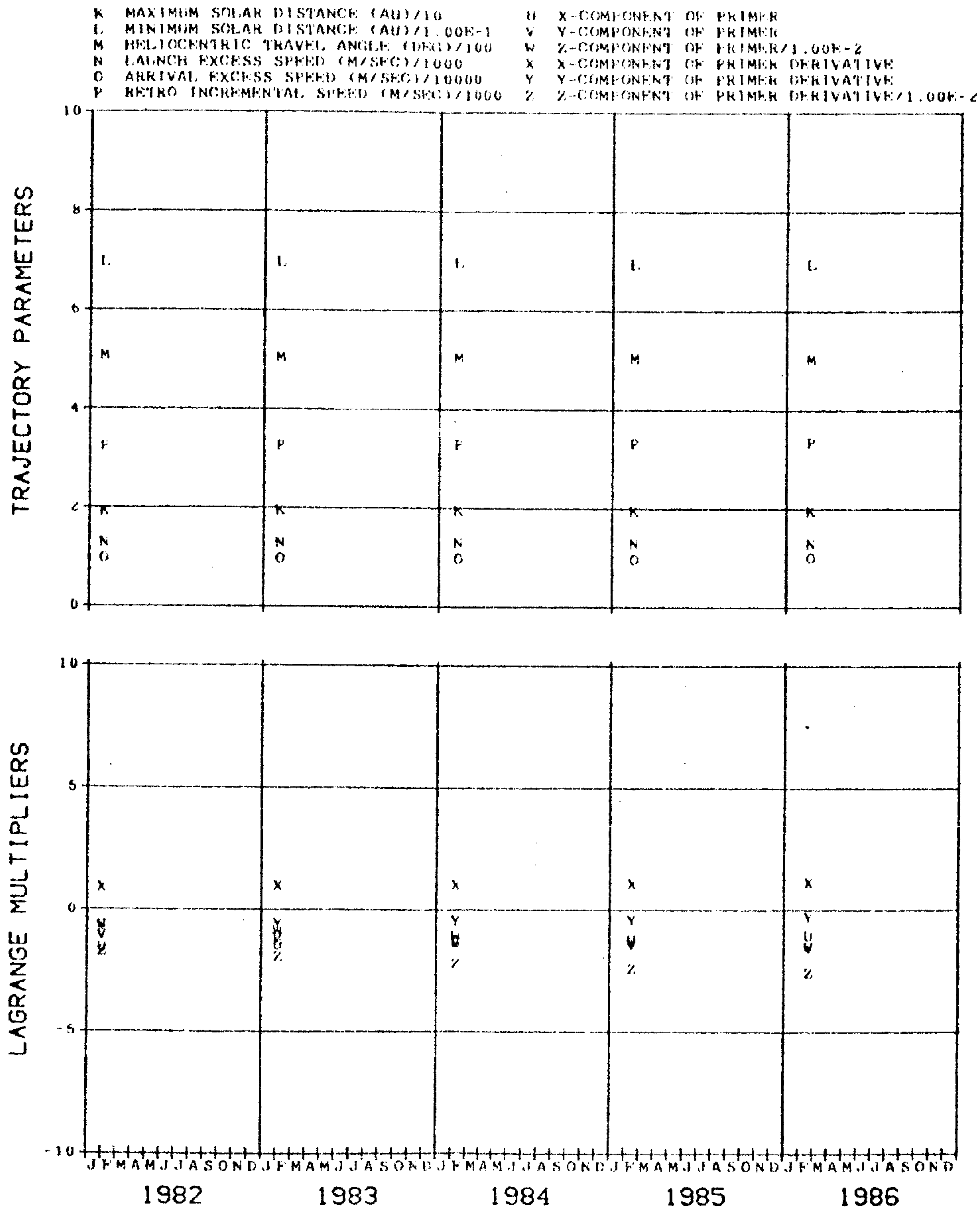

FIG. 31C. (CONCLUDED)

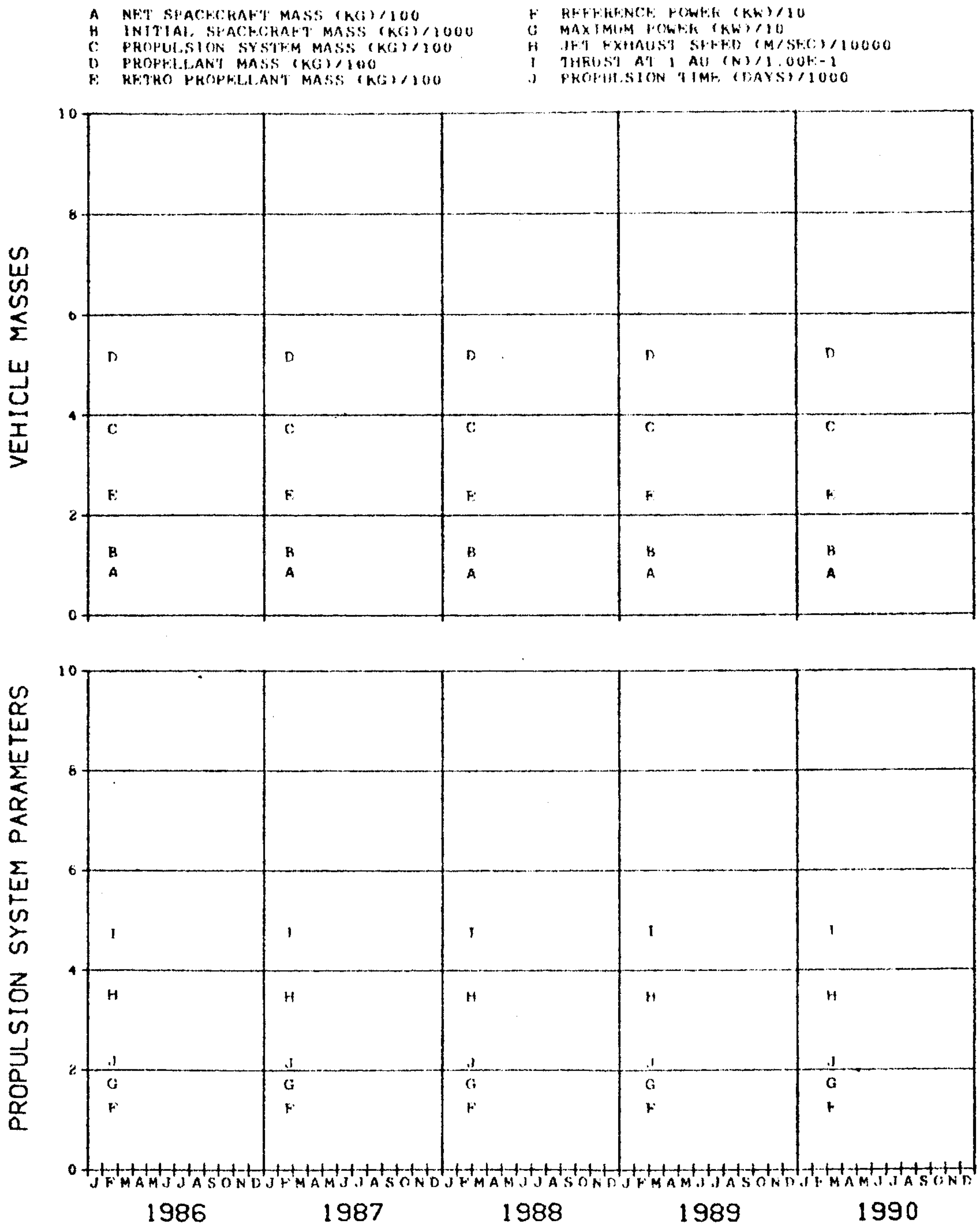

FIG. 31D. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 3000 DAYS

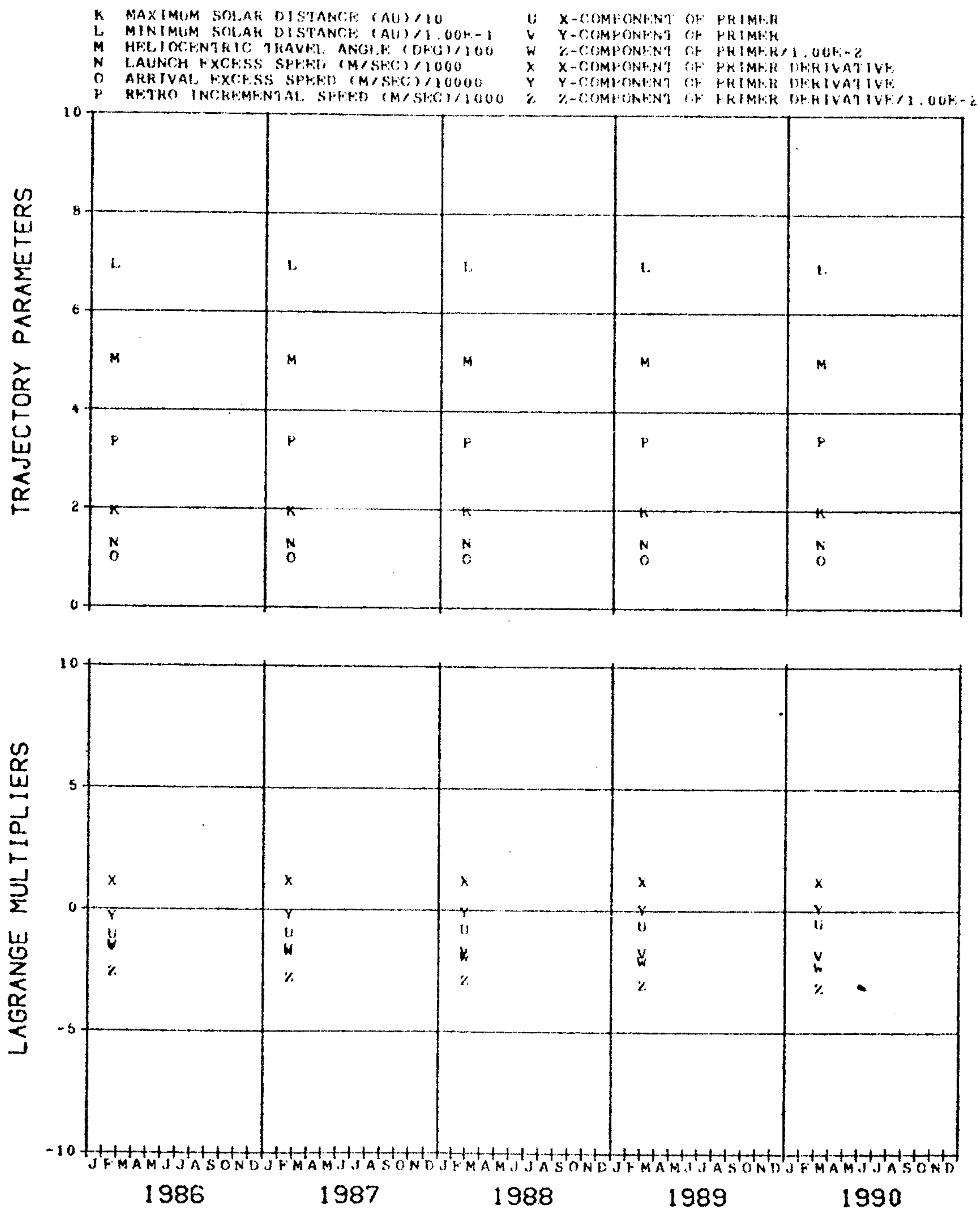

FIG. 31D. (CONCLUDED)

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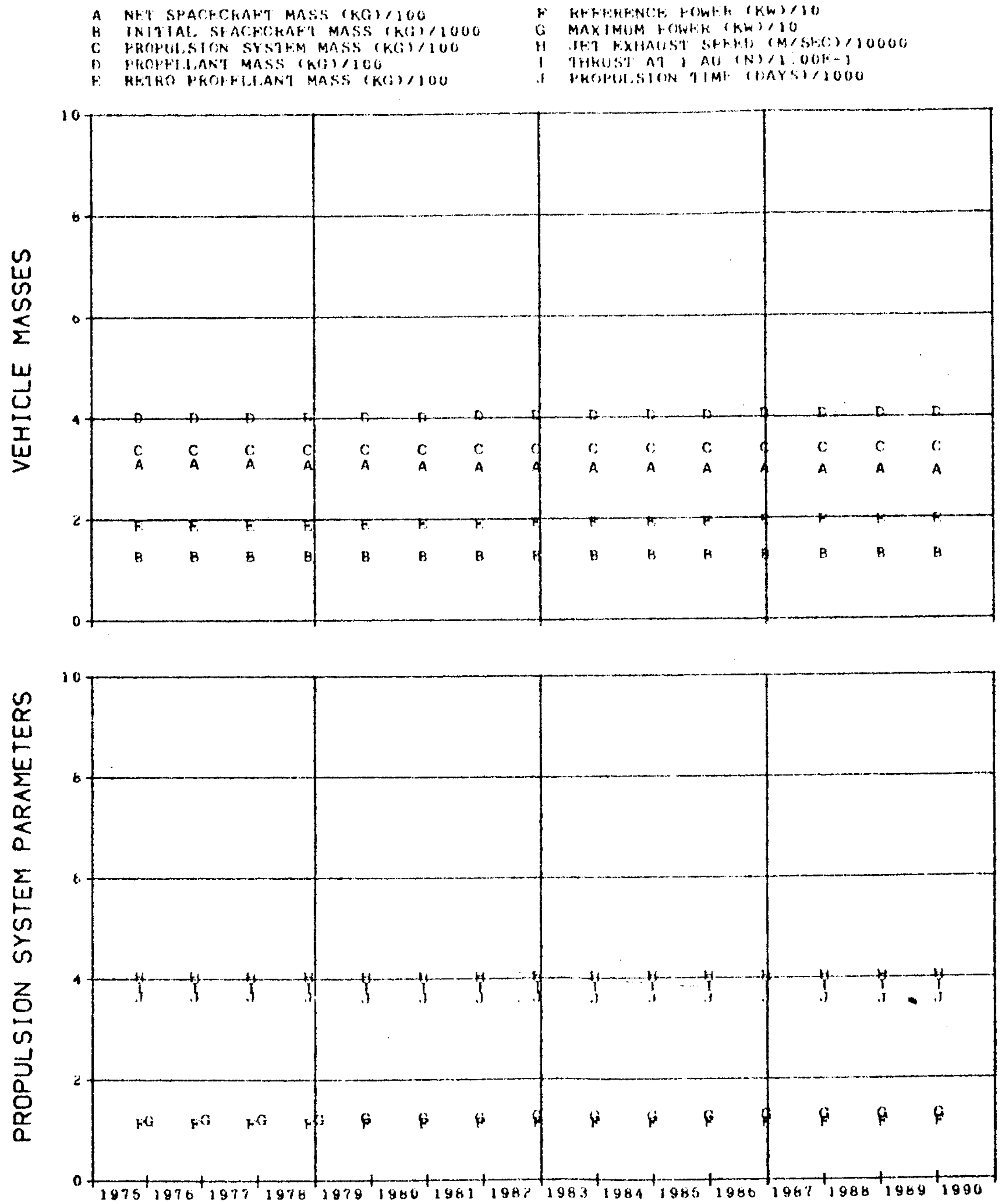

FIG. 32. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4600 DAYS

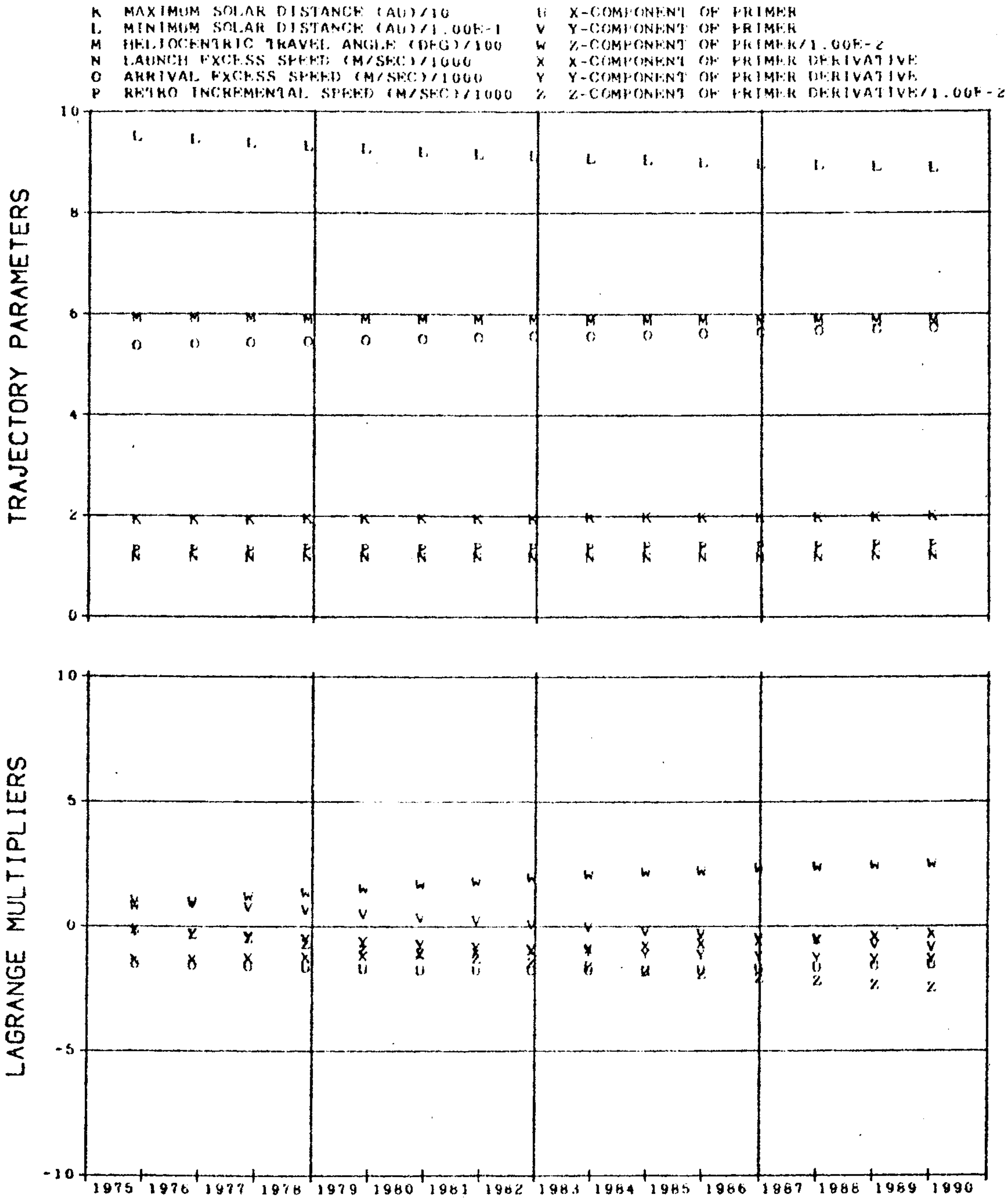

FIG. 32. (CONCLUDED)

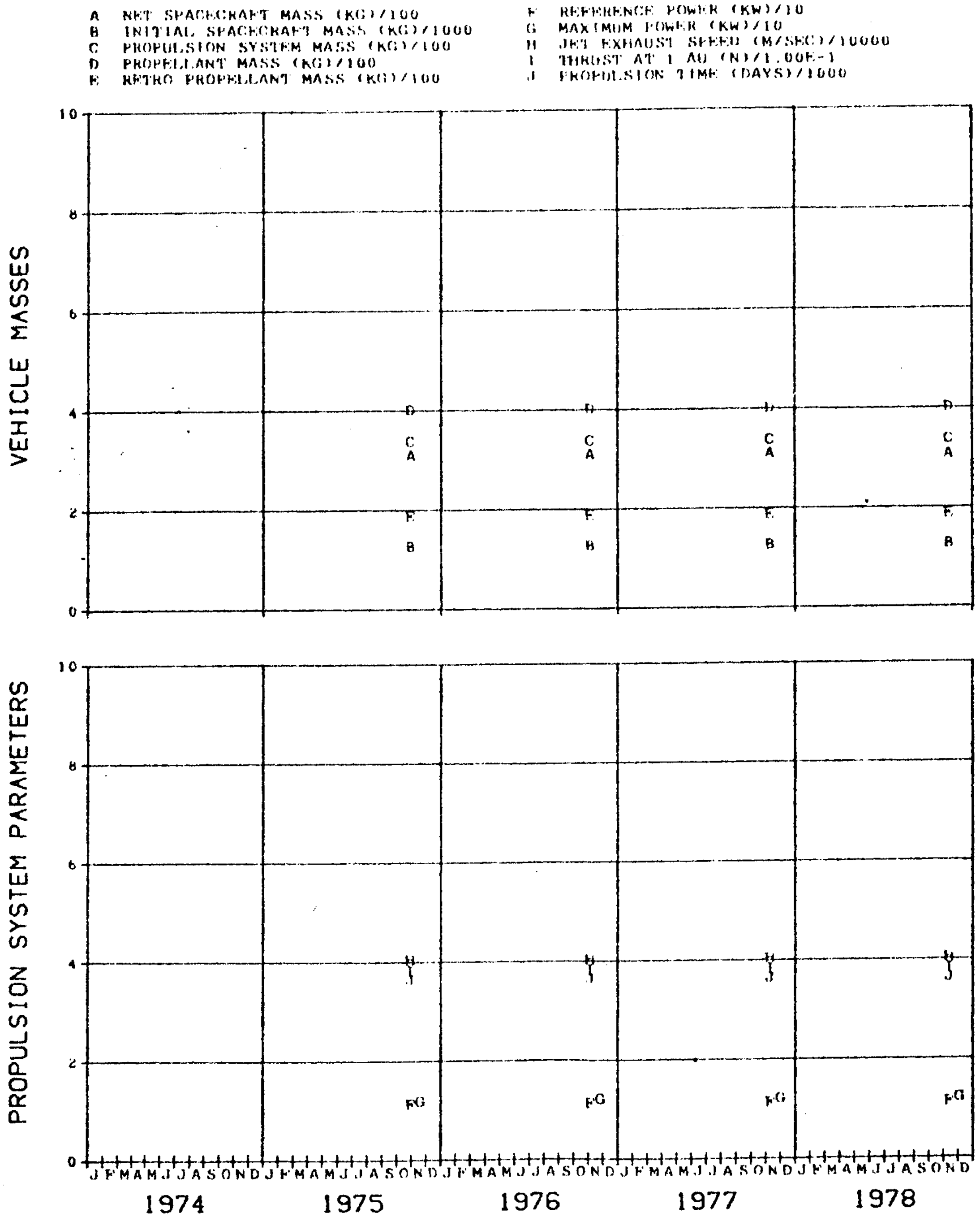

FIG. 32A. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4600 DAYS

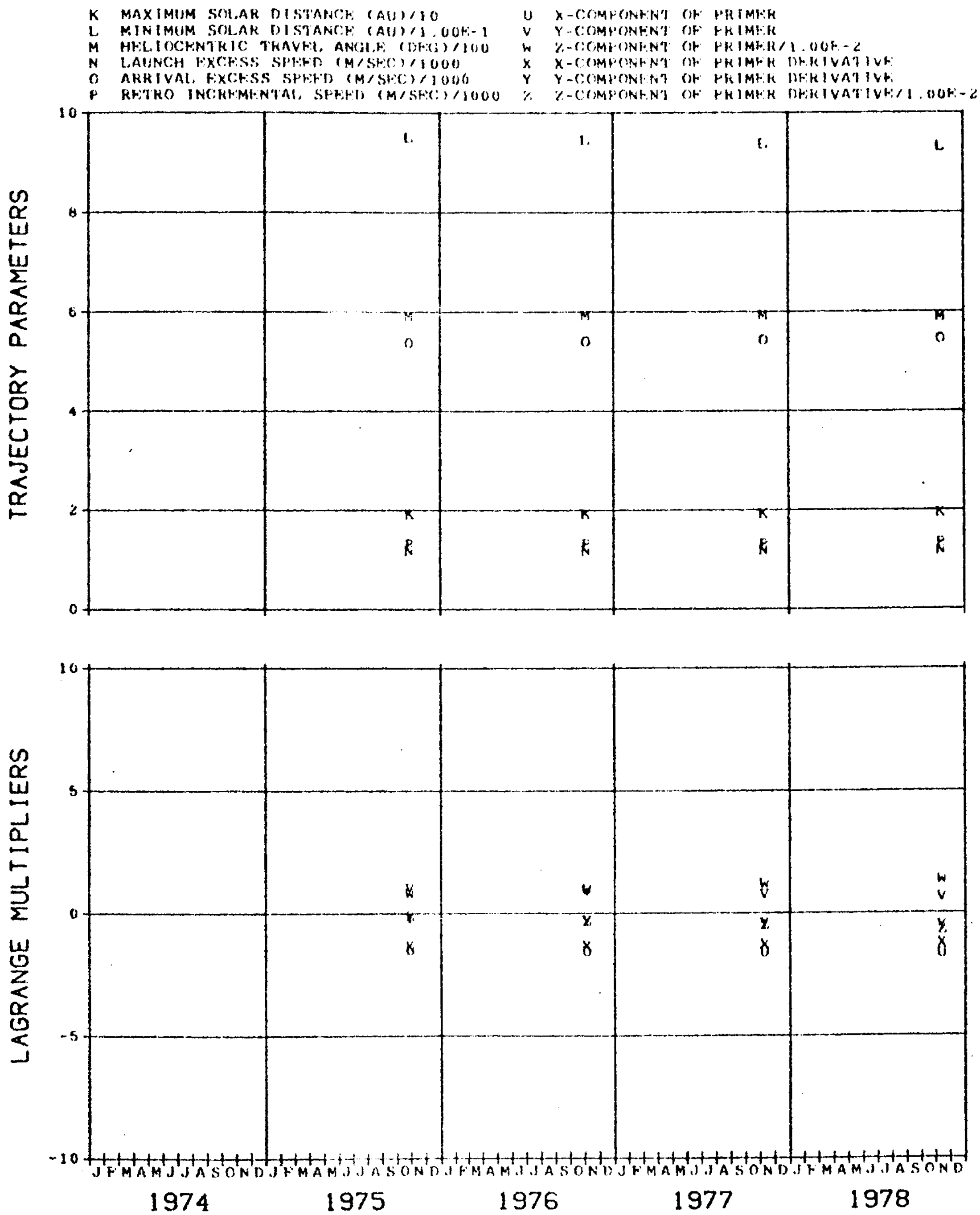

FIG. 32A. (CONCLUDED)

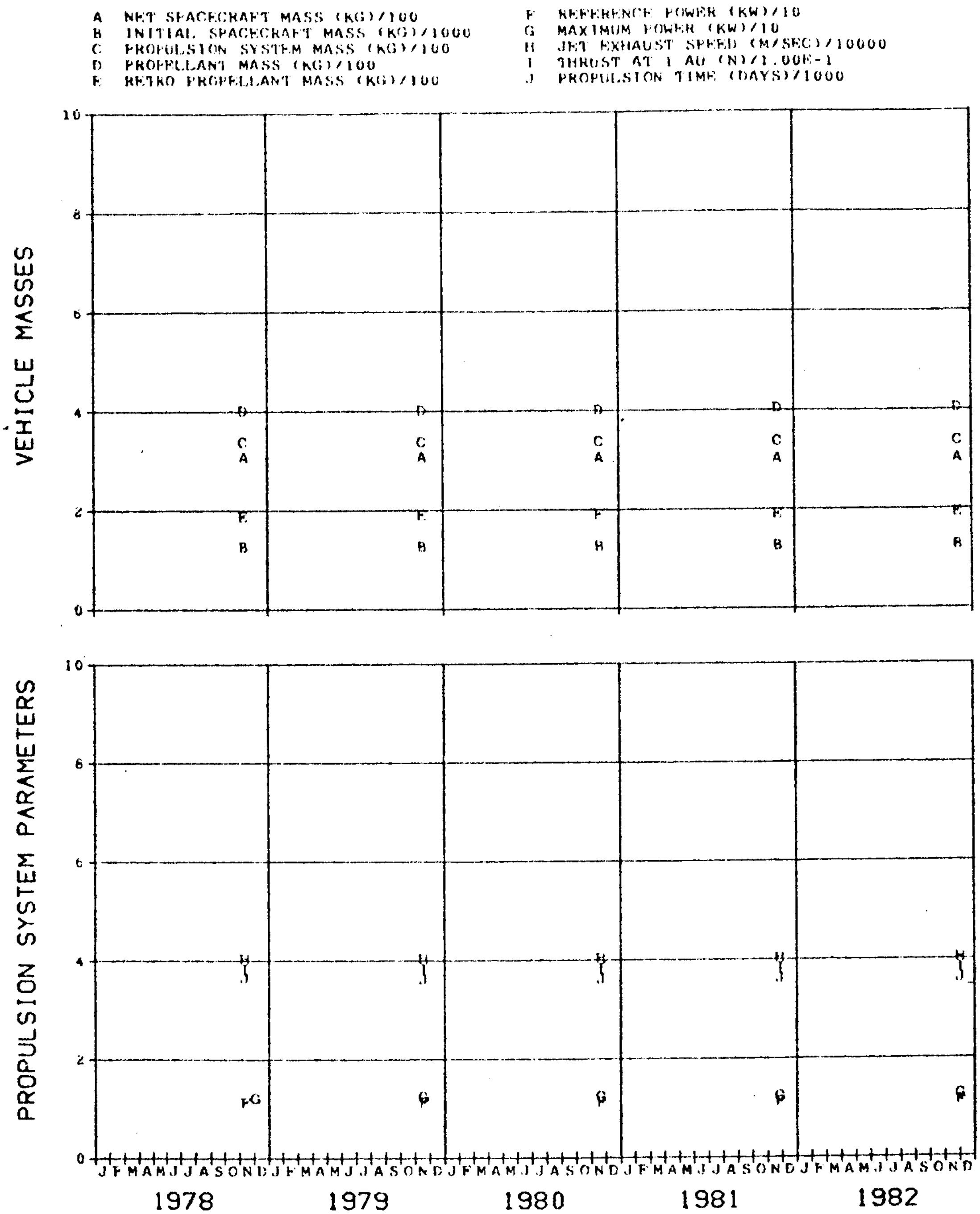

FIG. 32B. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4600 DAYS

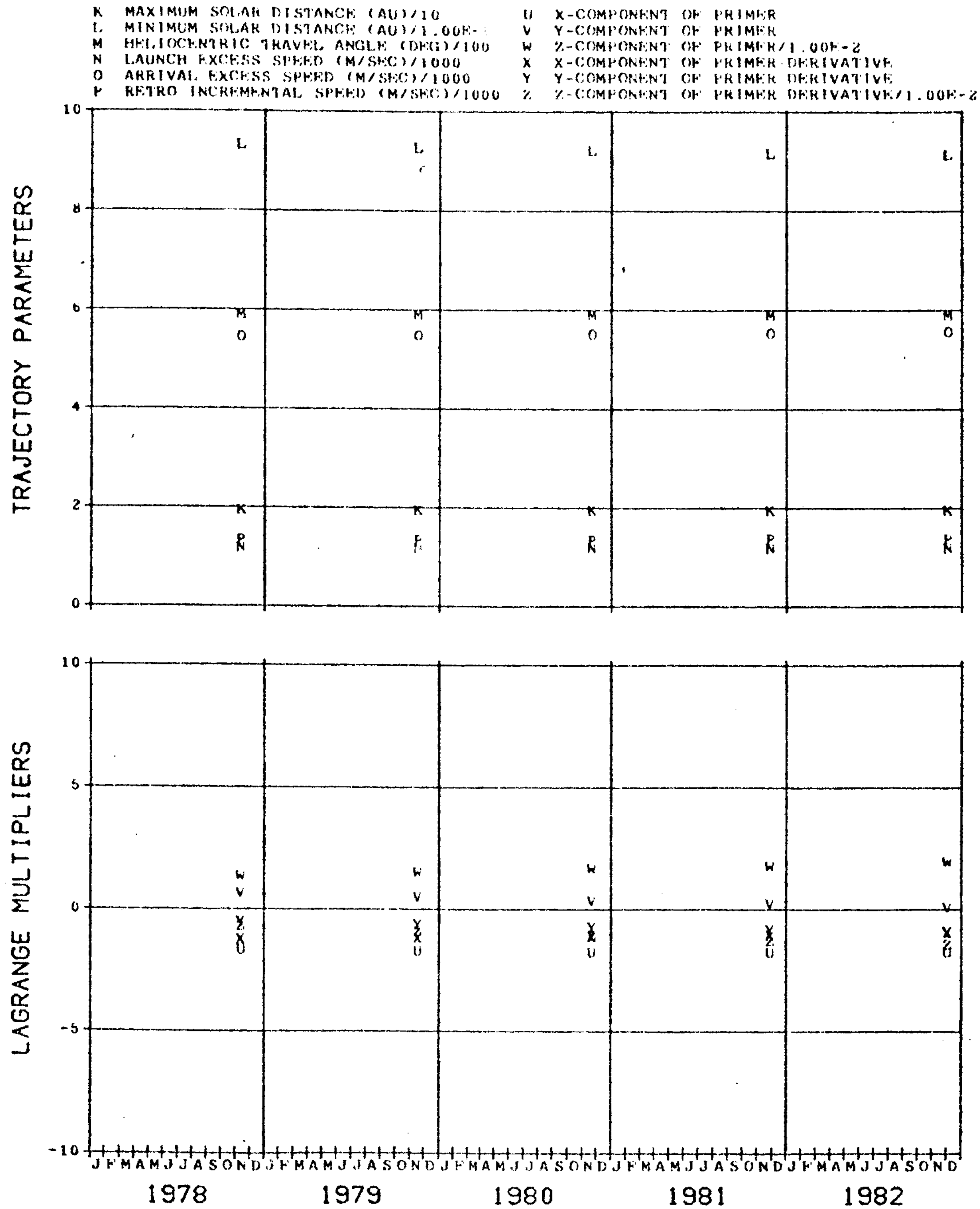

FIG. 32B. (CONCLUDED)

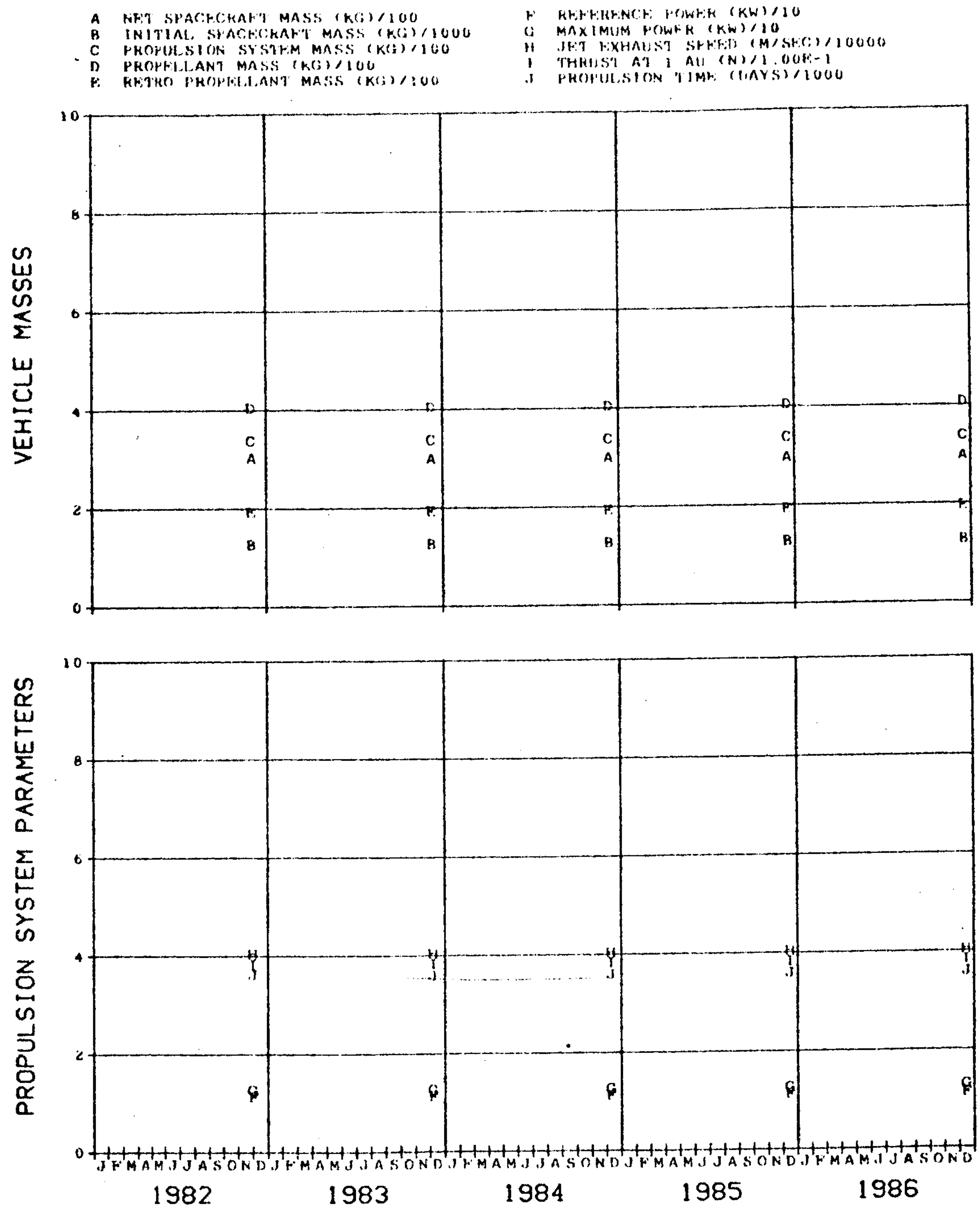

FIG. 32C. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4600 DAYS

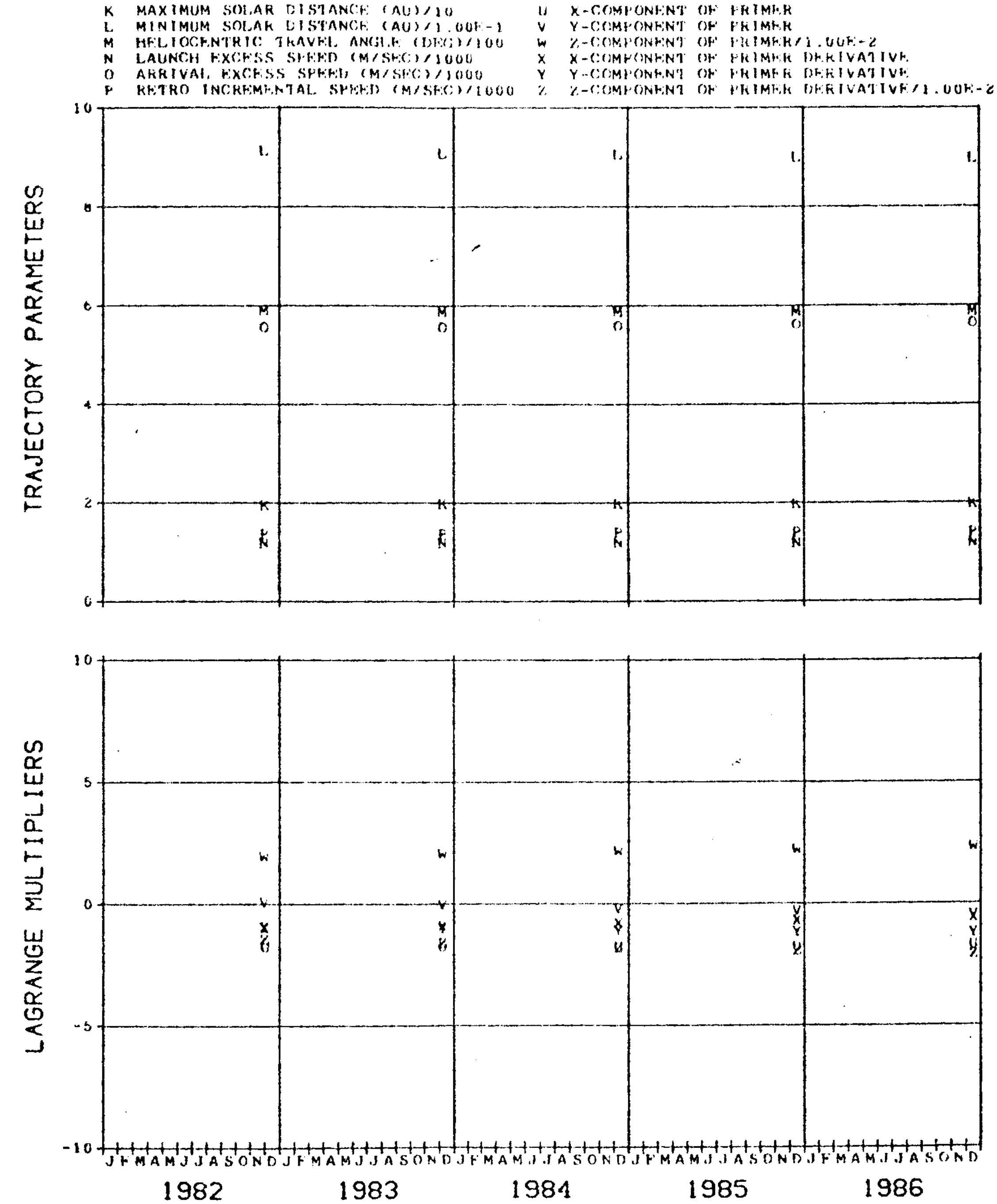

FIG. 32C. (CONCLUDED)

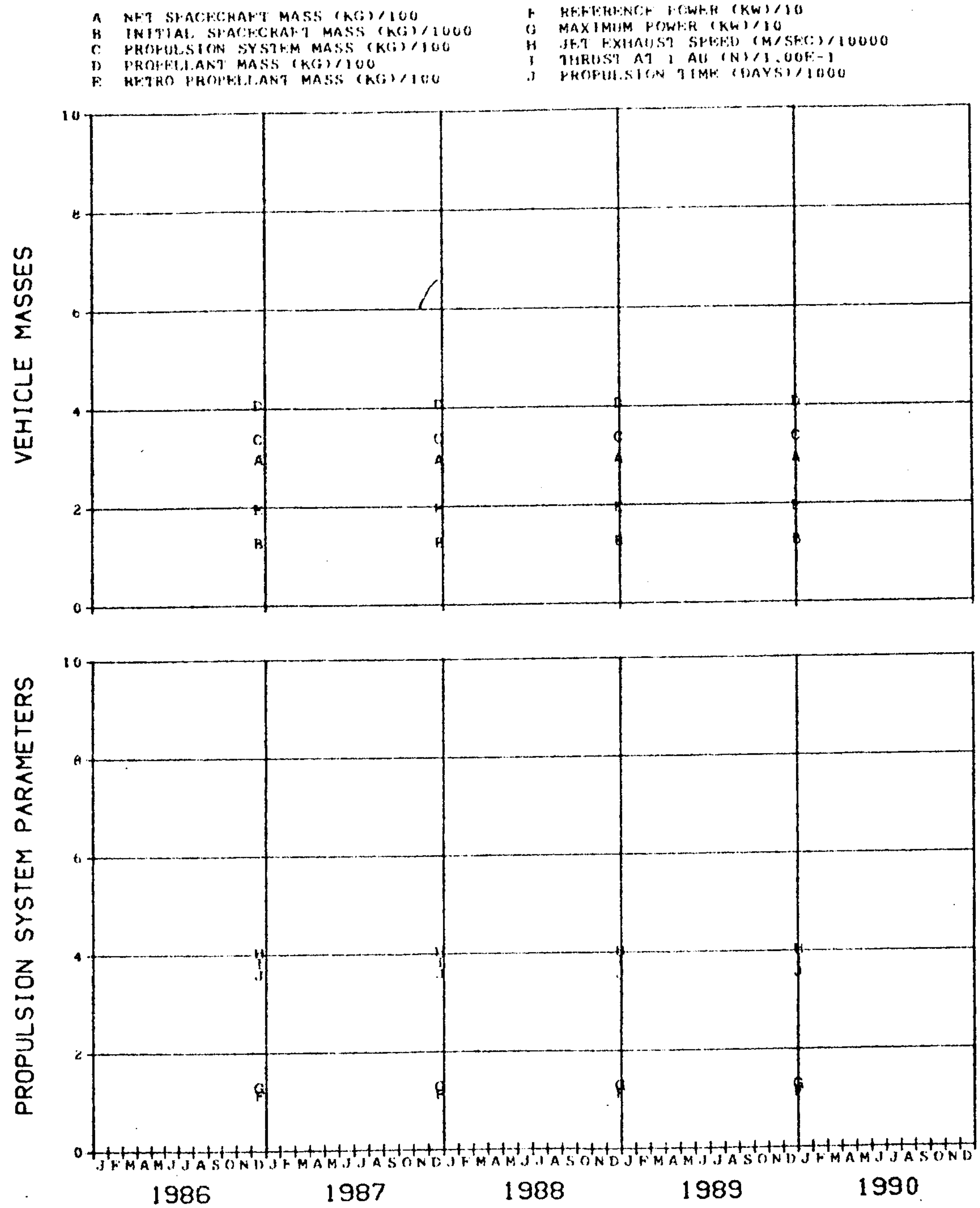

FIG. 32D. URANUS MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4600 DAYS

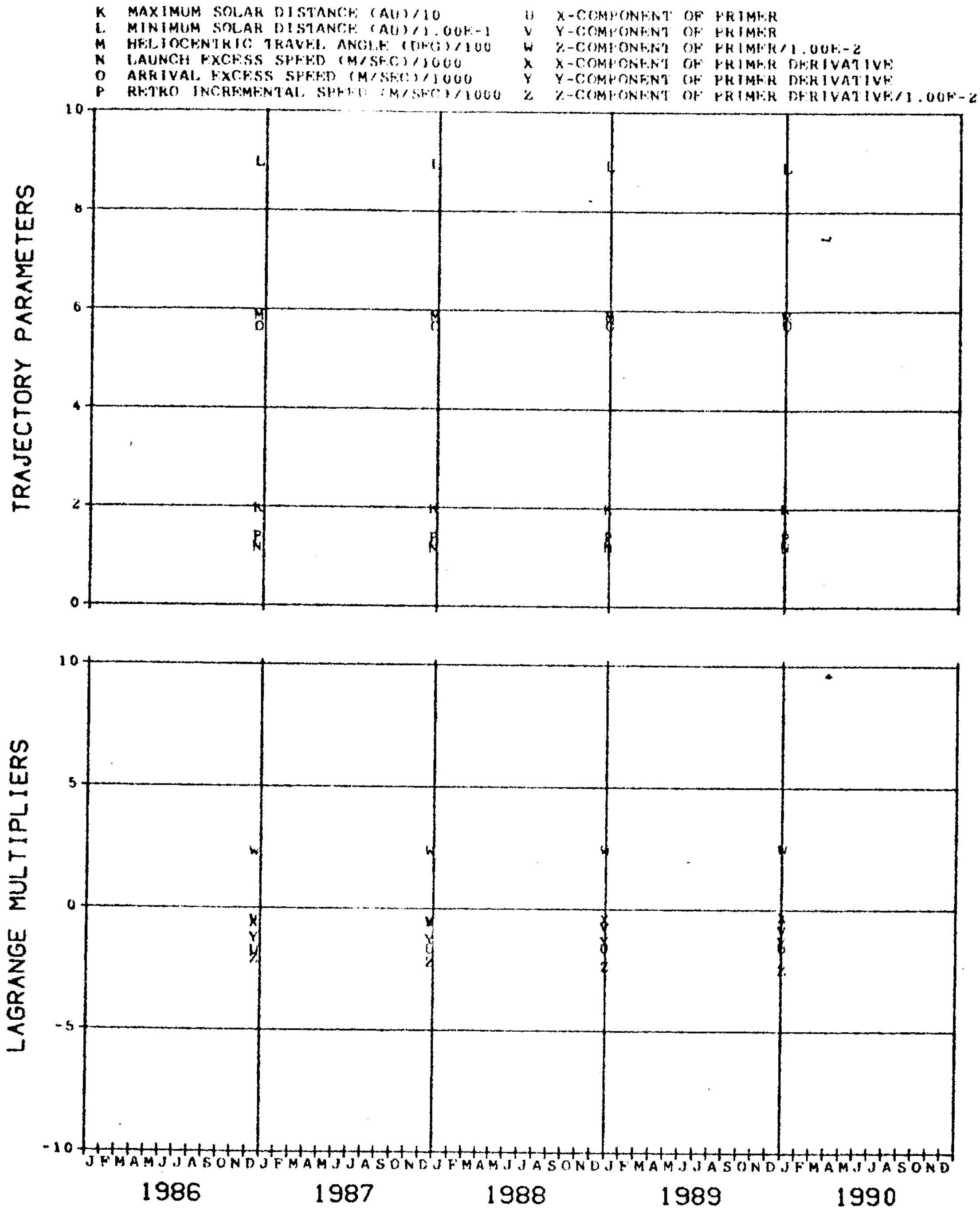

FIG. 32D. (CONCLUDED)

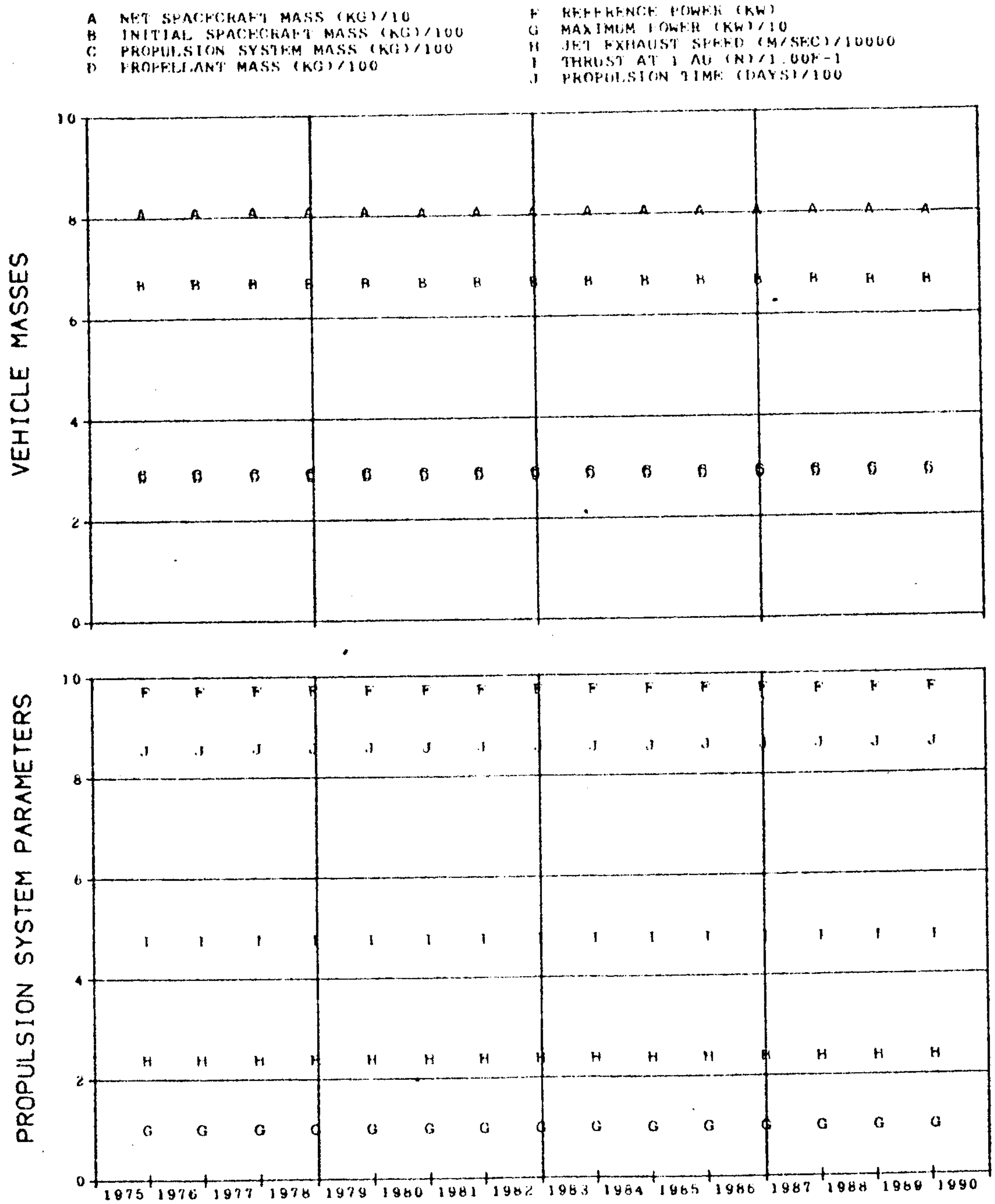

FIG. 33. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

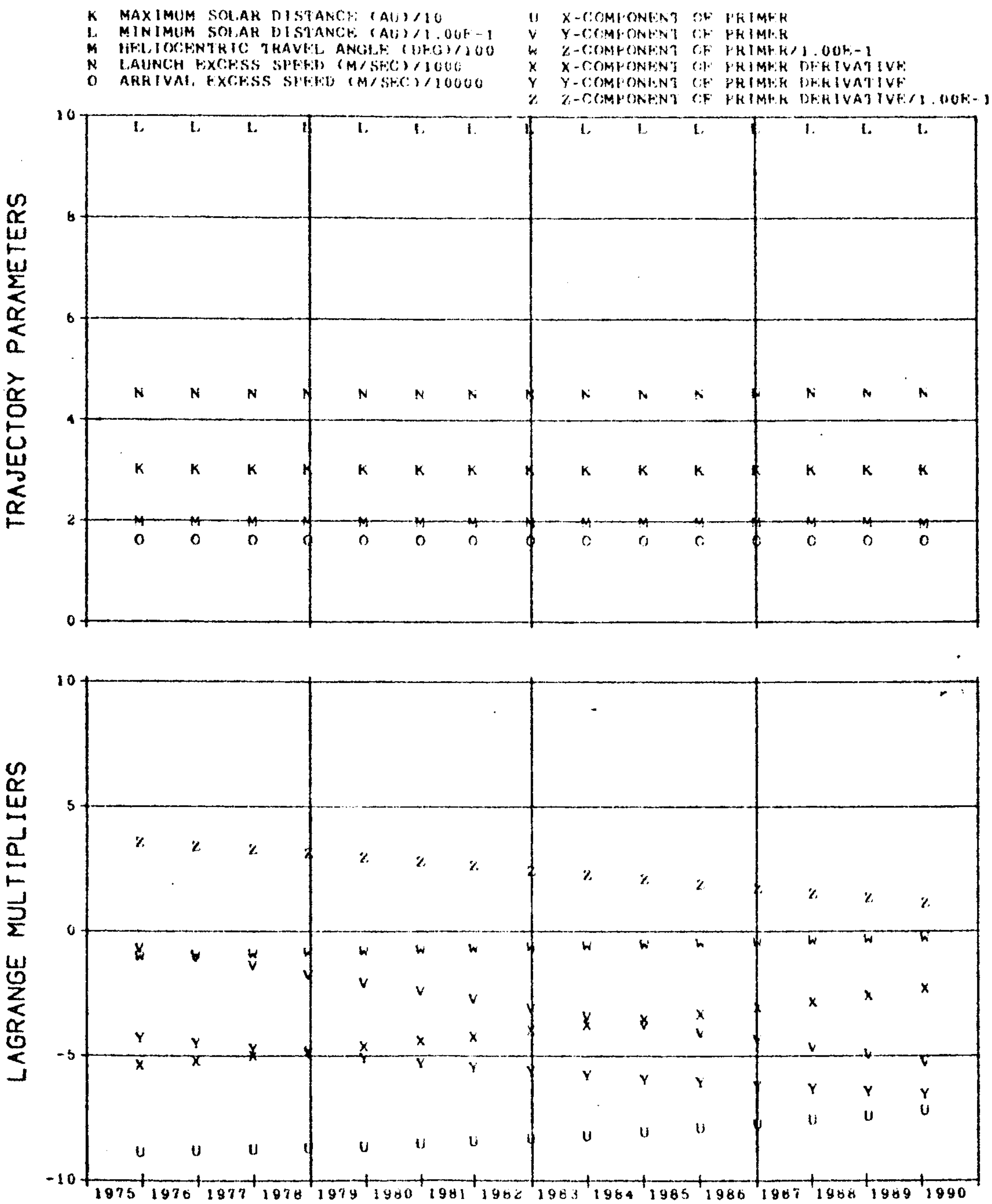

FIG. 33. (CONCLUDED)

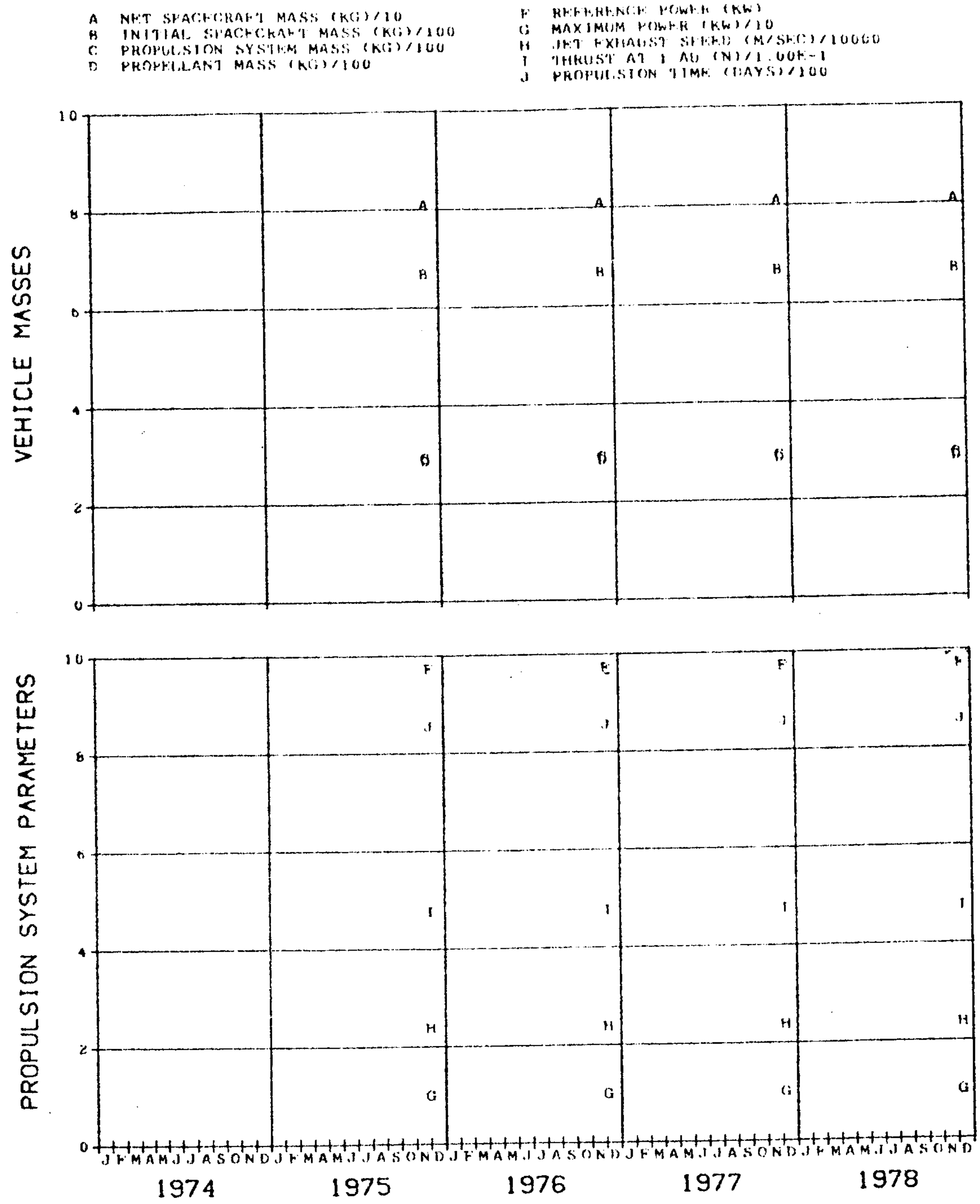

FIG. 33A. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

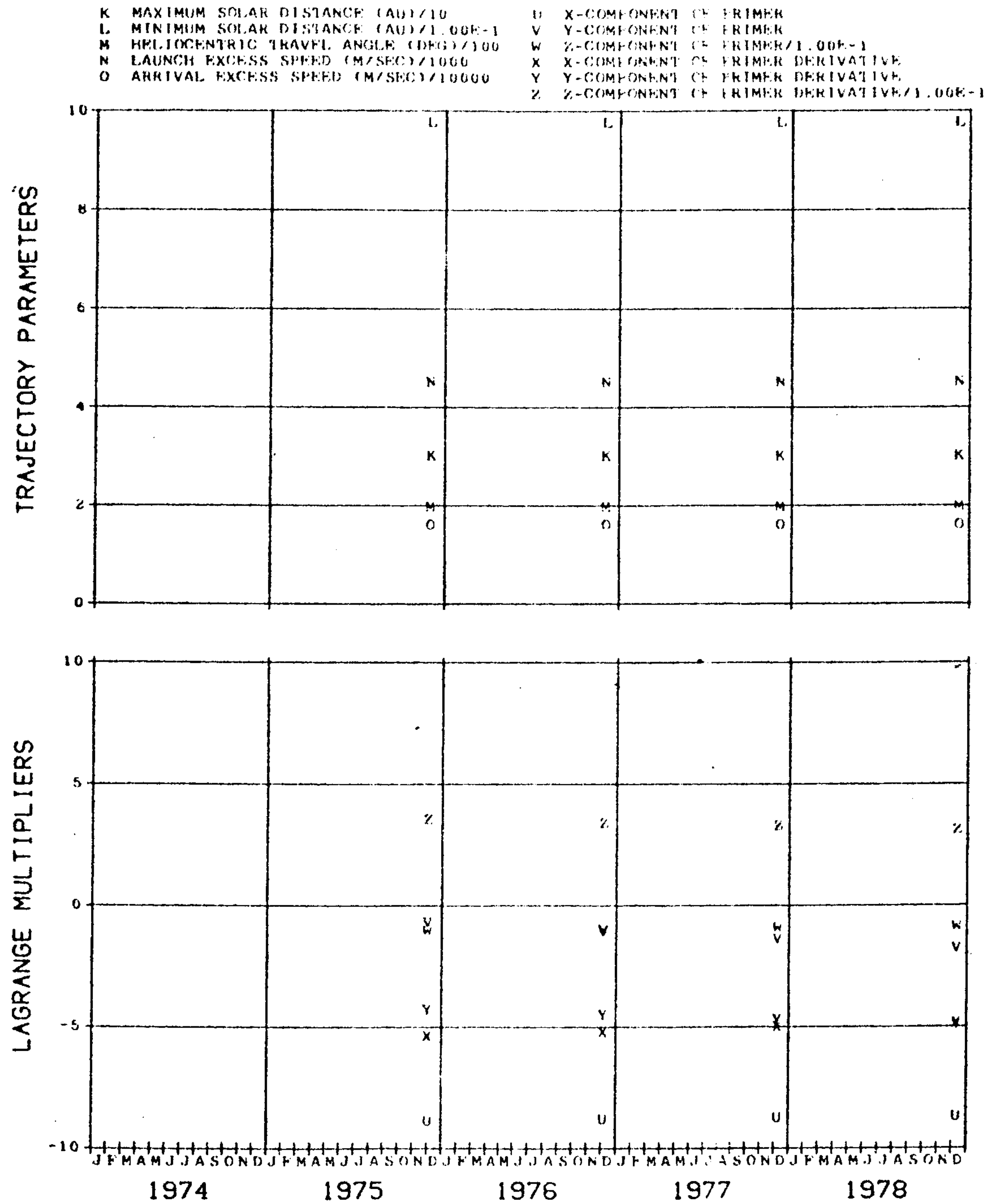

FIG. 33A. (CONCLUDED)

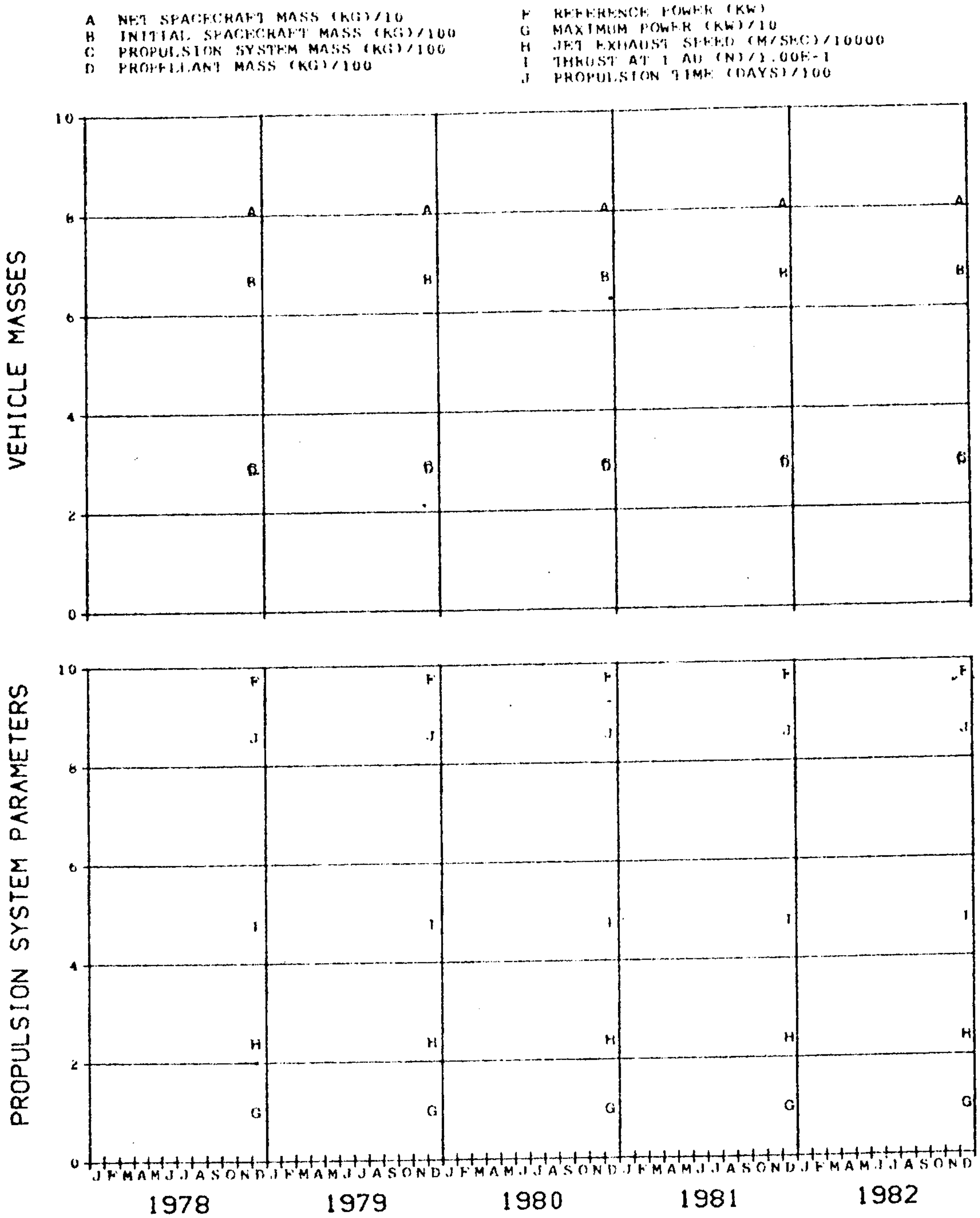

FIG. 33B. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

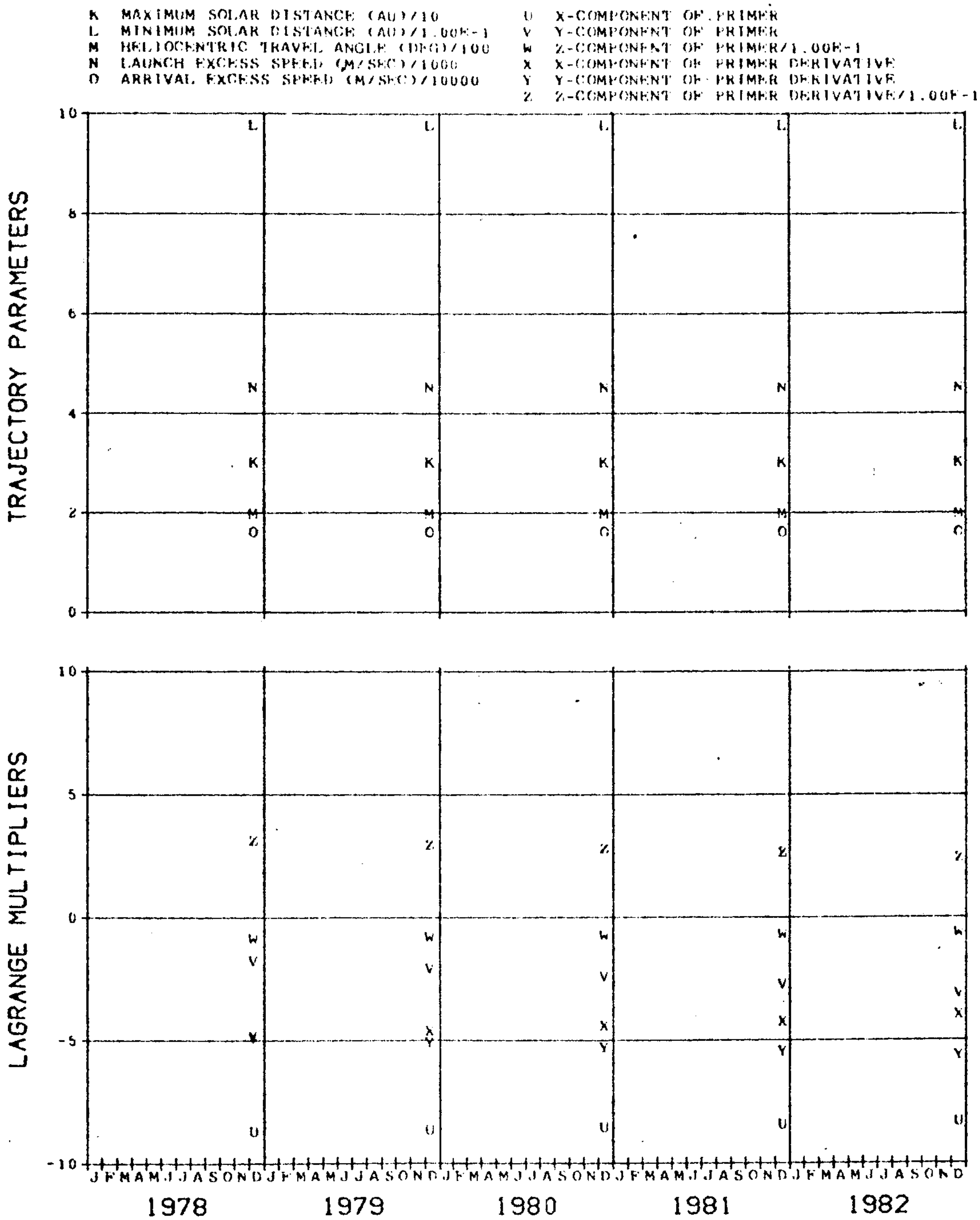

FIG. 33B. (CONCLUDED)

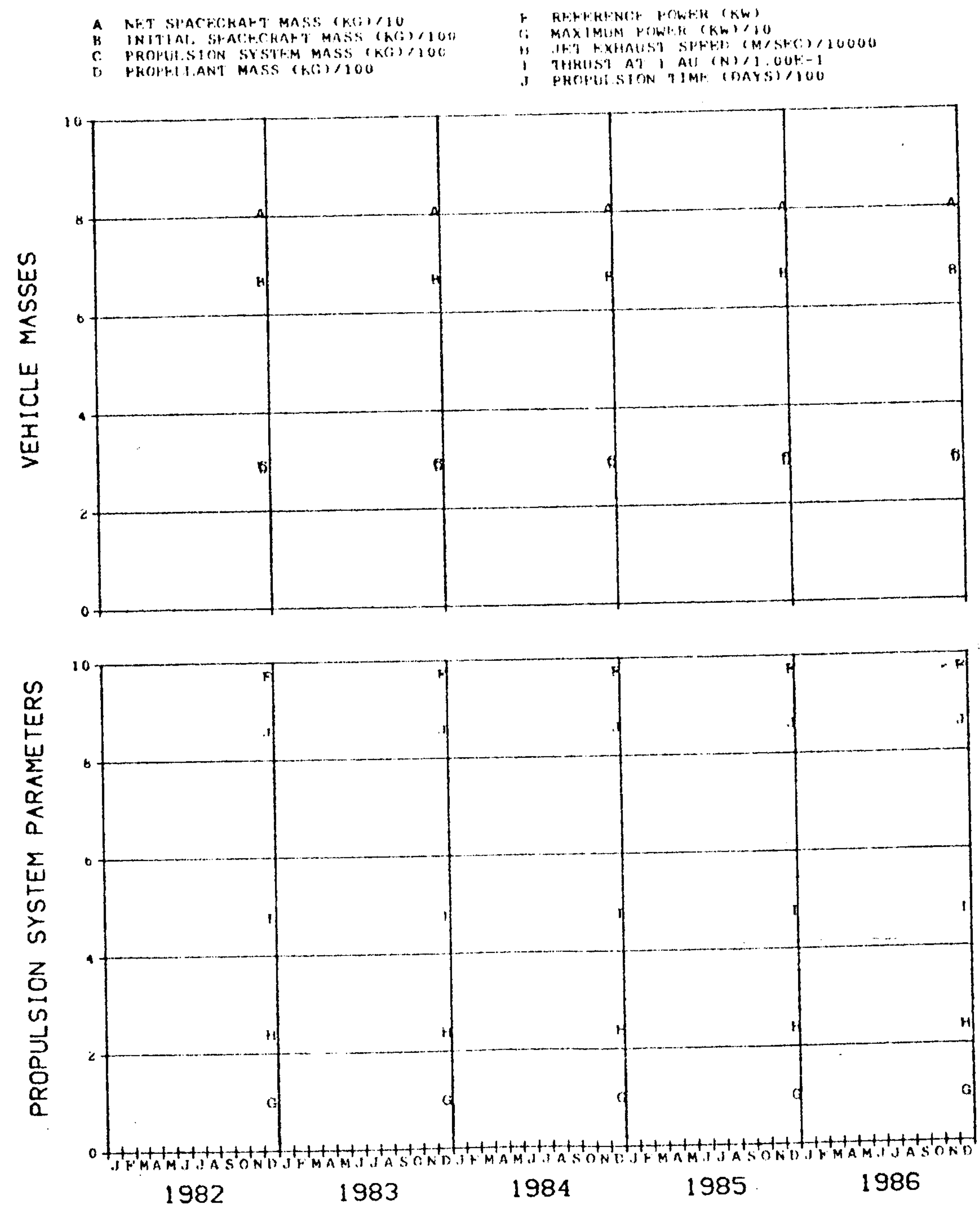

FIG. 33C. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

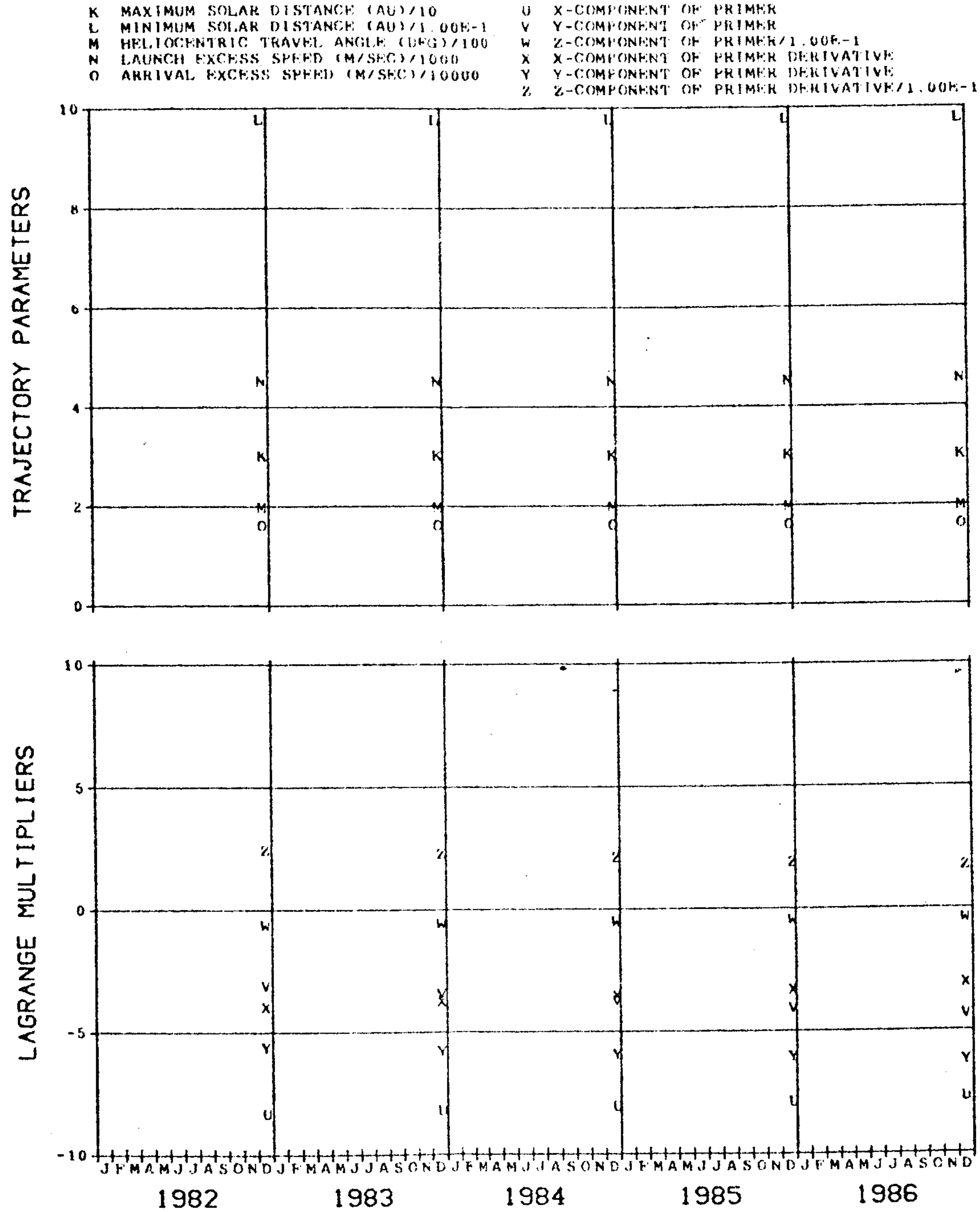

FIG. 33C. (CONCLUDED)

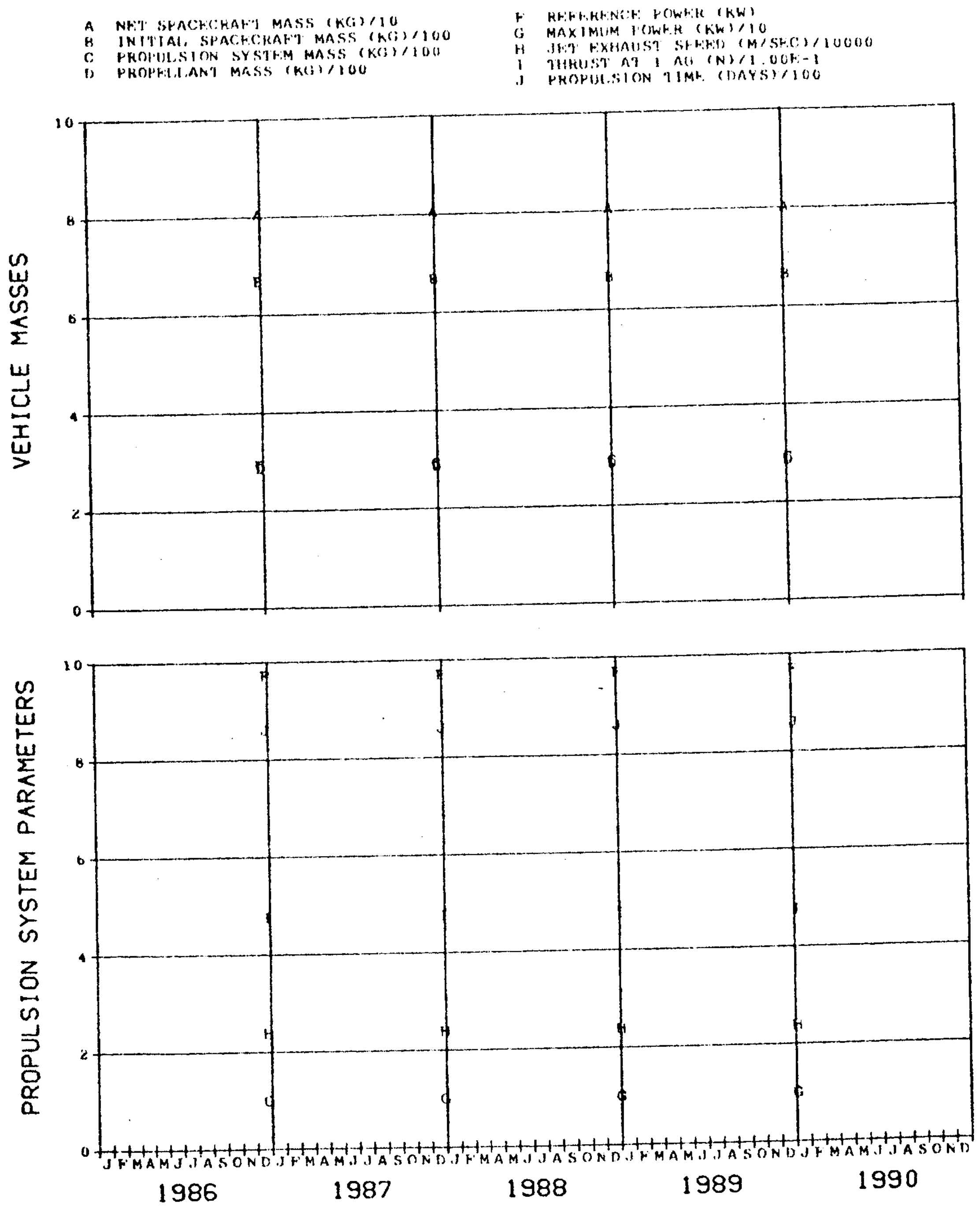

FIG. 33D. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

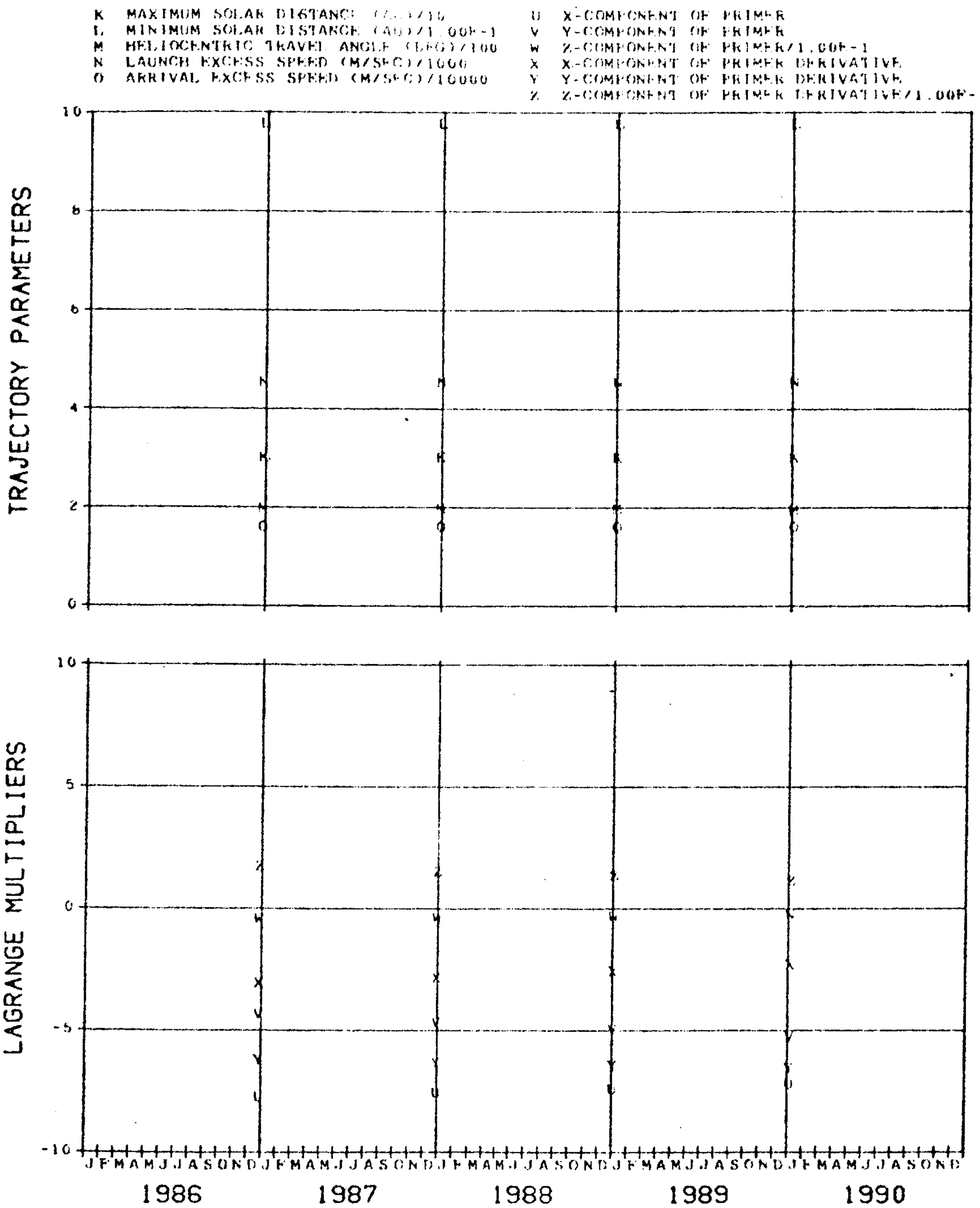

FIG. 33D. (CONCLUDED)

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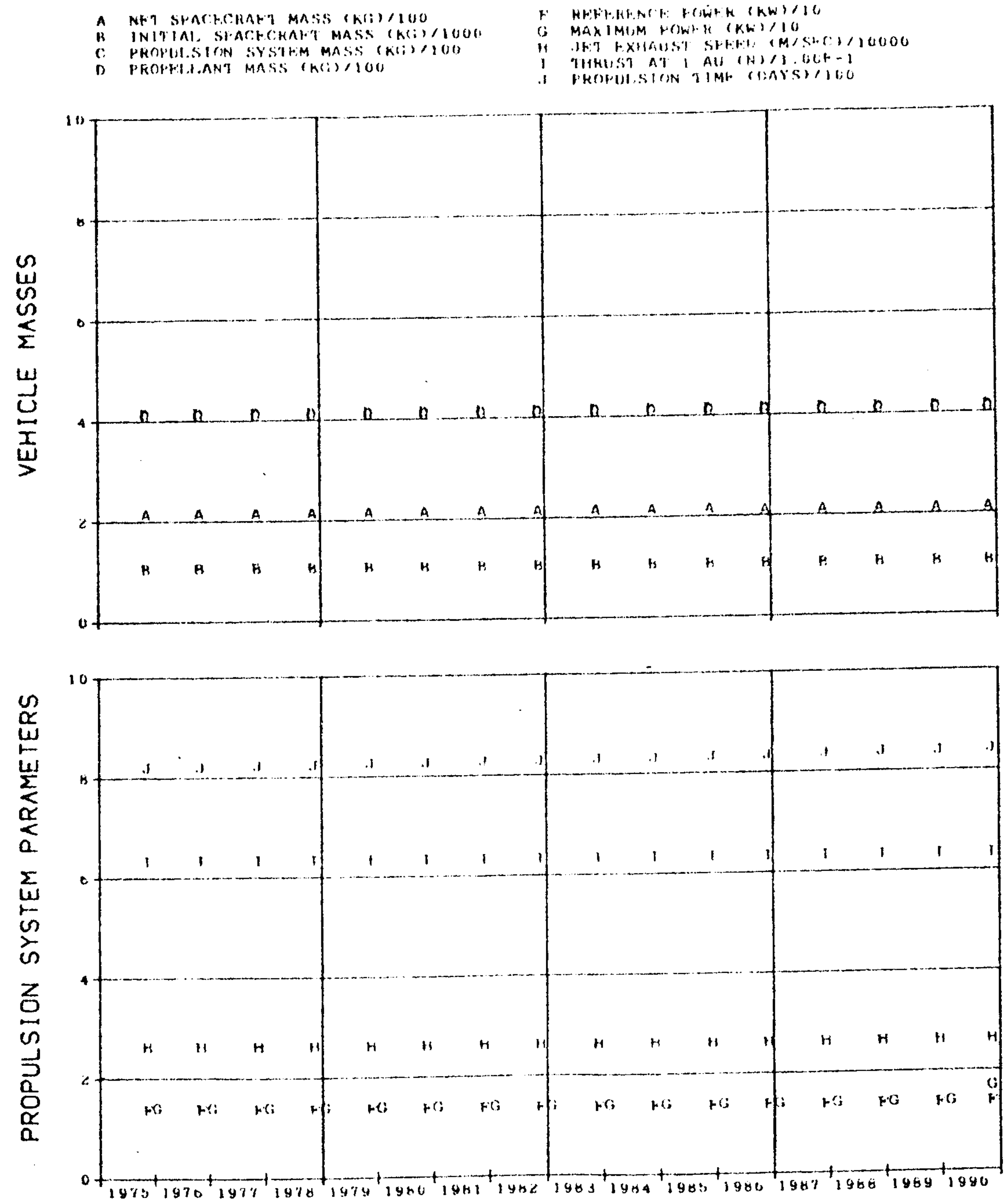

FIG. 34. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

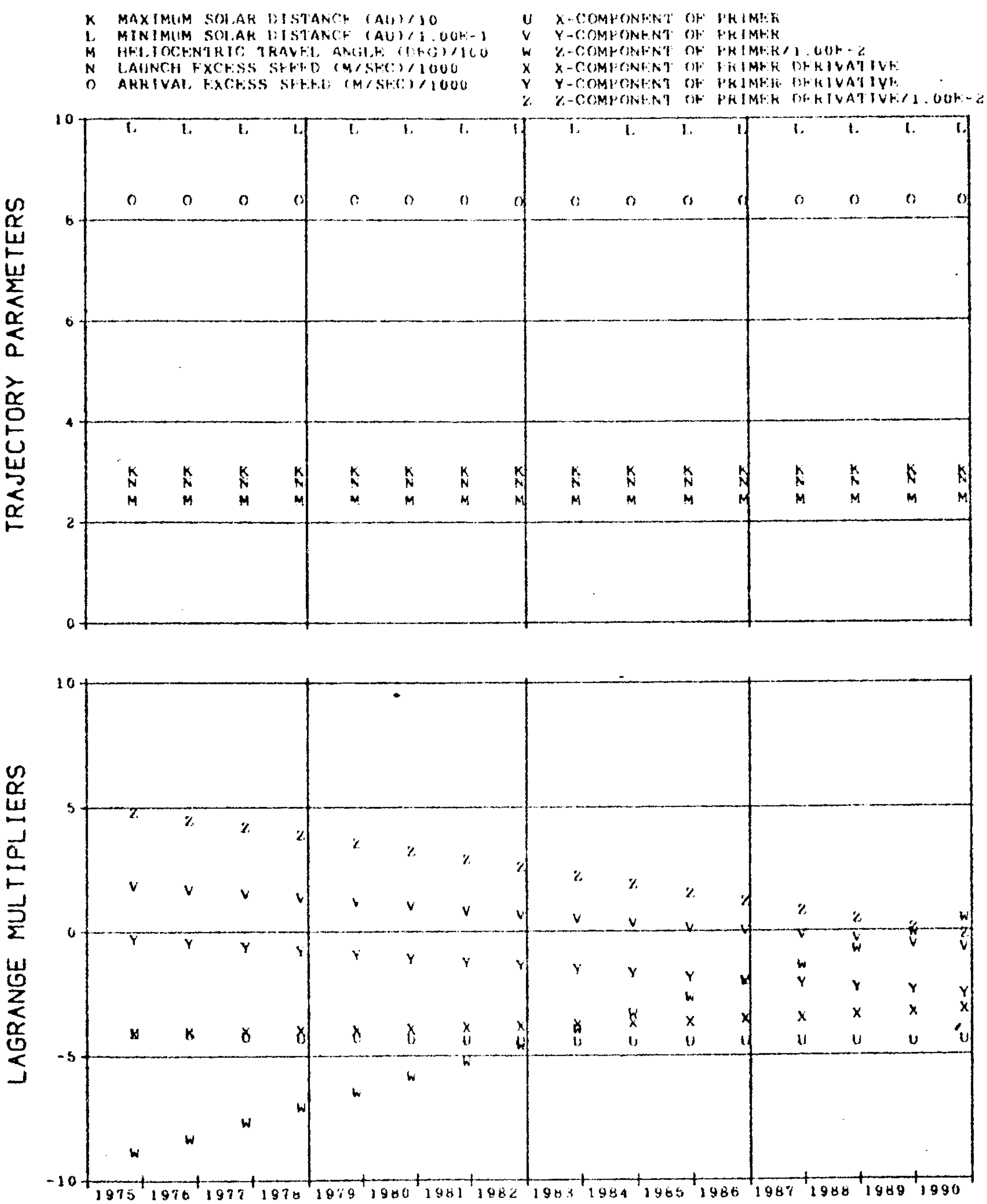

FIG. 34. (CONCLUDED)

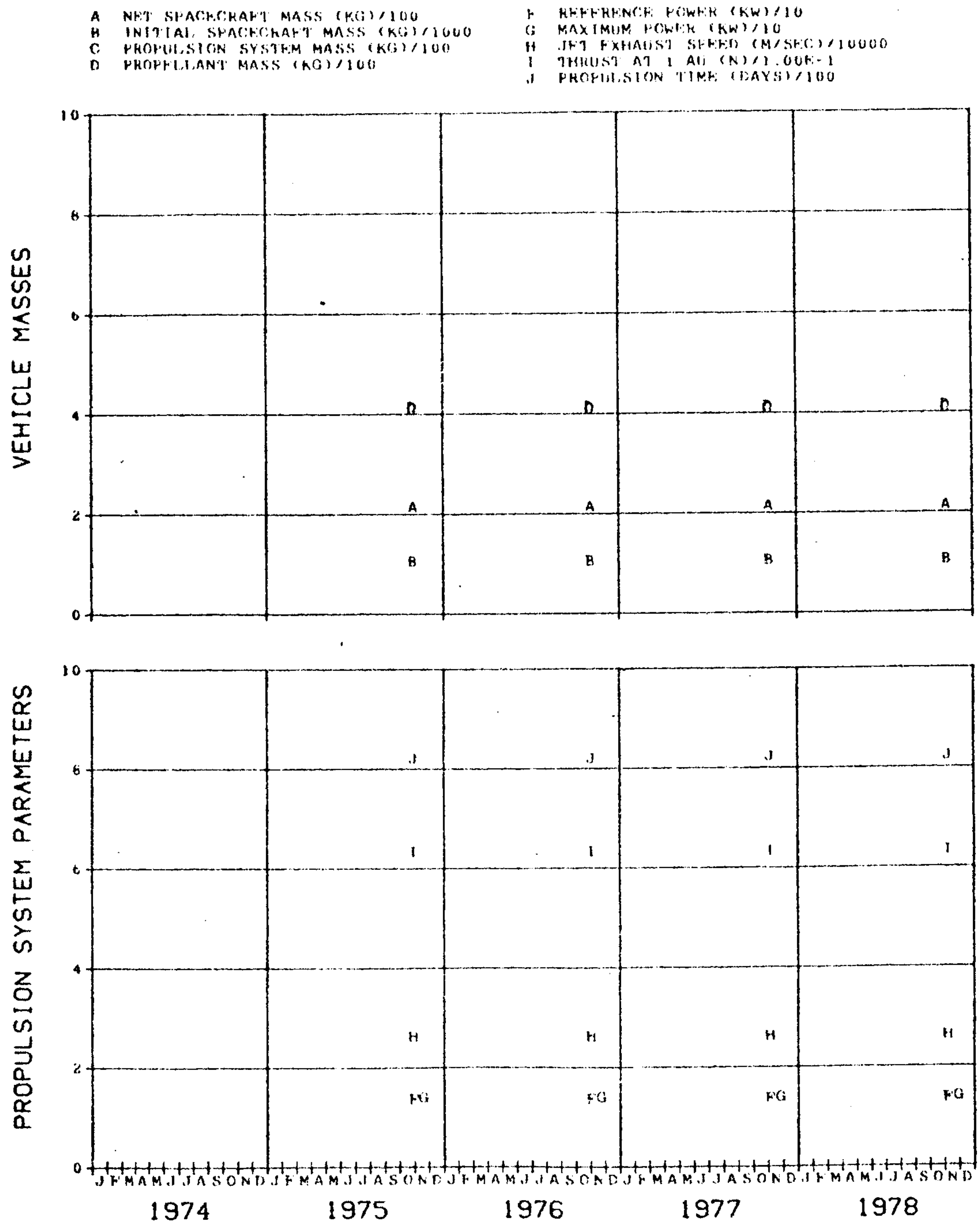

FIG. 34A. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

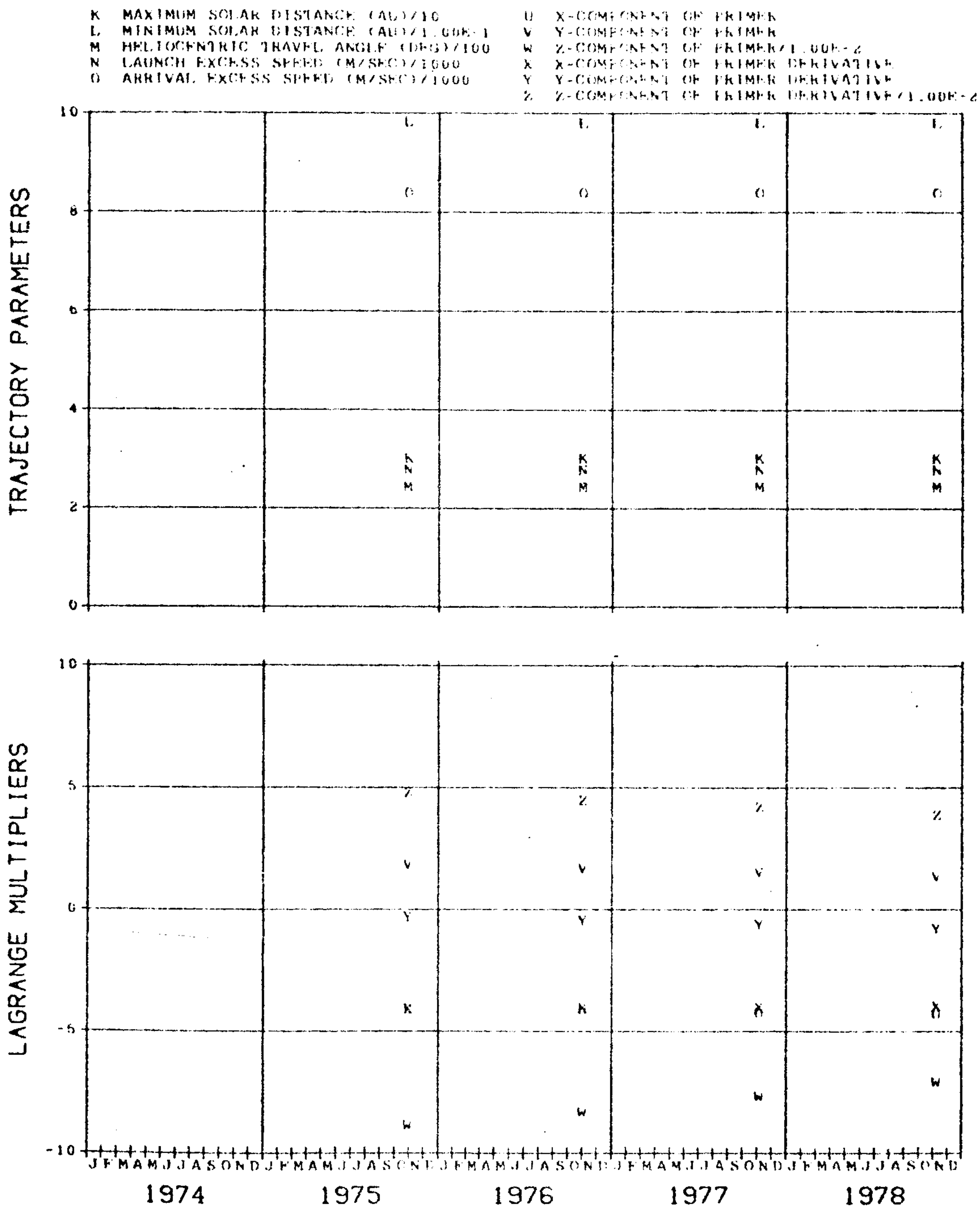

FIG. 34A. (CONCLUDED)

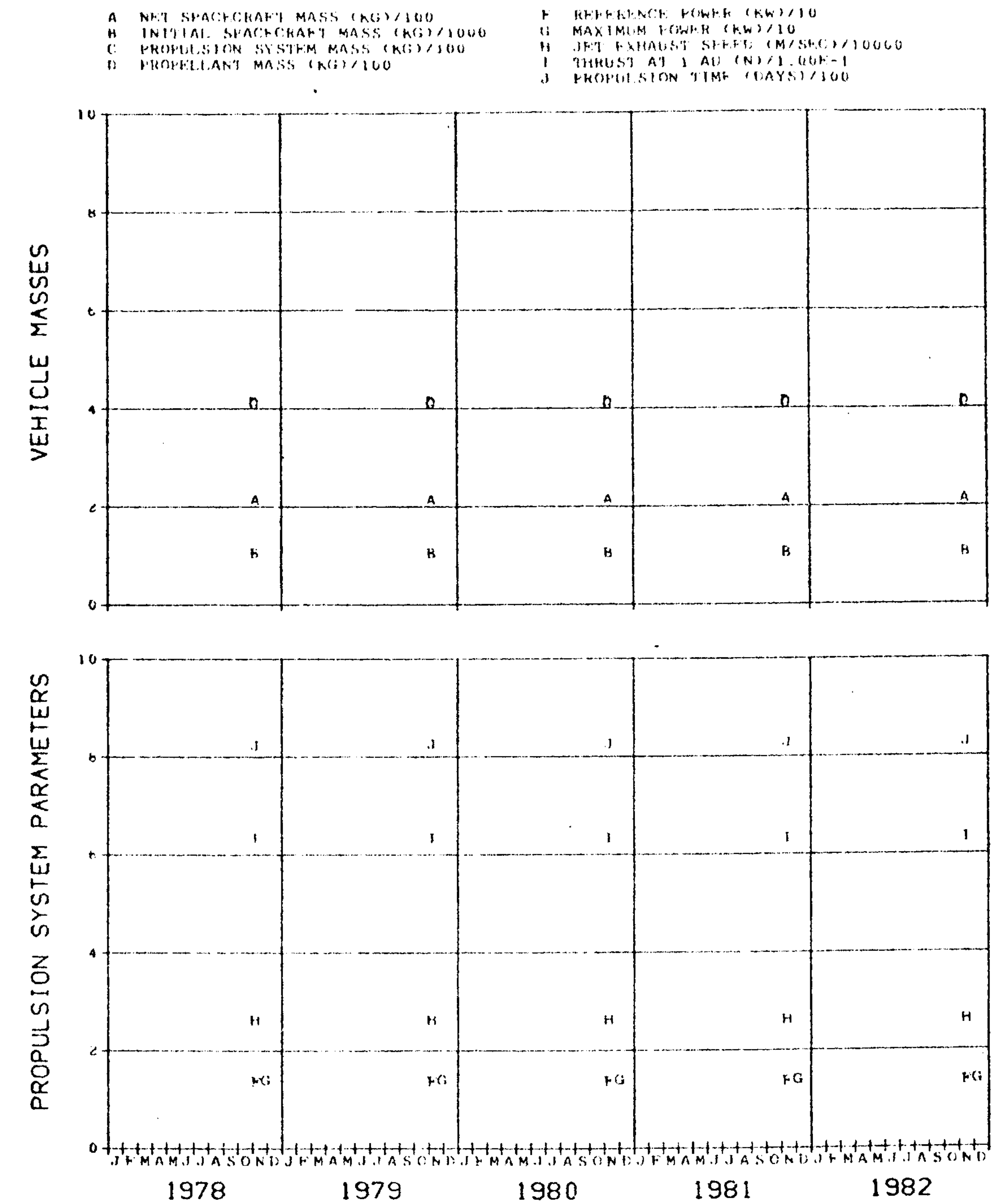

FIG. 34B. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

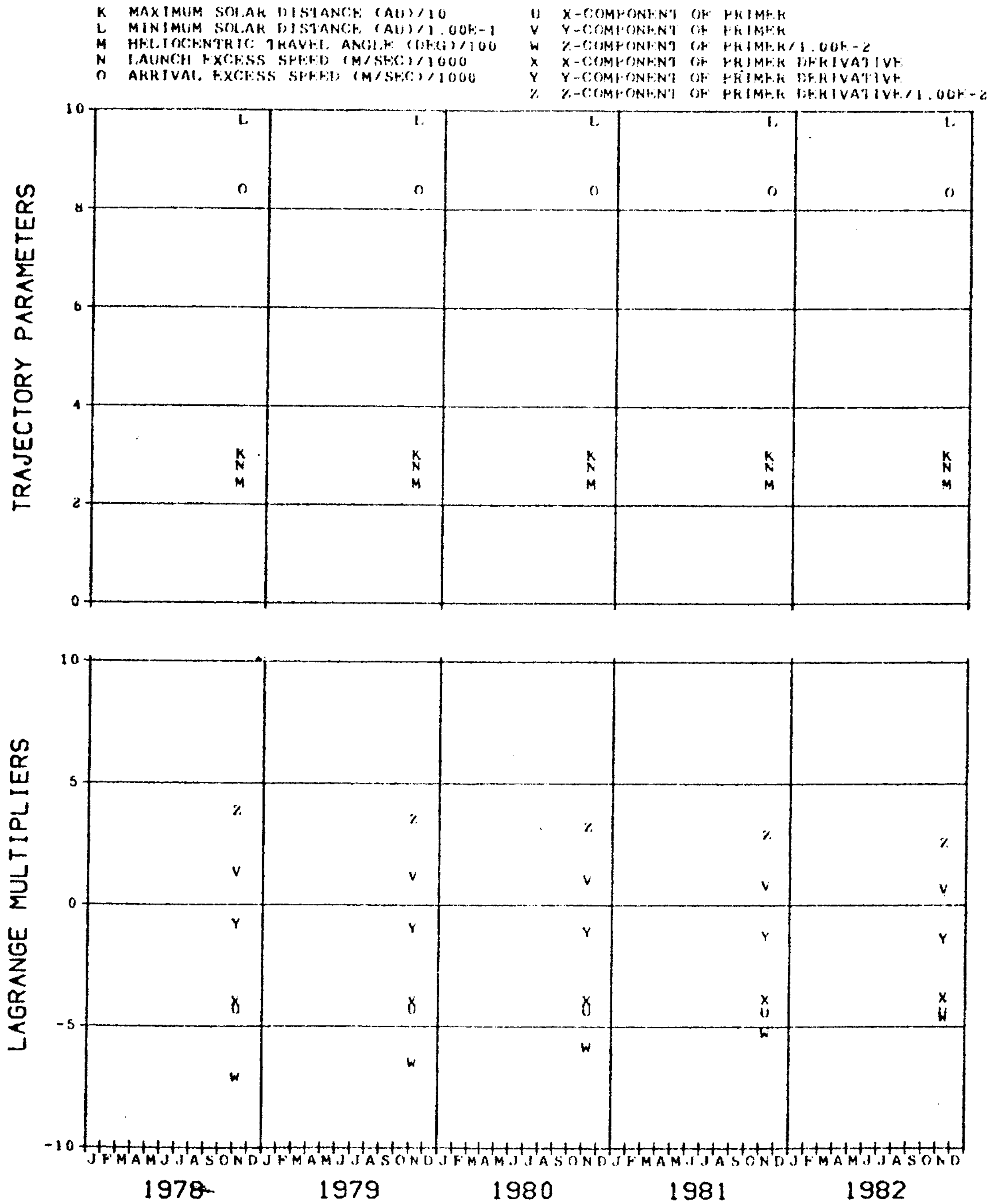

FIG. 34B. (CONCLUDED)

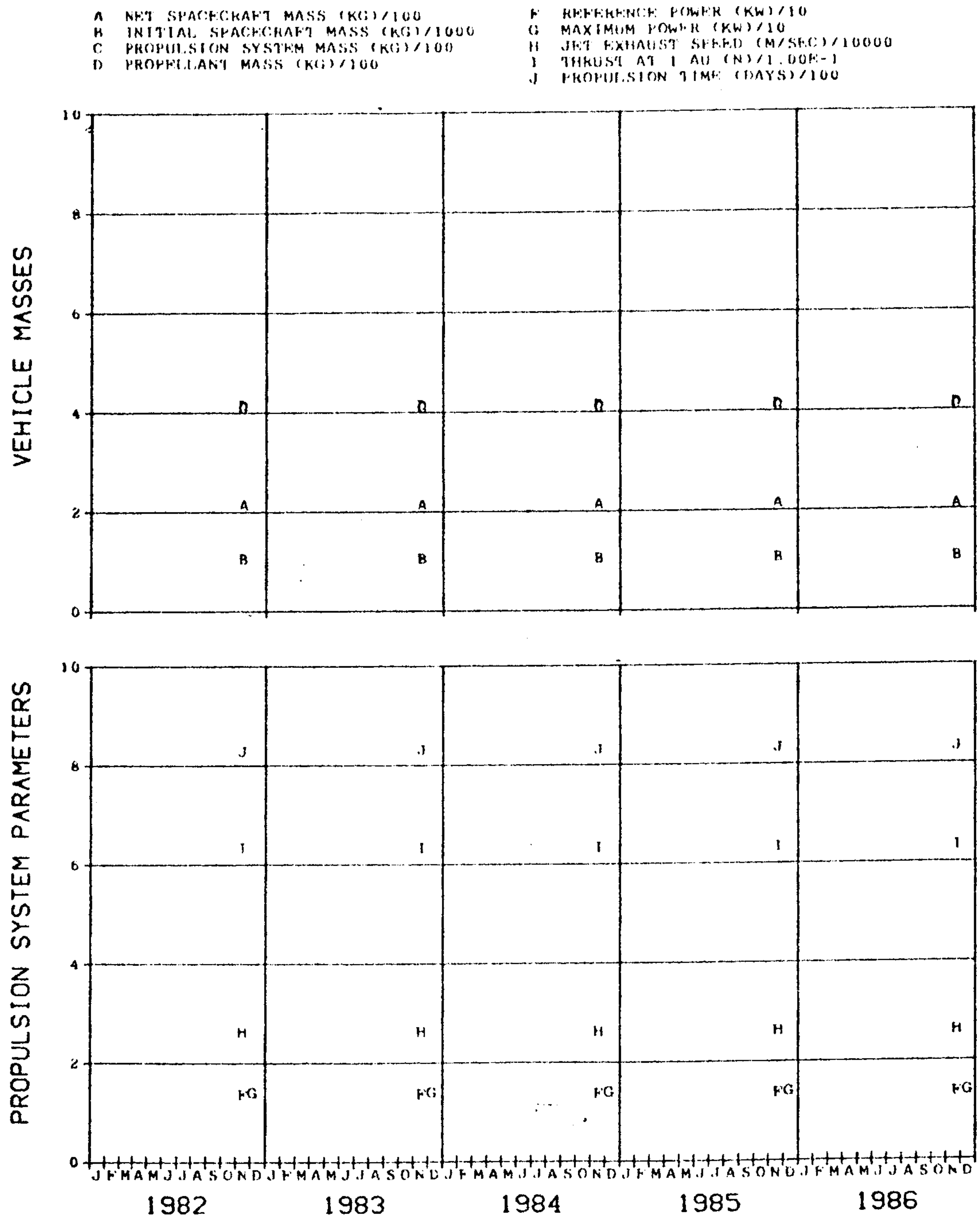

FIG. 34C. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

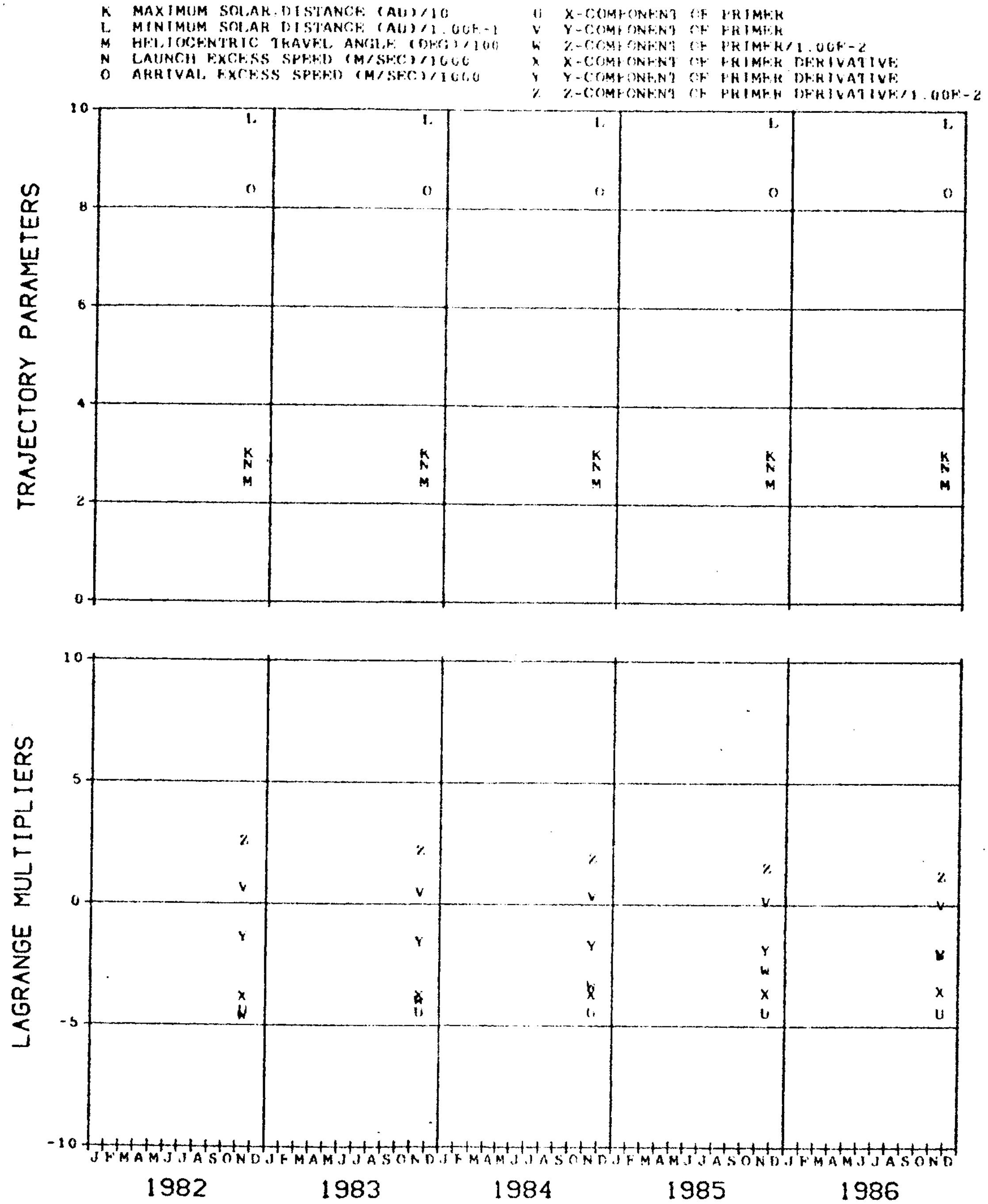

FIG. 34C. (CONCLUDED)

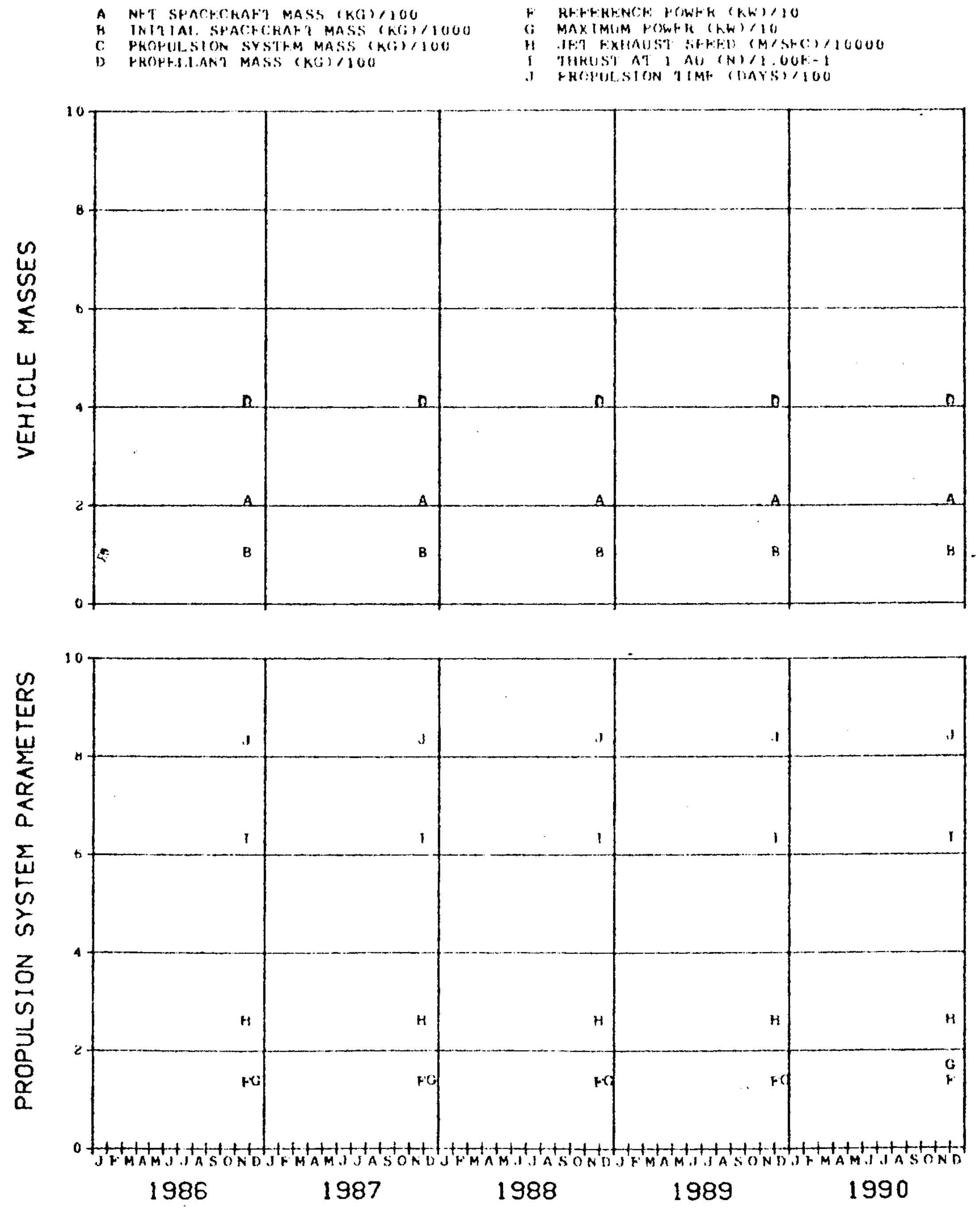

FIG. 34D. NEPTUNE MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

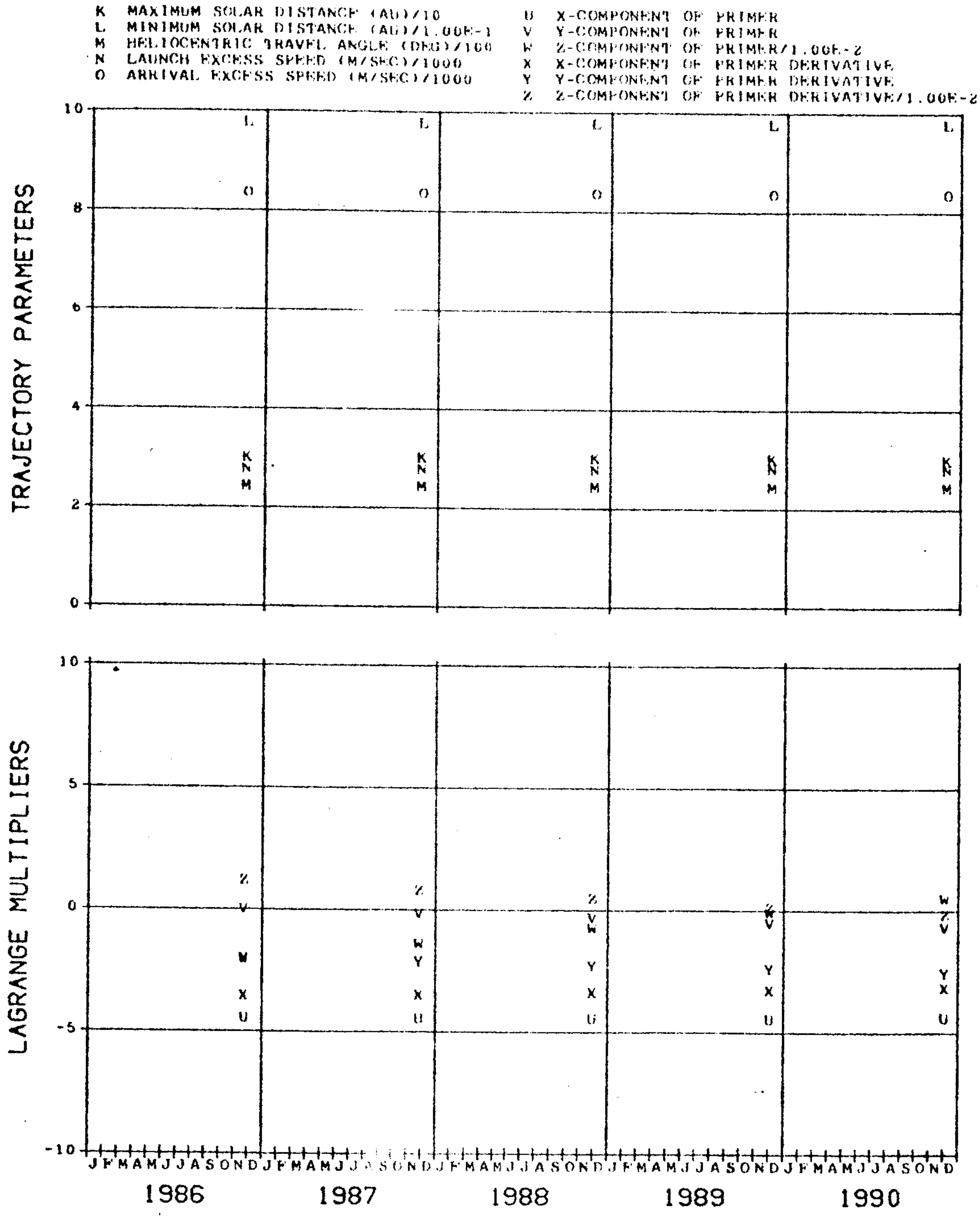

FIG. 34D. (CONCLUDED)

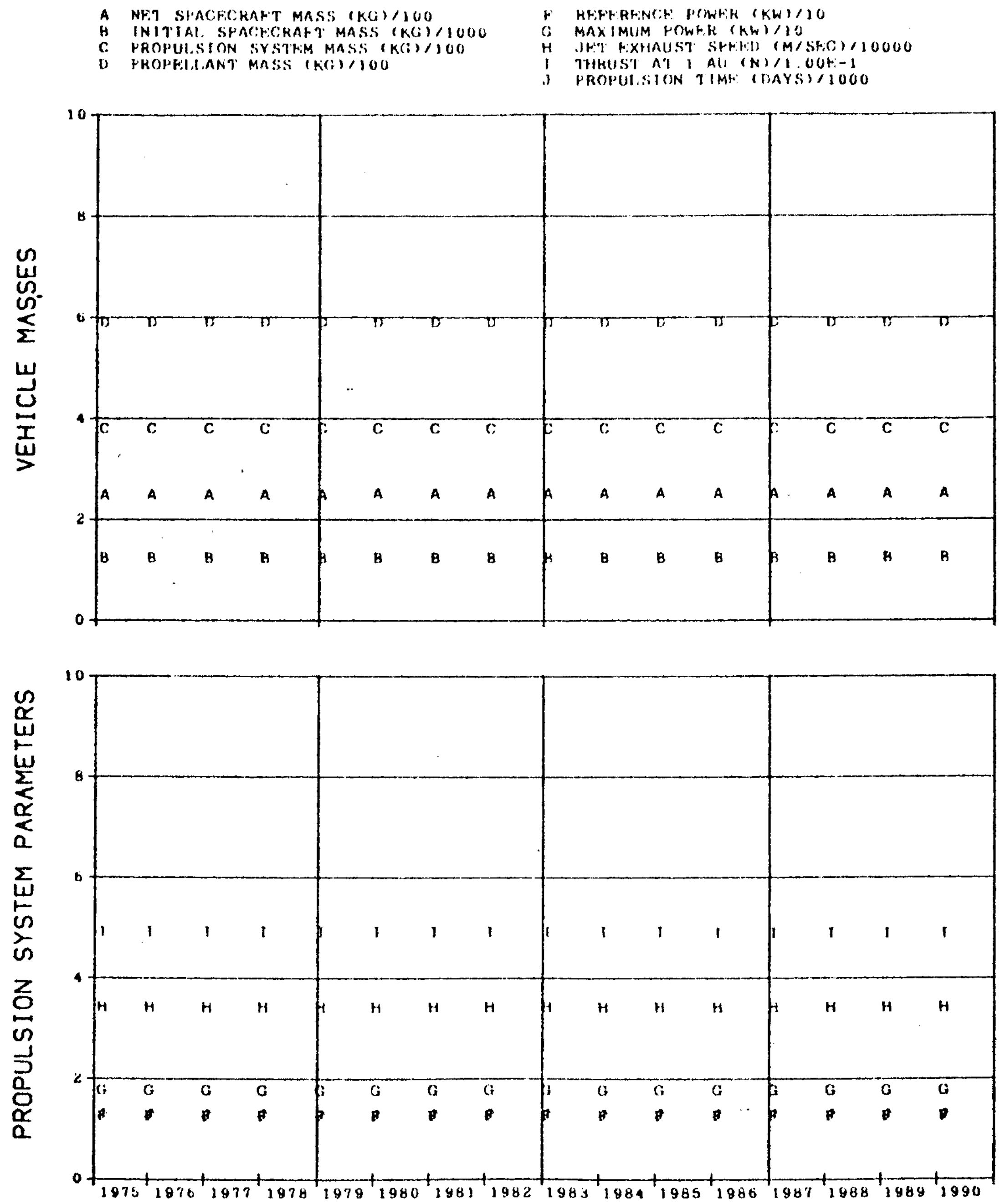

FIG. 35. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

XXXX 344

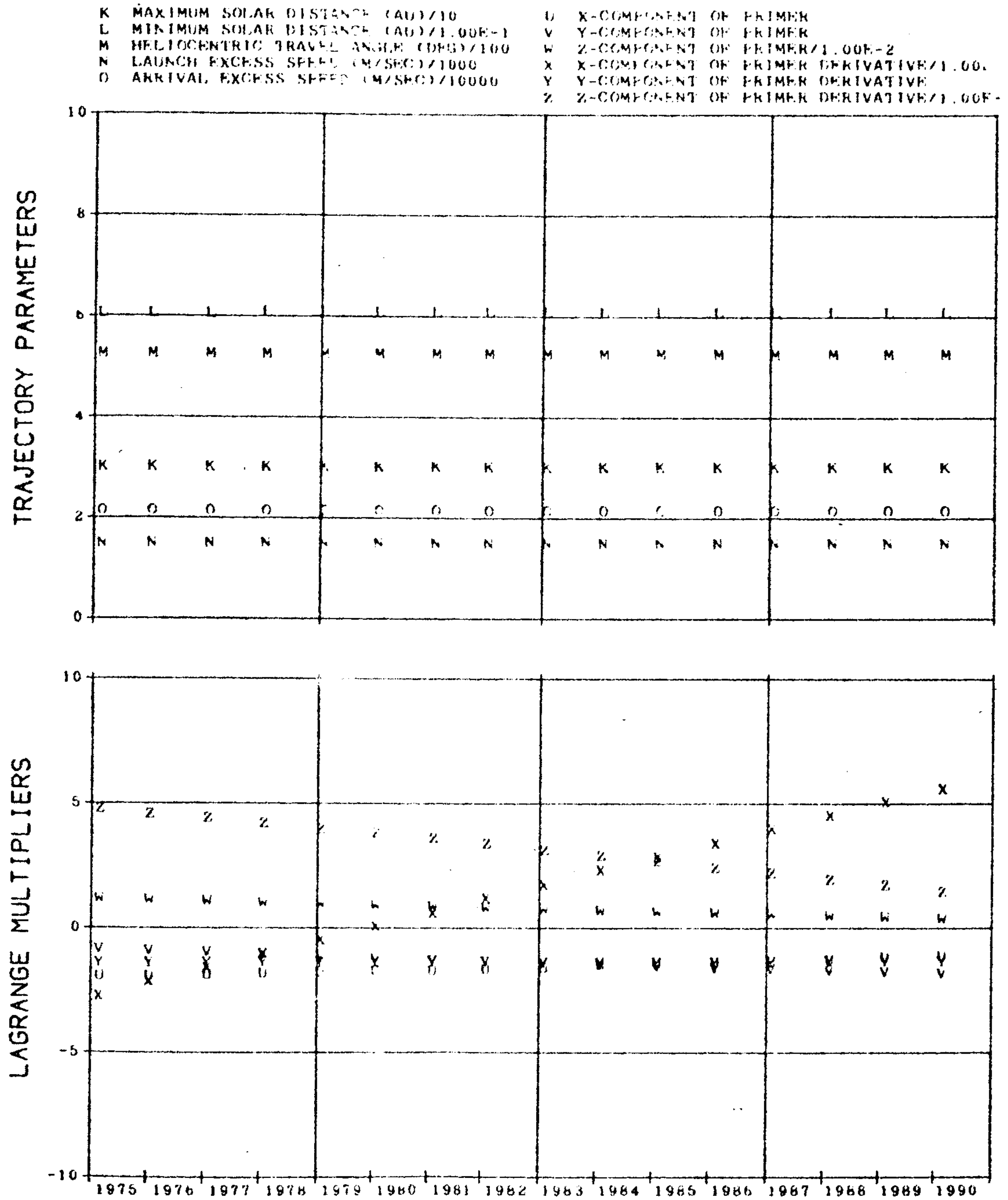

FIG. 35. (CONCLUDED)

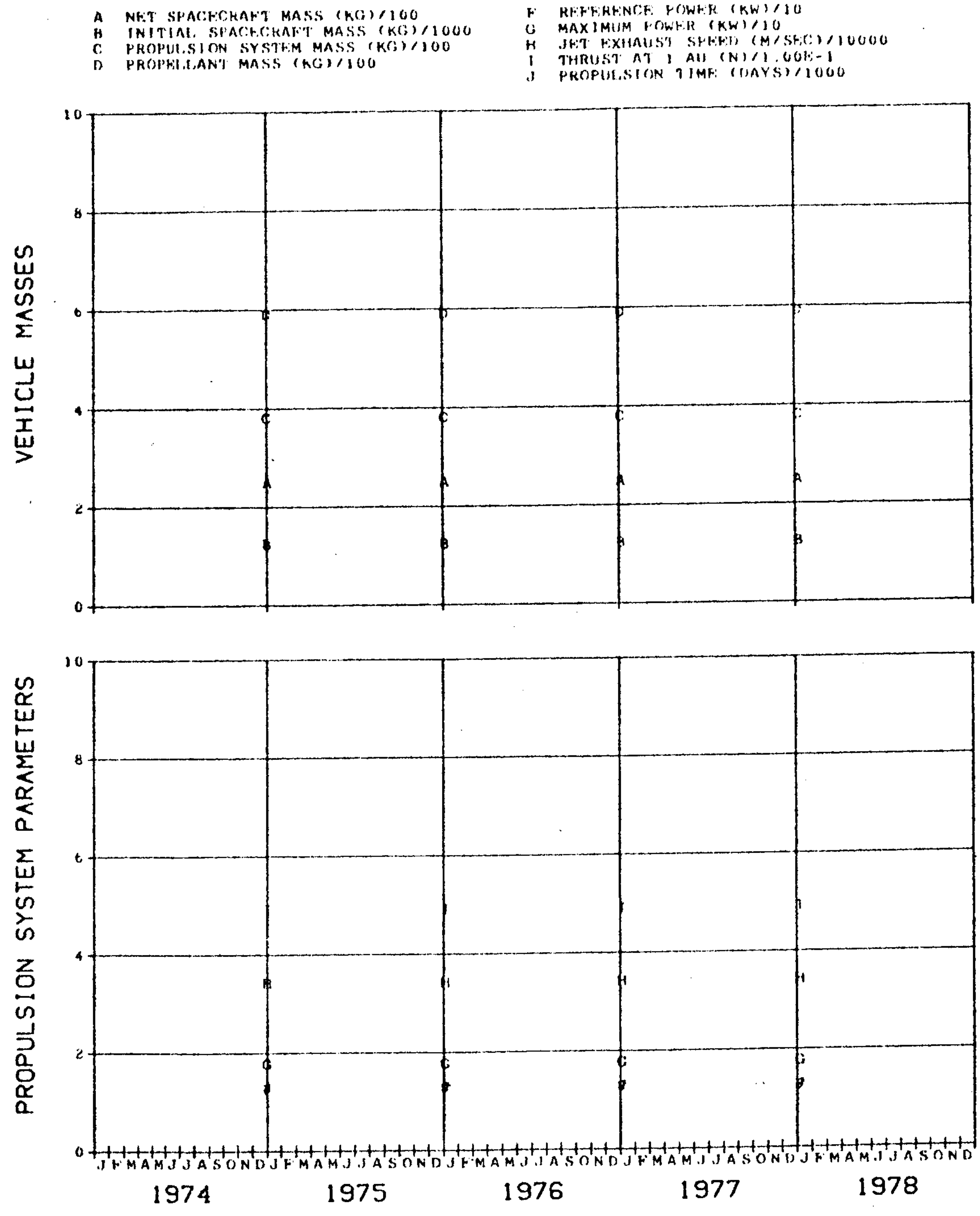

FIG. 35A. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

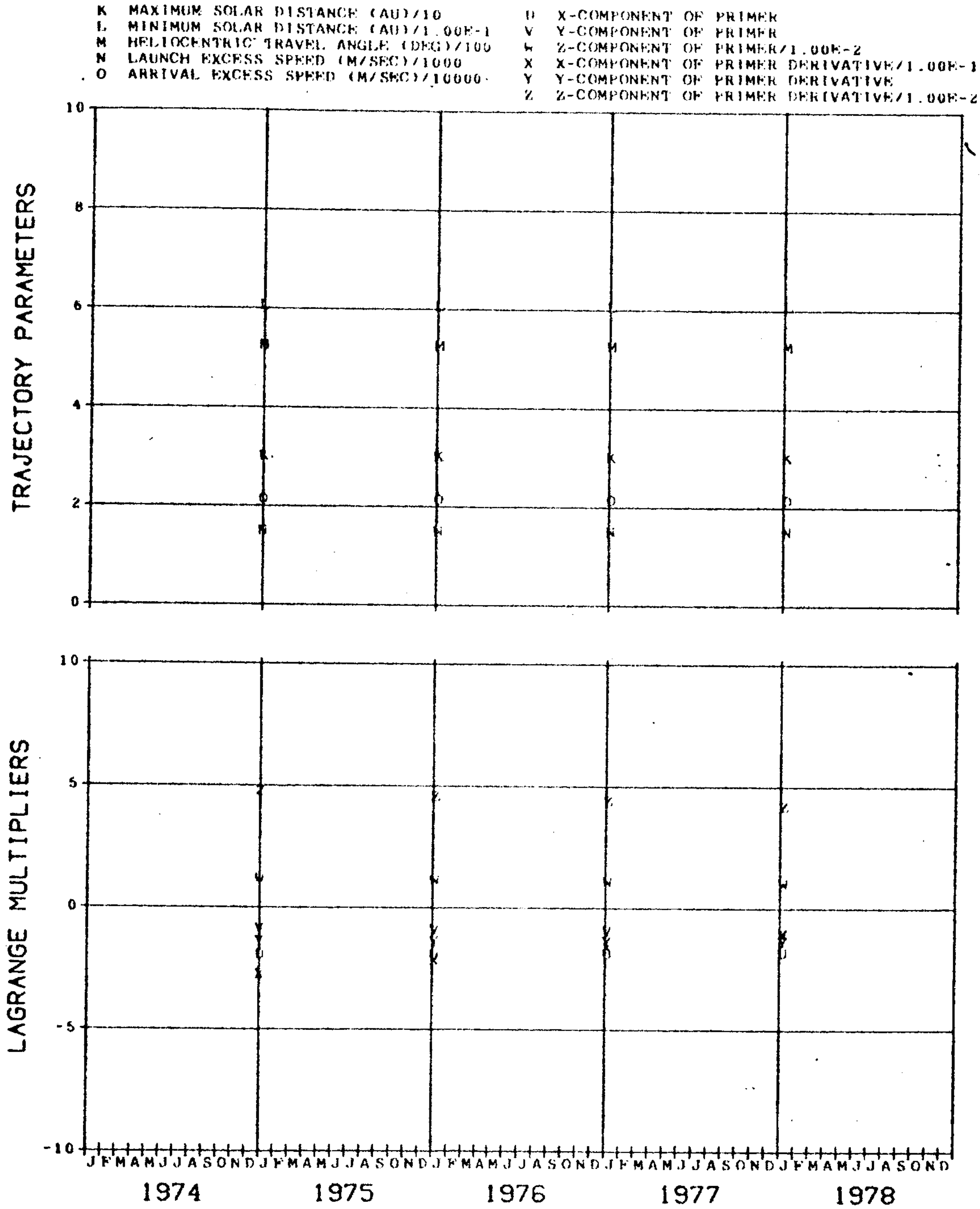

FIG. 35A. (CONCLUDED)

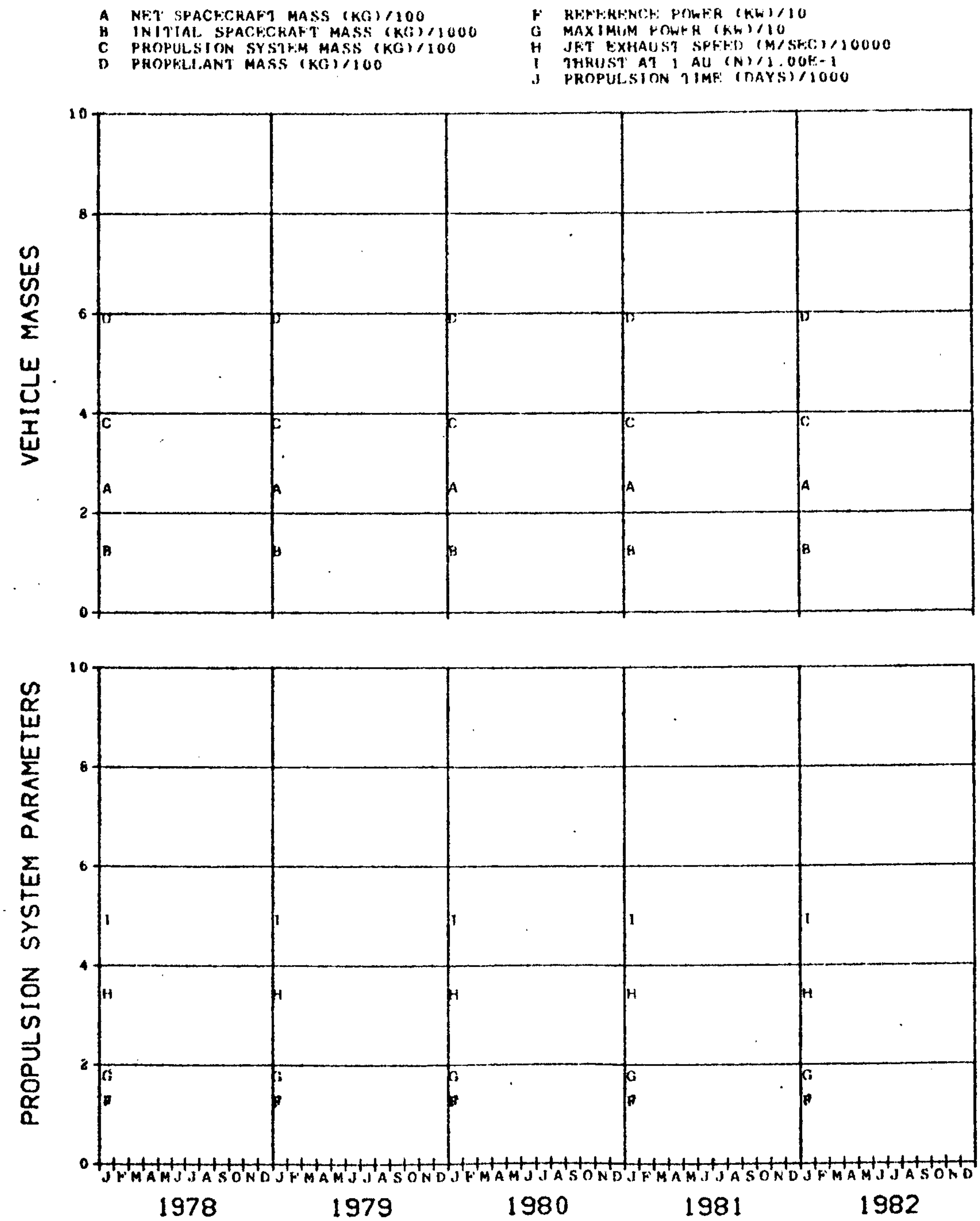

FIG. 35B. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

XXXX 348

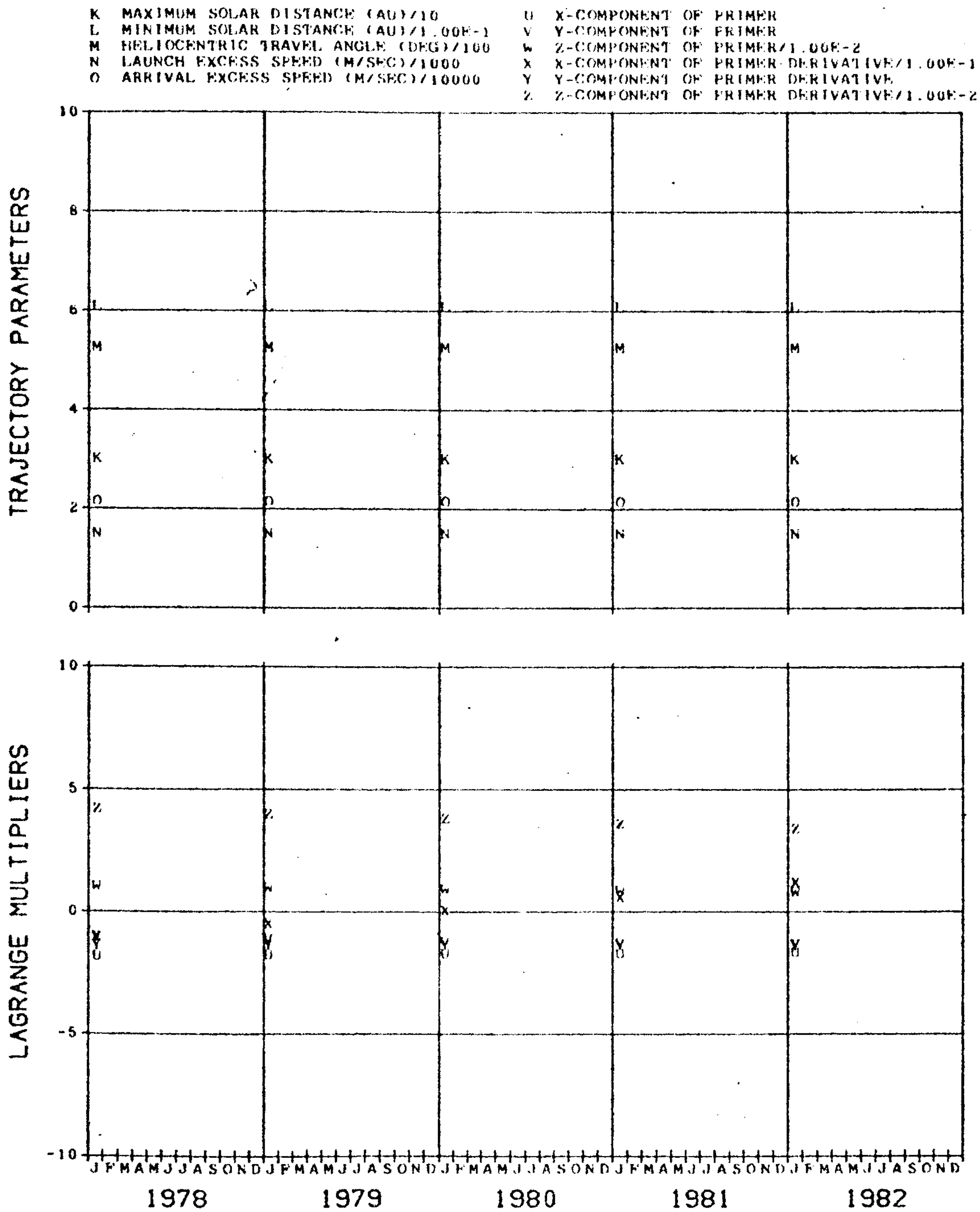

FIG. 35B. (CONCLUDED)

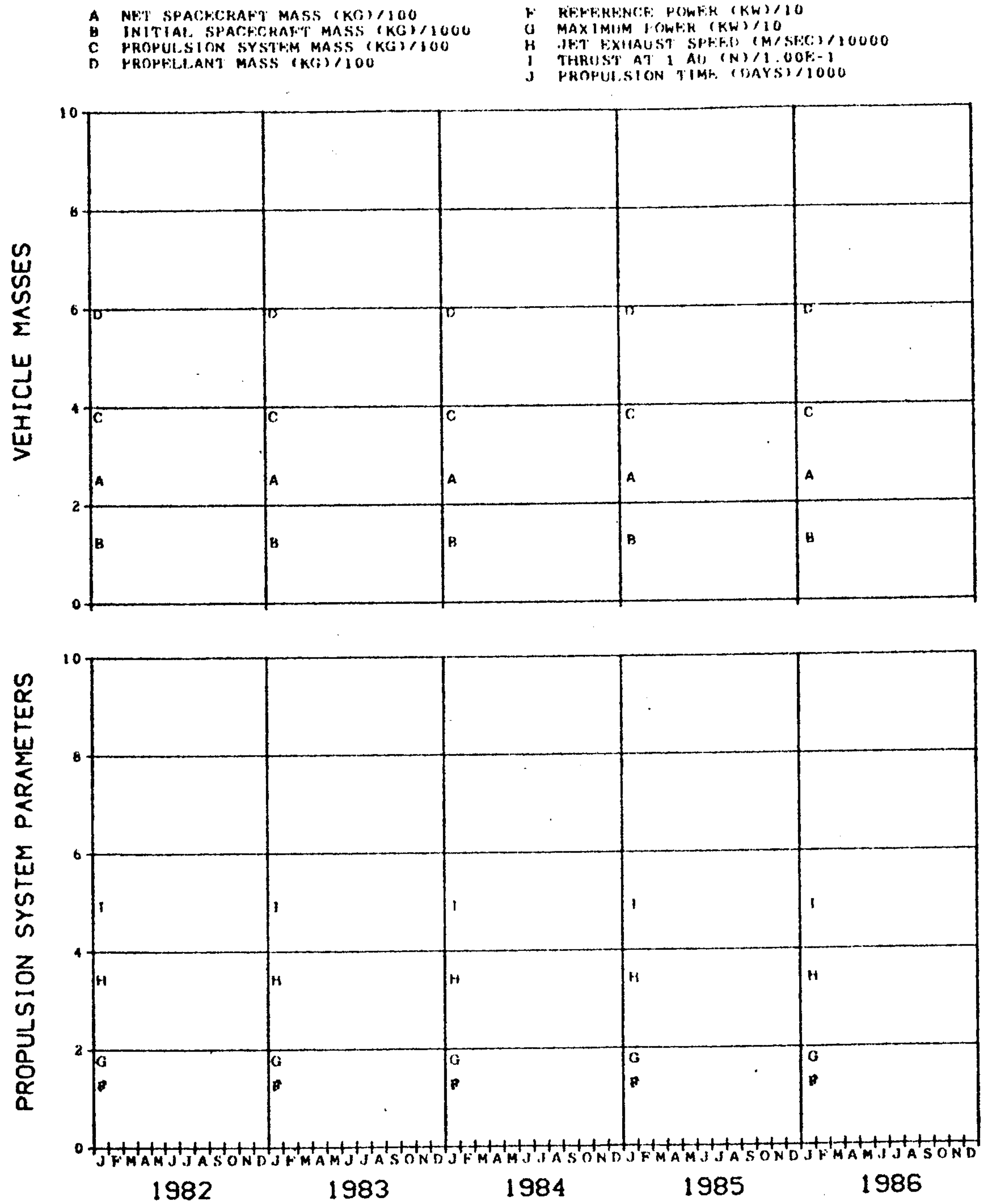

FIG. 35C. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

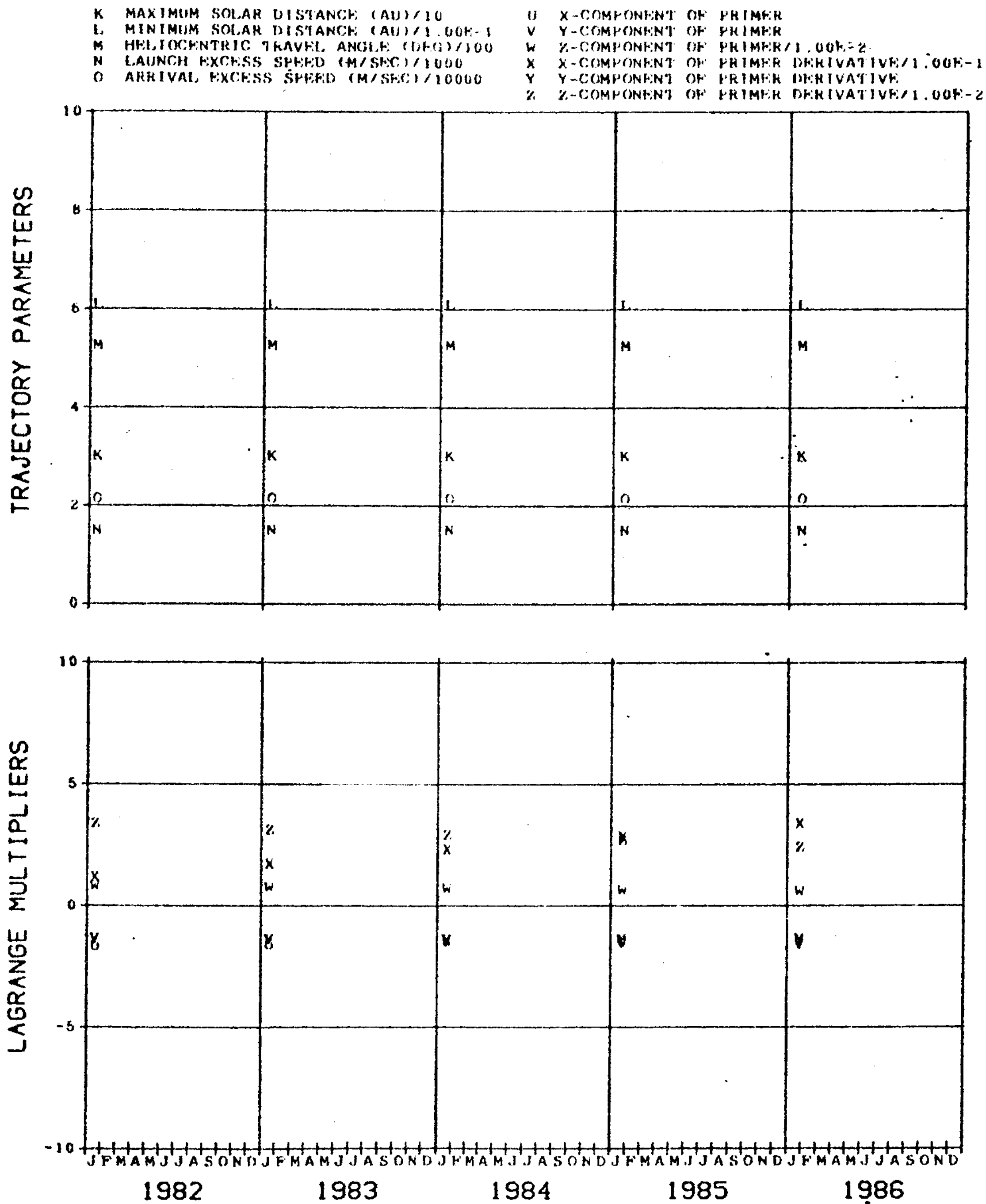

FIG. 35C. (CONCLUDED)

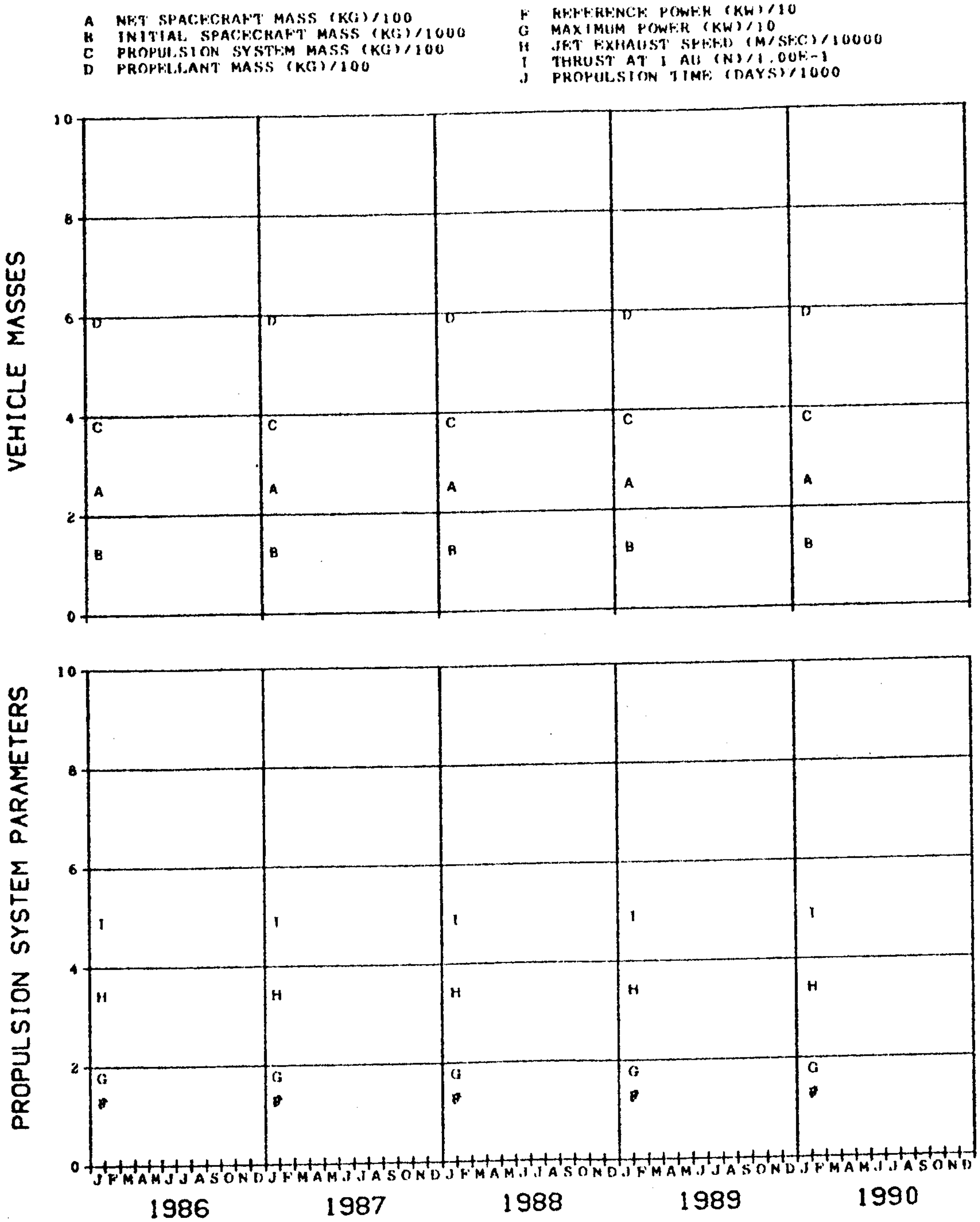

FIG. 35D. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

K MAXIMUM SOLAR DISTANCE (AU)/10
L MINIMUM SOLAR DISTANCE (AU)/1.00E-1
M HELIOCENTRIC TRAVEL ANGLE (DEG)/100
N LAUNCH EXCESS SPEED (M/SEC)/1000
O ARRIVAL EXCESS SPEED (M/SEC)/10000
U X-COMPONENT OF PRIMER
V Y-COMPONENT OF PRIMER
W Z-COMPONENT OF PRIMER/1.00E-2
X X-COMPONENT OF PRIMER DERIVATIVE/1.00E-1
Y Y-COMPONENT OF PRIMER DERIVATIVE
Z Z-COMPONENT OF PRIMER DERIVATIVE/1.00E-2

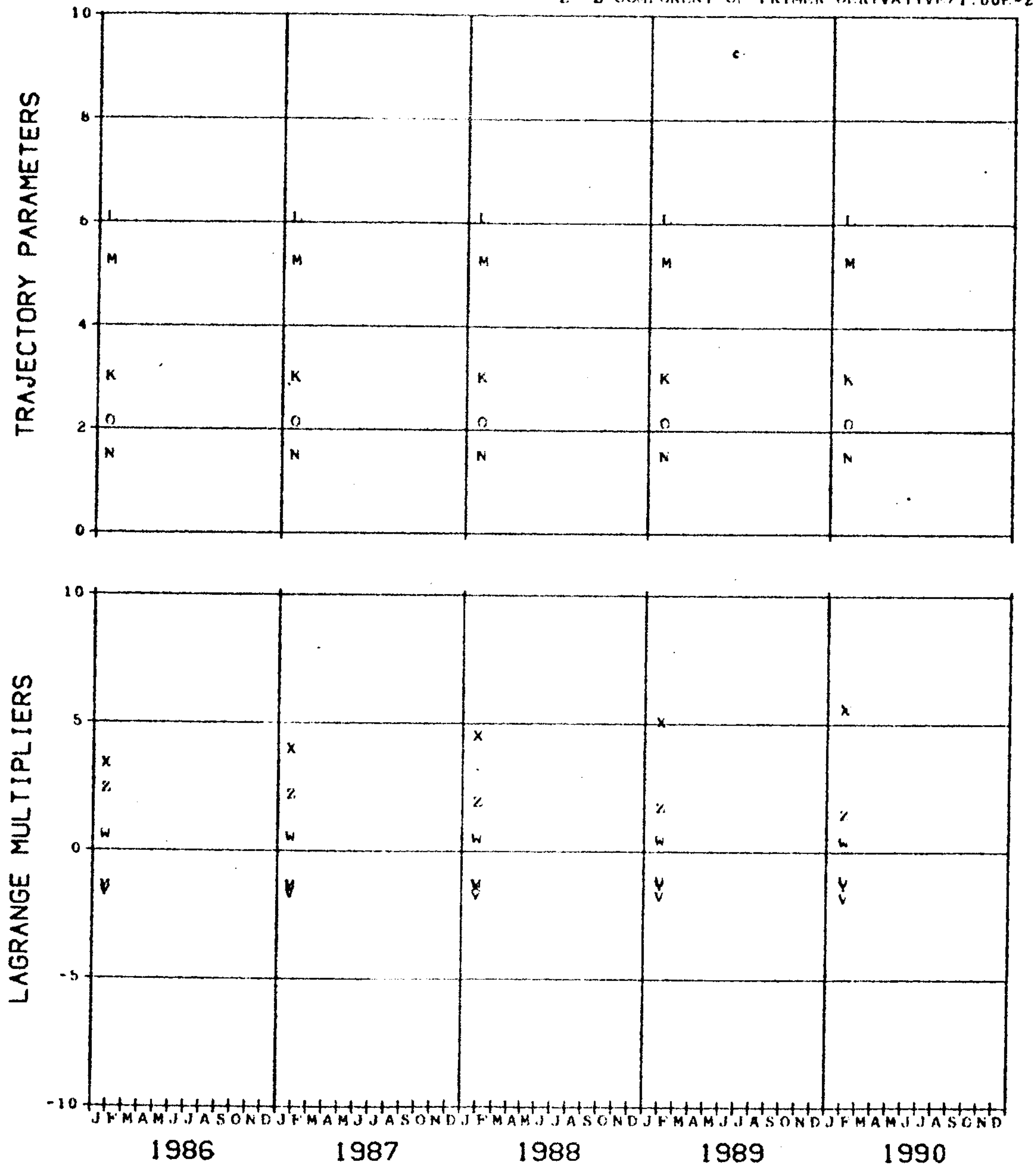

FIG. 35D. (CONCLUDED)

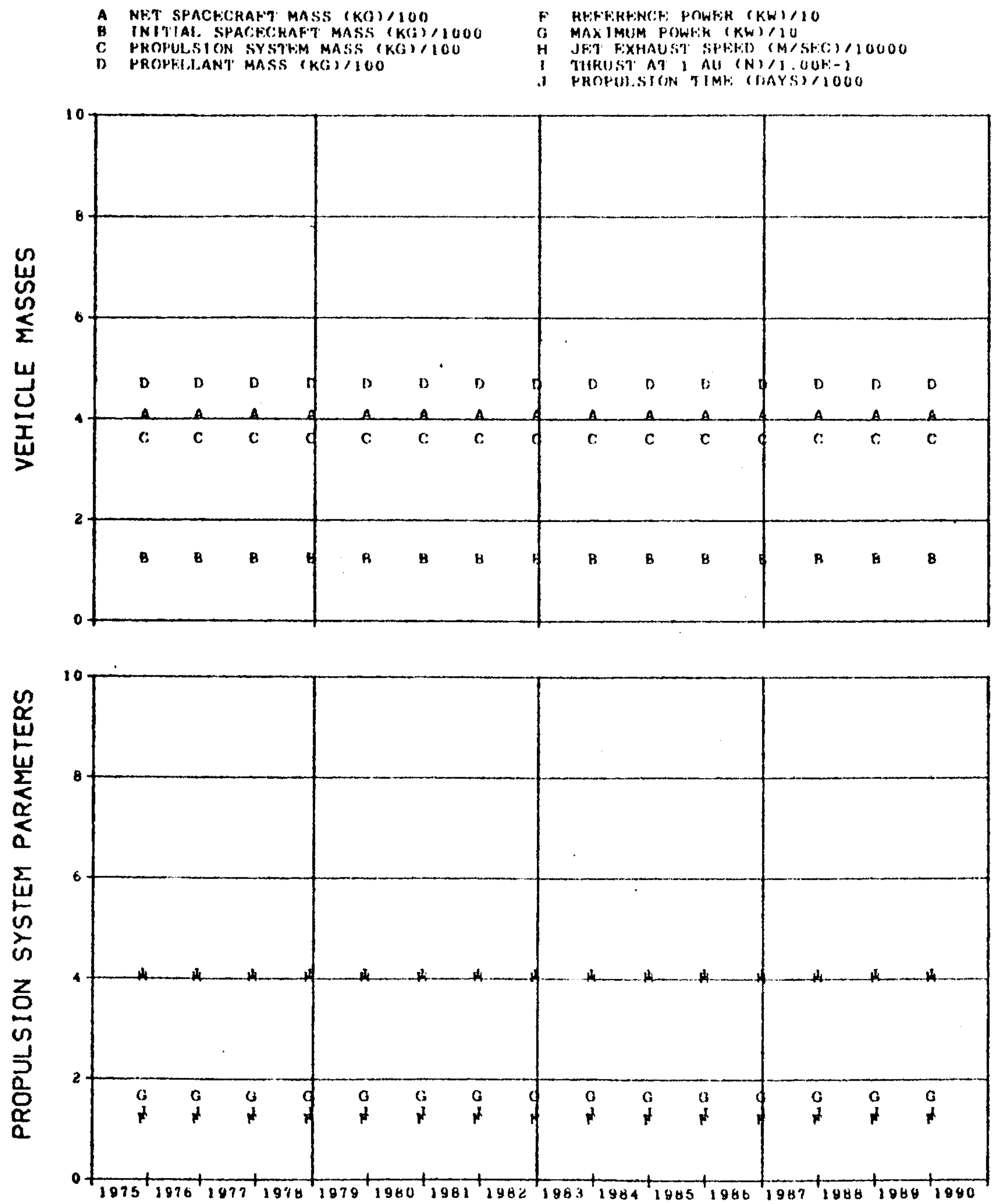

FIG. 36. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 4000 DAYS

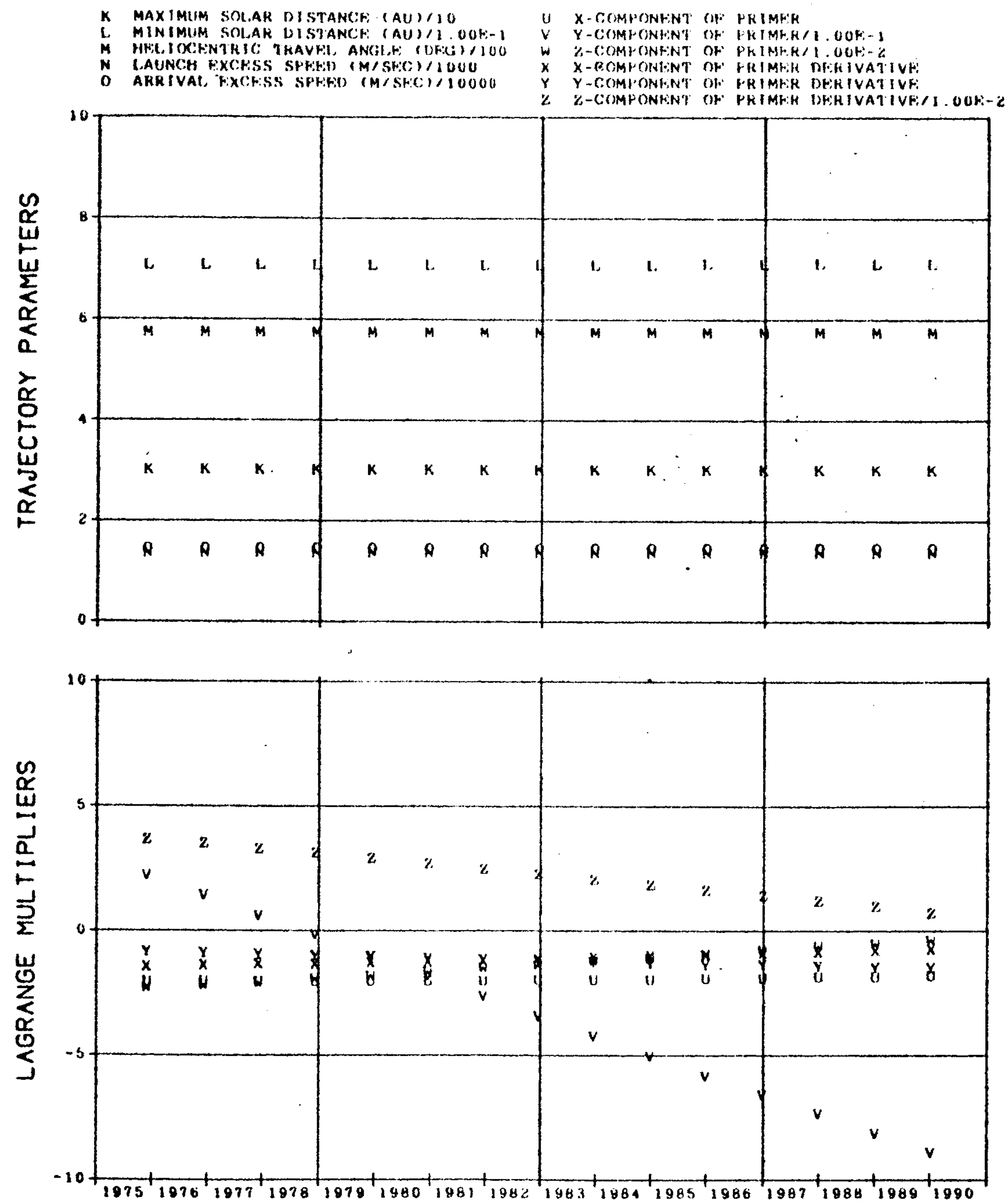

FIG. 36. (CONCLUDED)

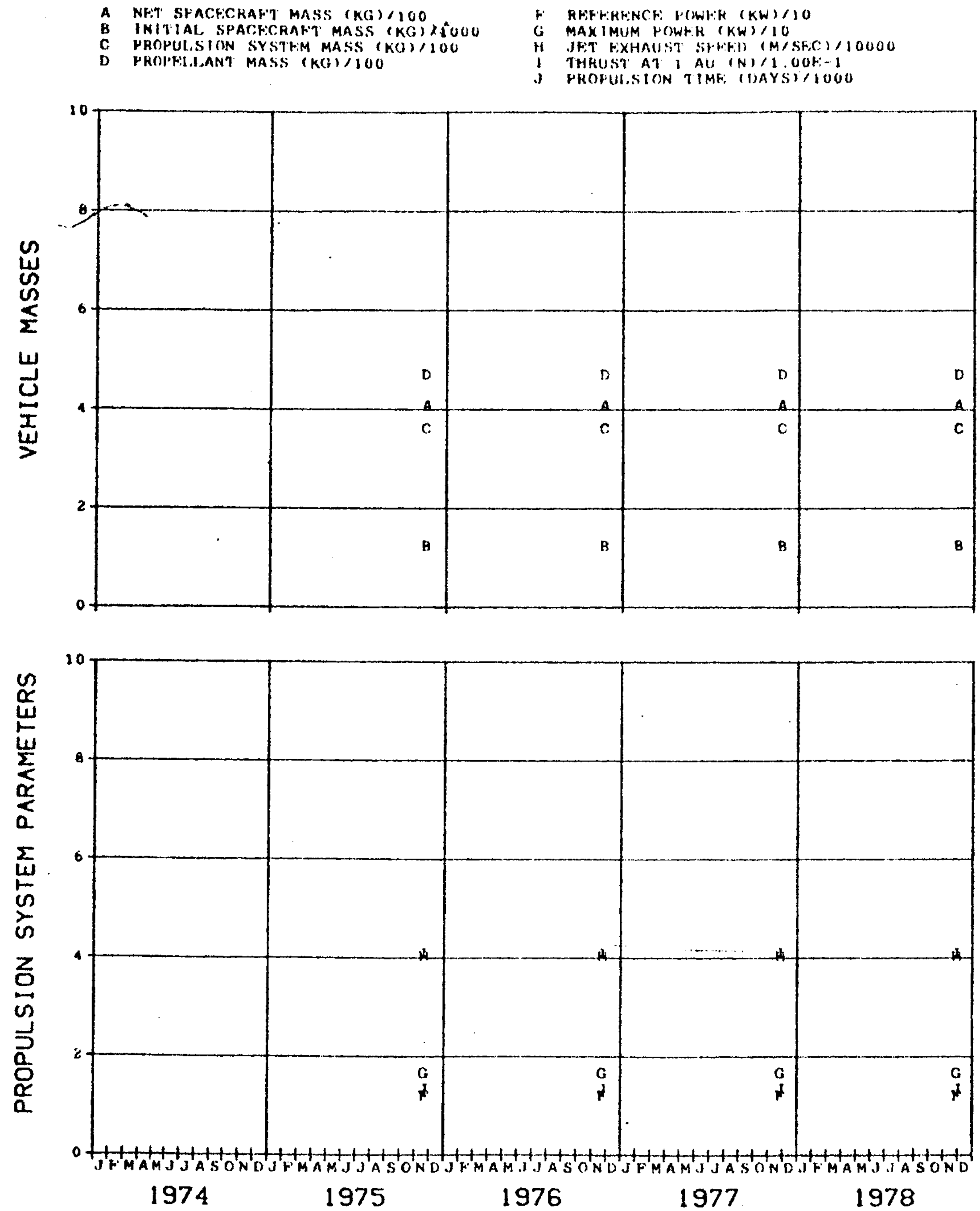

FIG. 36A. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 4000 DAYS

XXXX 356

K MAXIMUM SOLAR DISTANCE (AU)/10
L MINIMUM SOLAR DISTANCE (AU)/1.00E-1
M HELIOCENTRIC TRAVEL ANGLE (DEG)/100
N LAUNCH EXCESS SPEED (M/SEC)/1000
O ARRIVAL EXCESS SPEED (M/SEC)/10000
U X-COMPONENT OF PRIMER
V Y-COMPONENT OF PRIMER/1.00E-1
W Z-COMPONENT OF PRIMER/1.00E-2
X X-COMPONENT OF PRIMER DERIVATIVE
Y Y-COMPONENT OF PRIMER DERIVATIVE
Z Z-COMPONENT OF PRIMER DERIVATIVE/1.00E-2

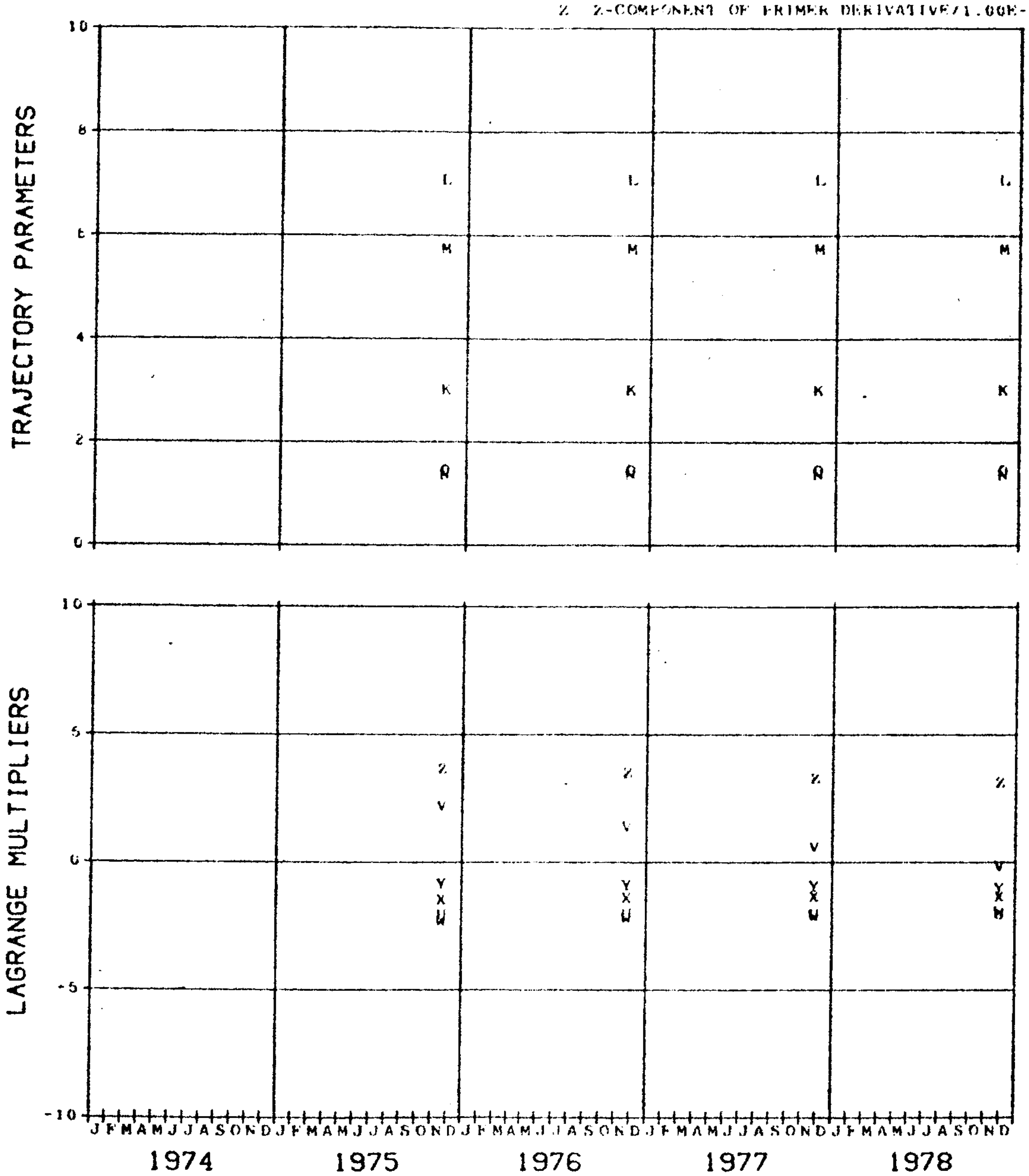

FIG. 36A. (CONCLUDED)

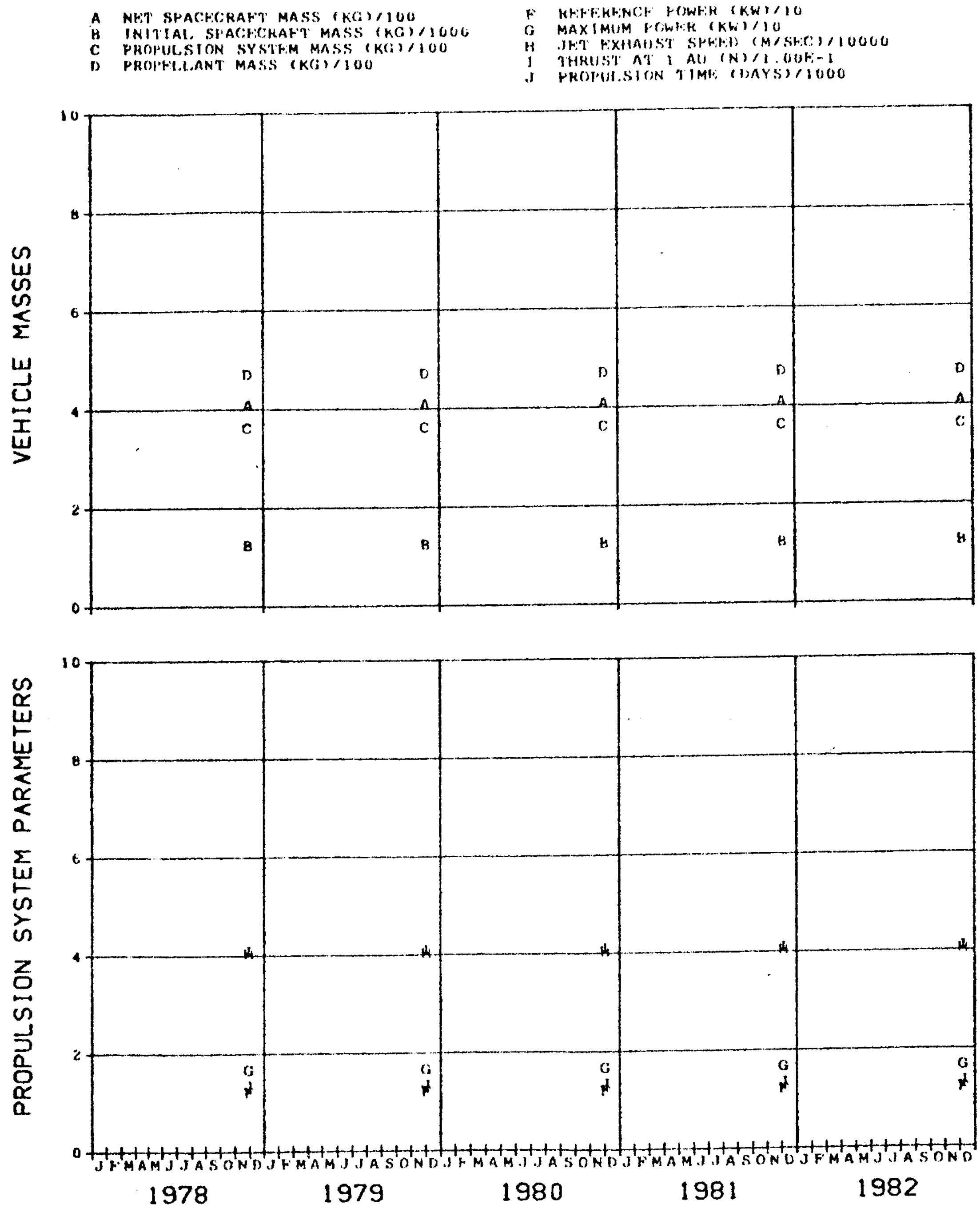

FIG. 36B. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 4000 DAYS

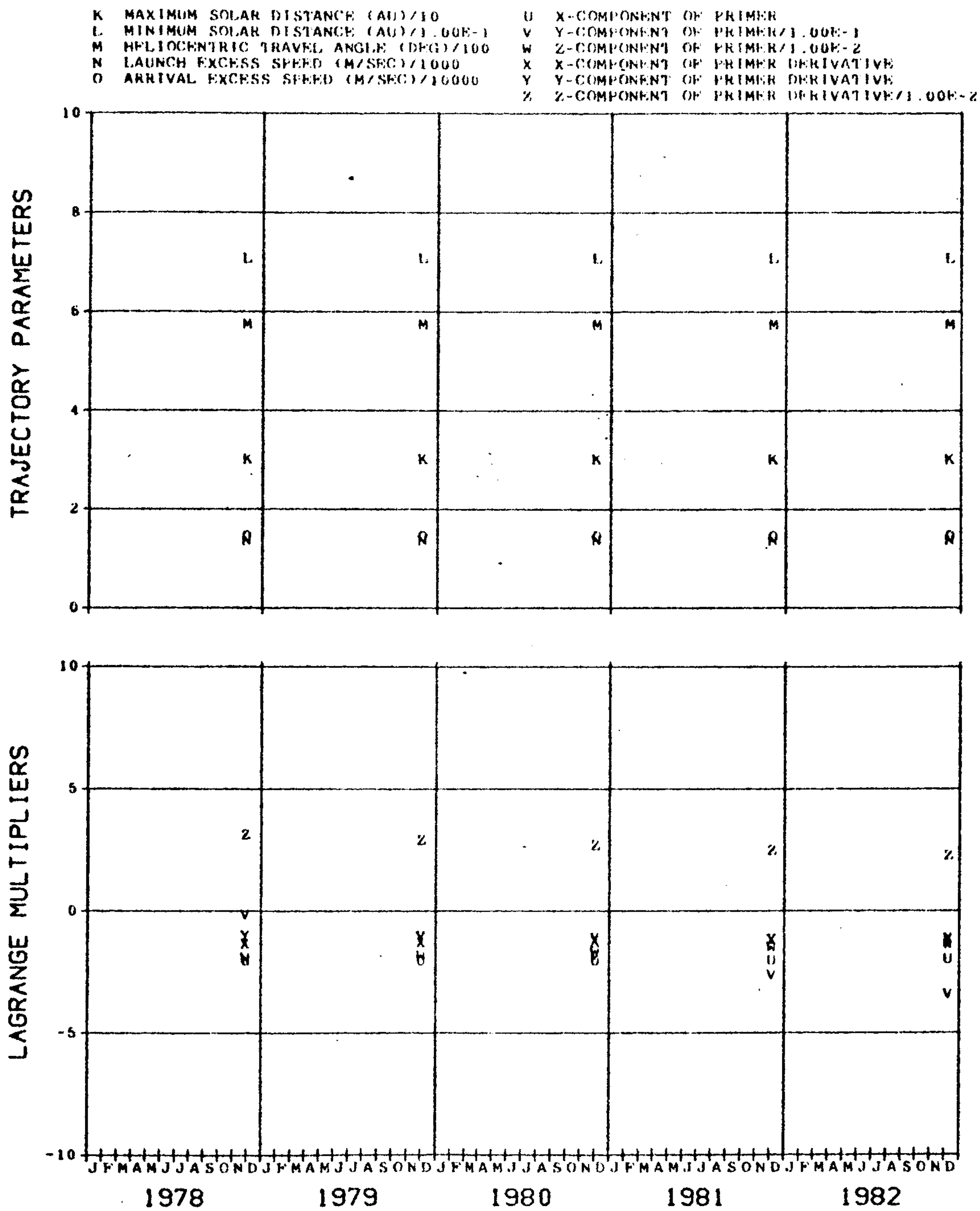

FIG. 36B. (CONCLUDED)

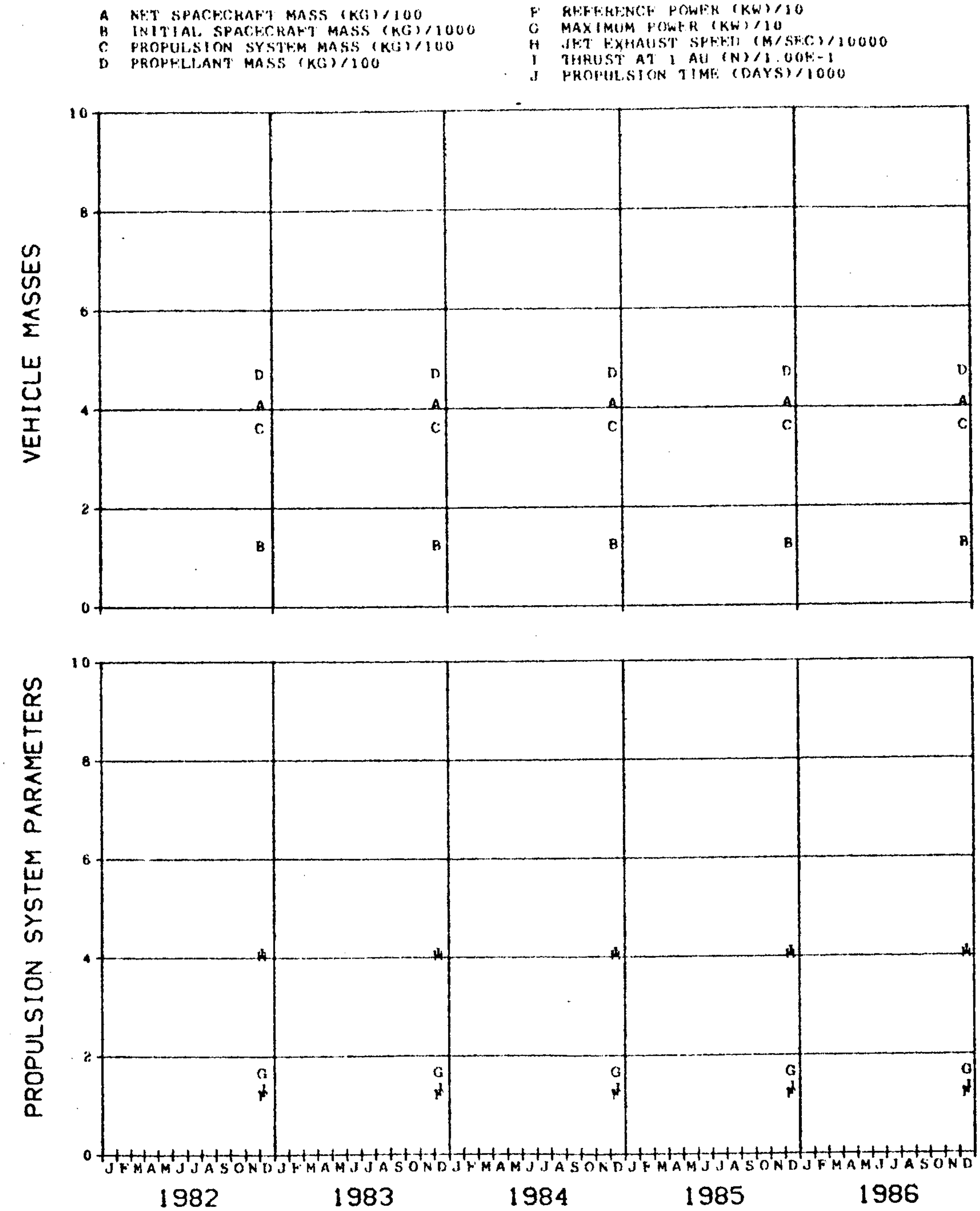

FIG. 36C. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 4000 DAYS

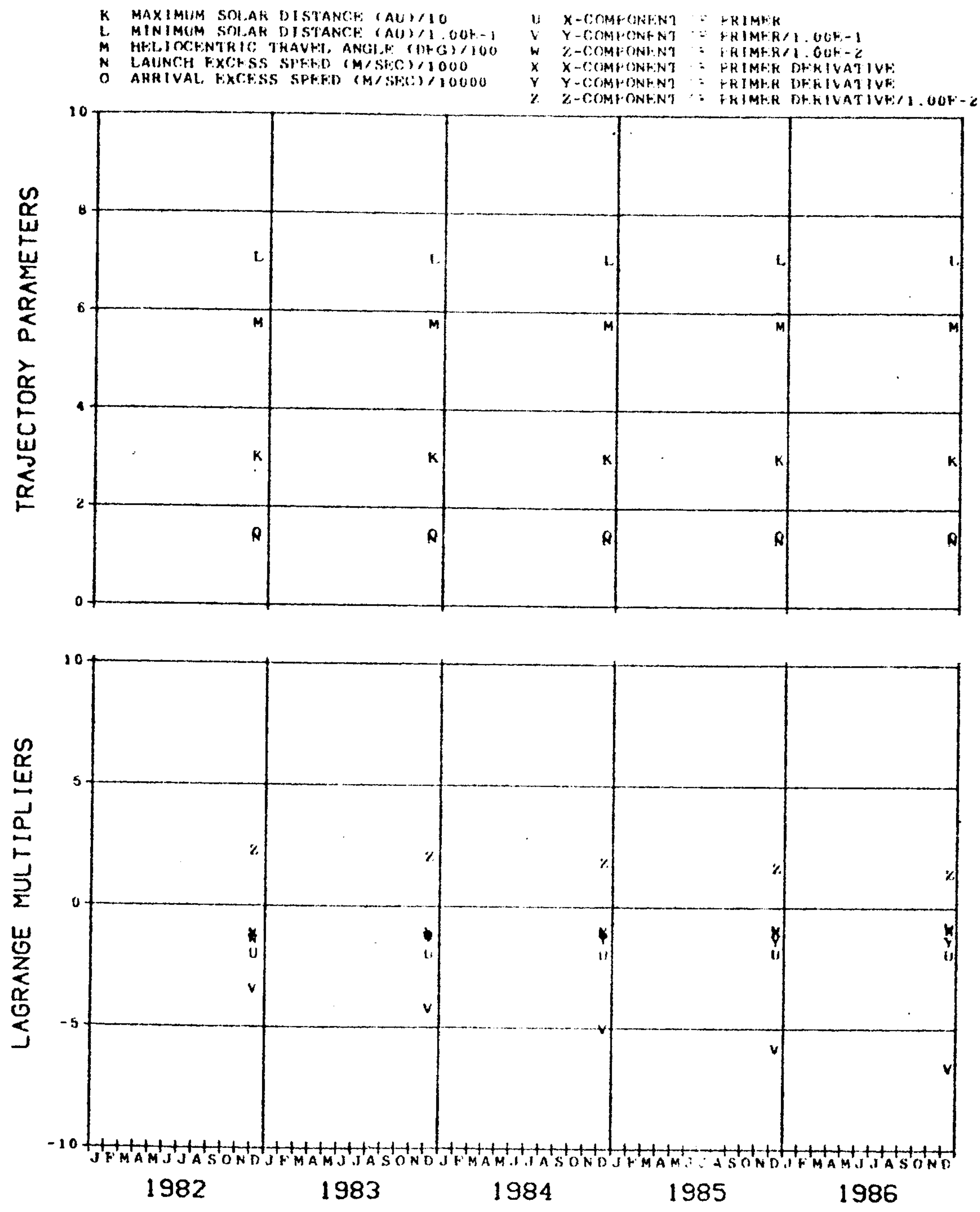

FIG. 36C. (CONCLUDED)

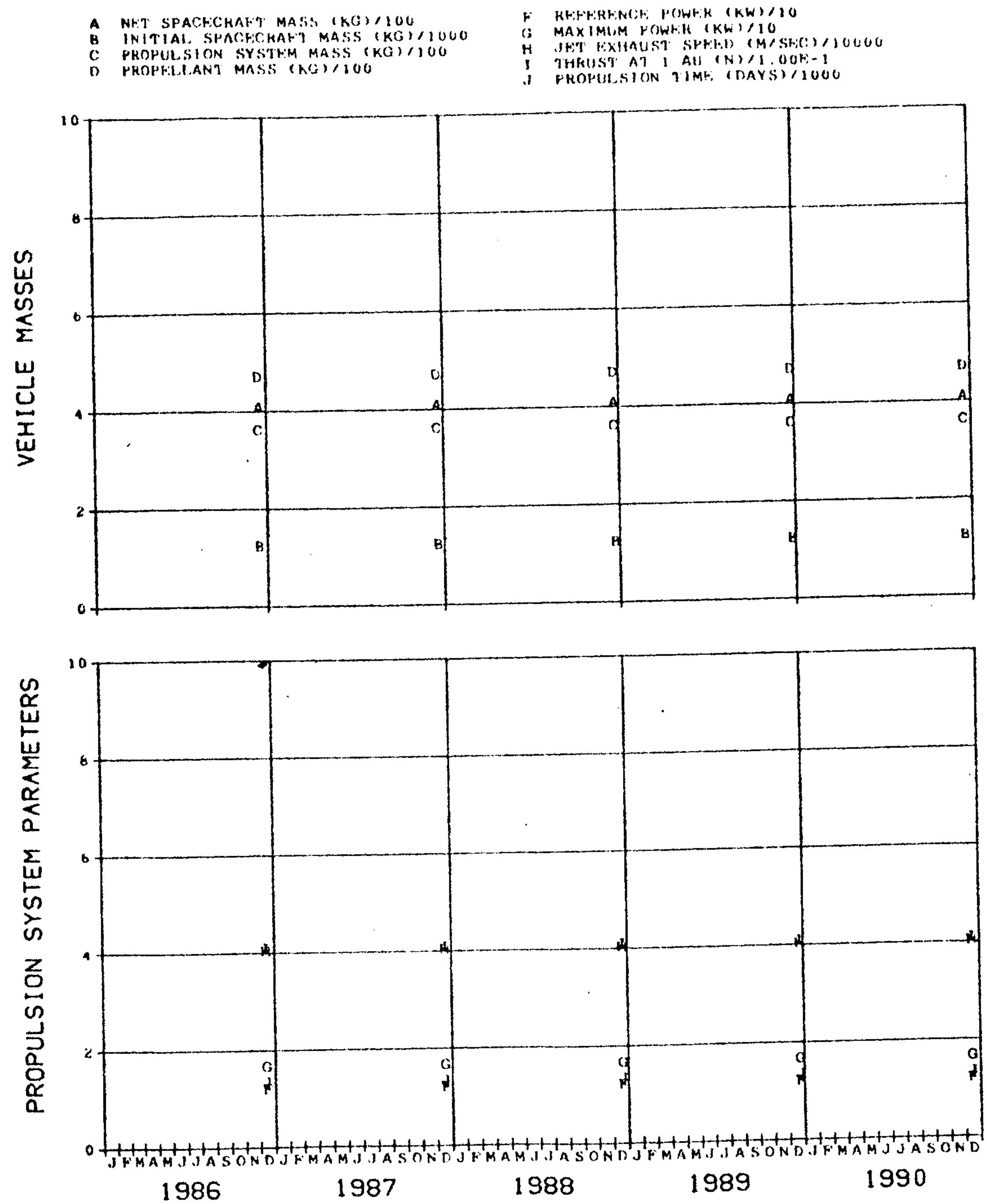

FIG. 36D. NEPTUNE MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 4000 DAYS

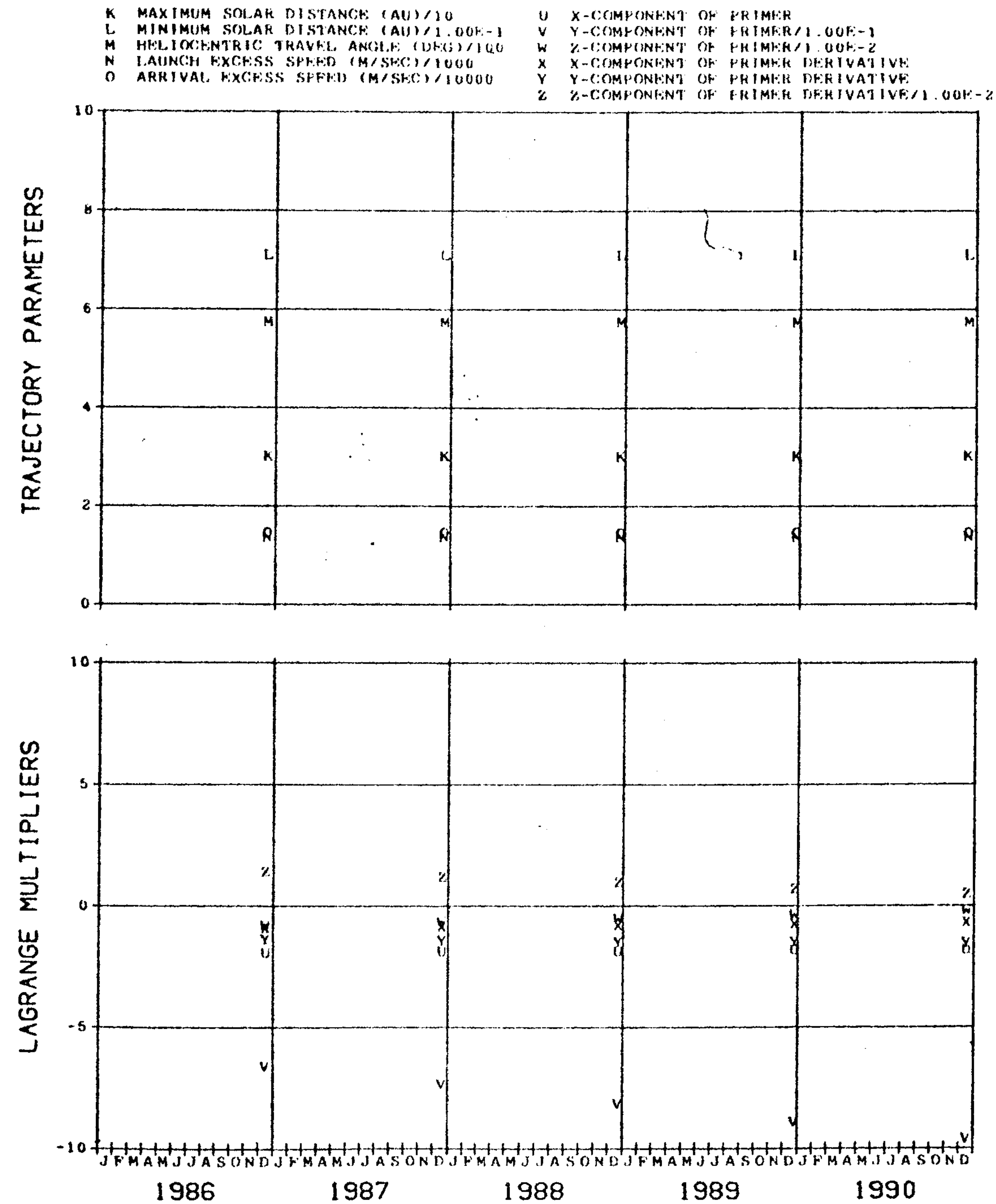

FIG. 36D. (CONCLUDED)

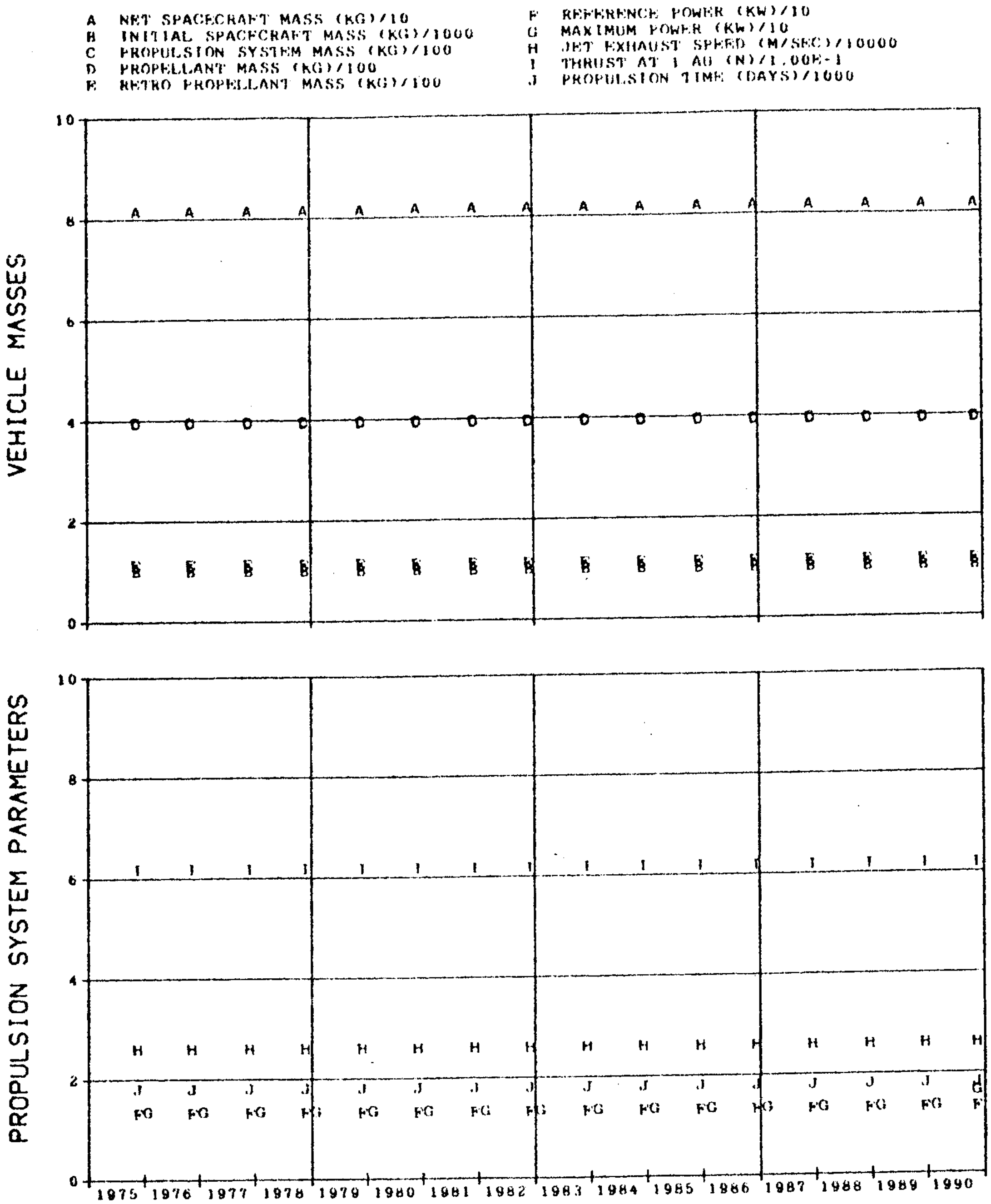

FIG. 37. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

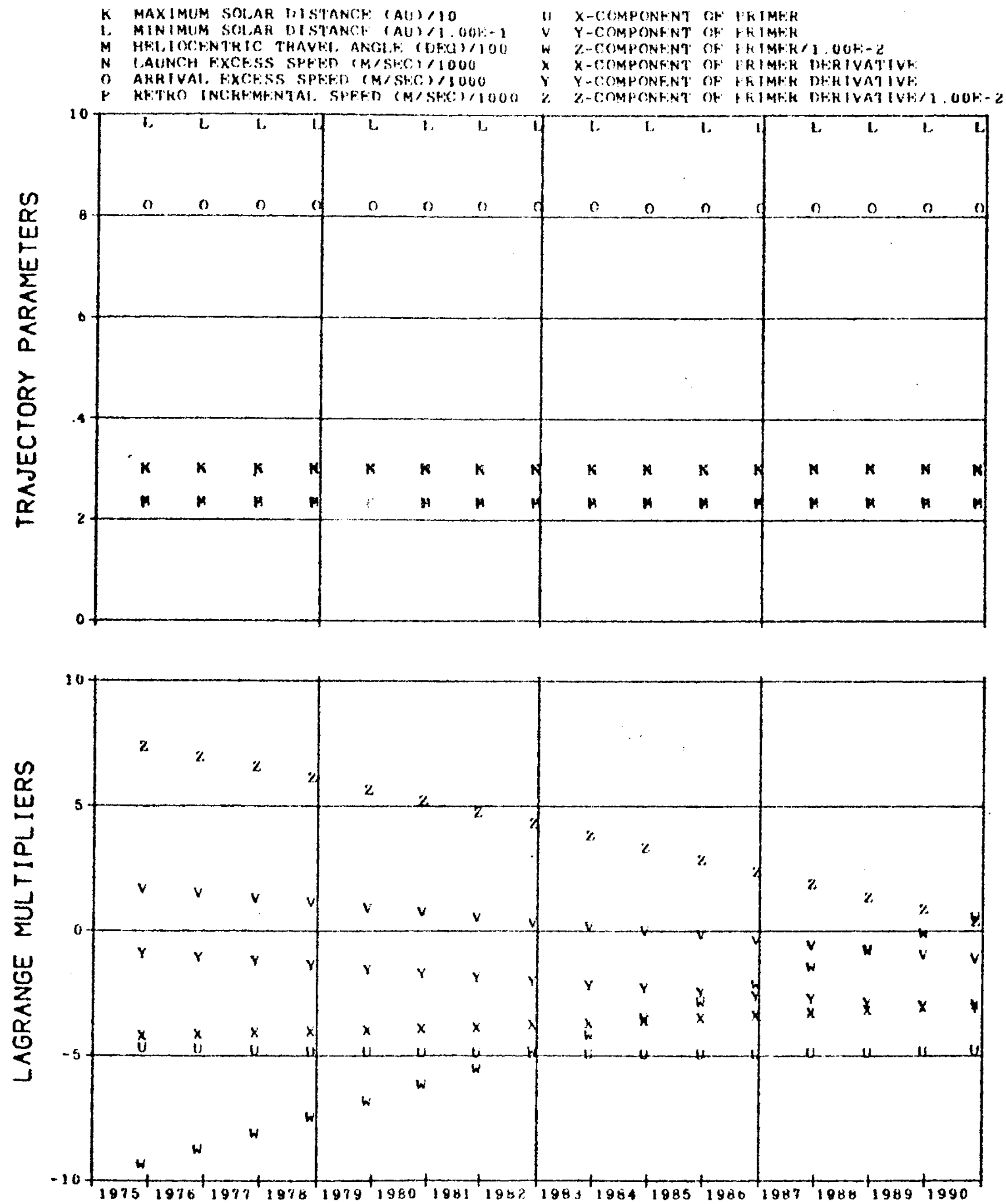

FIG. 37. (CONCLUDED)

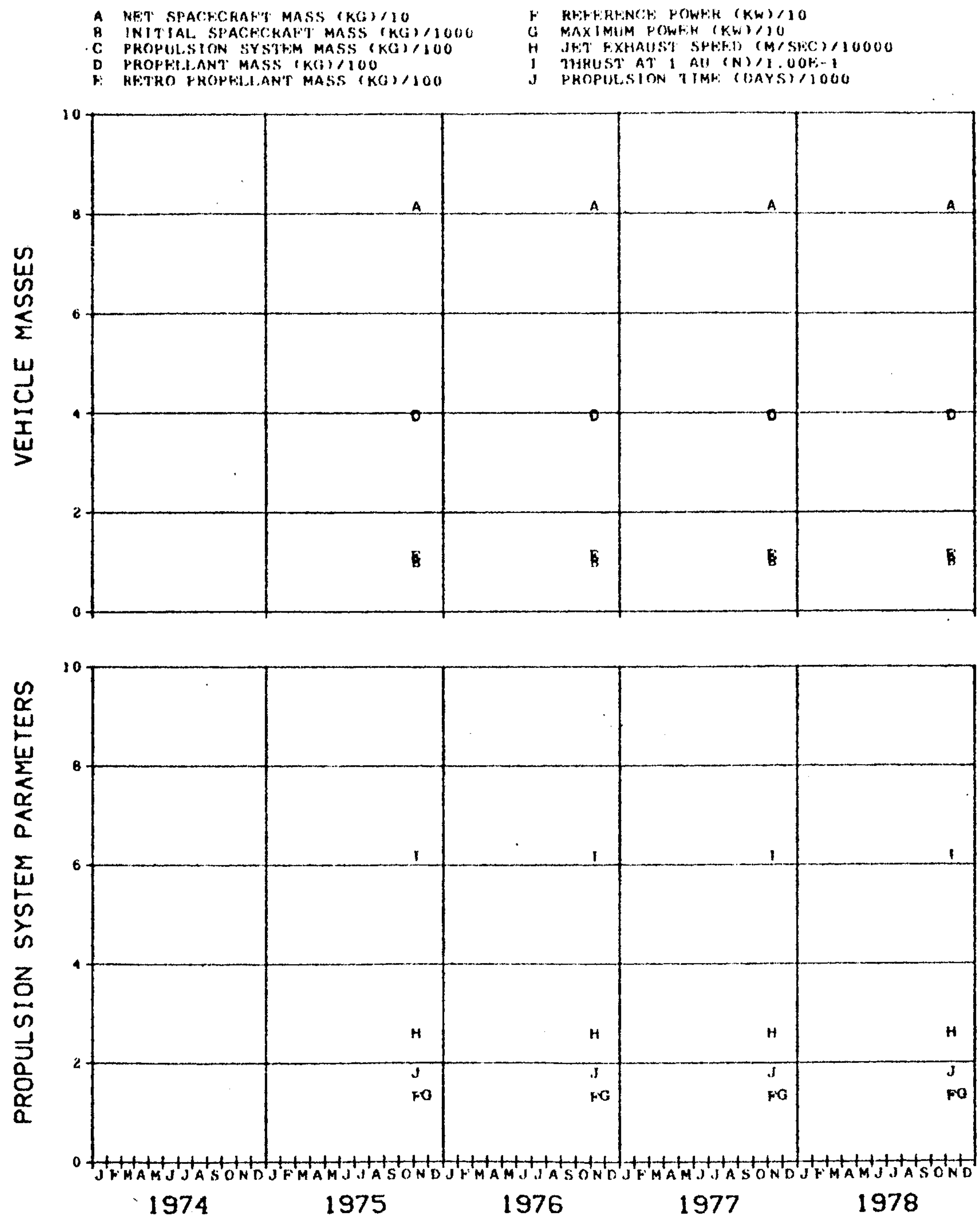

FIG. 37A. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

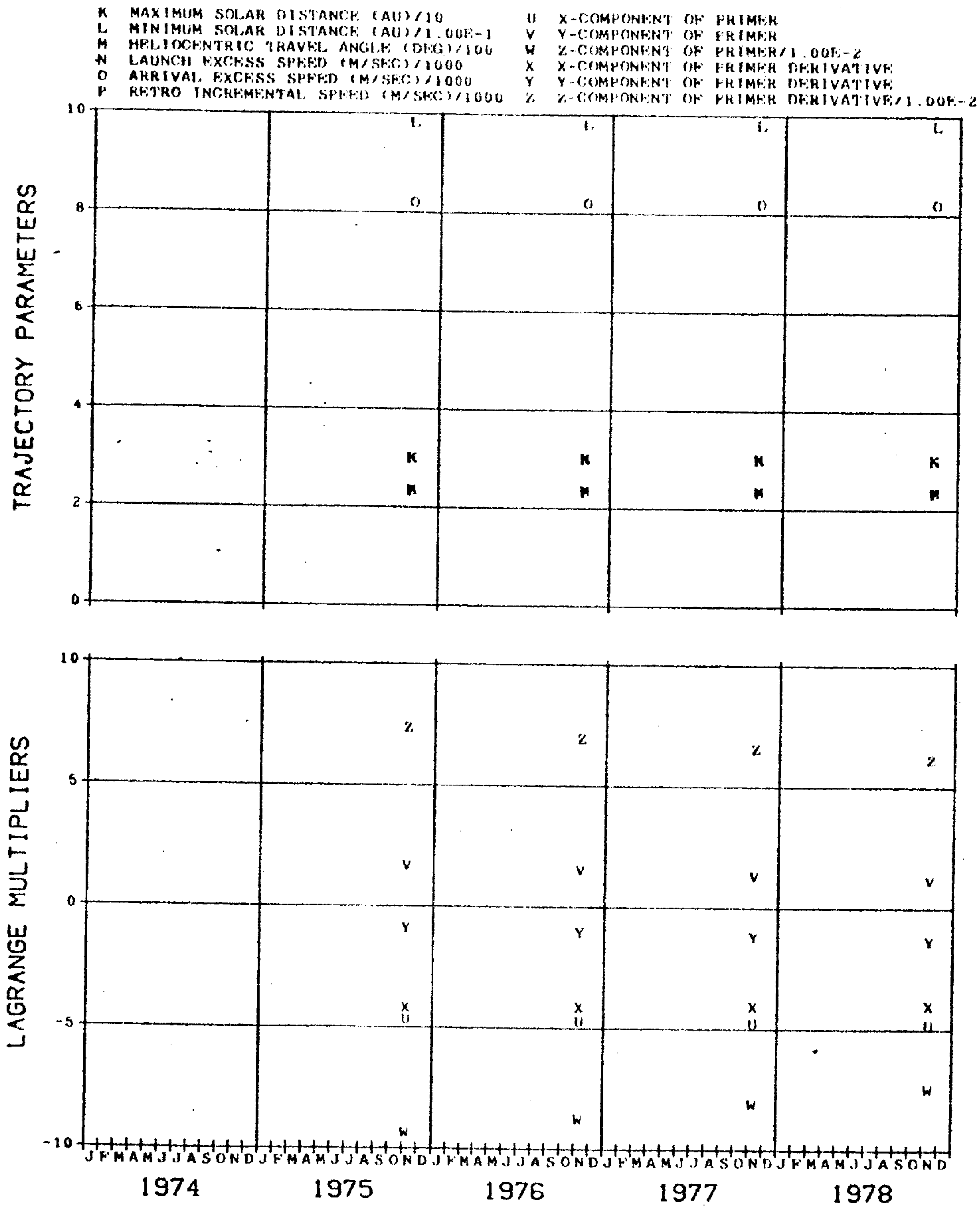

FIG. 37A. (CONCLUDED)

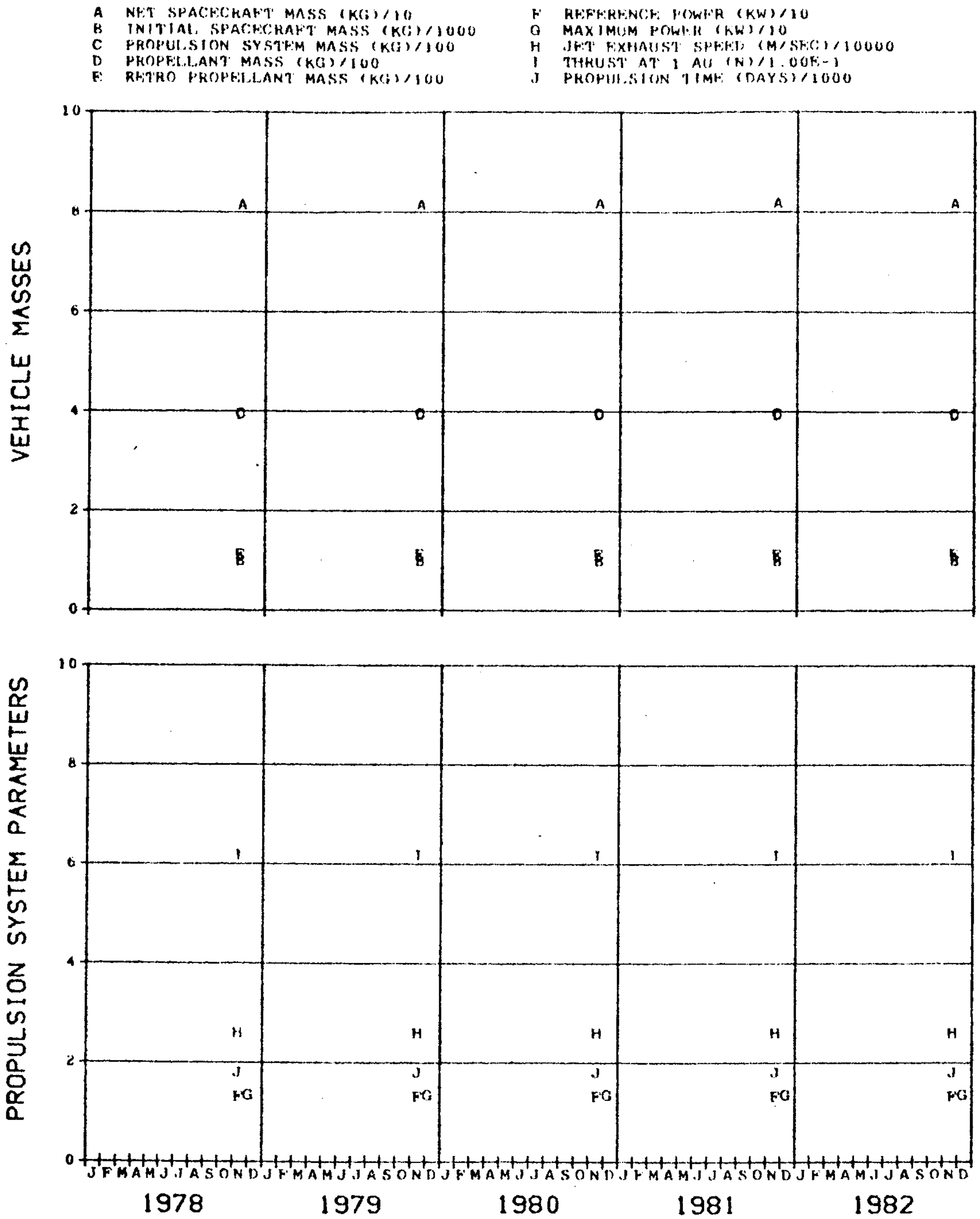

FIG. 37B. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

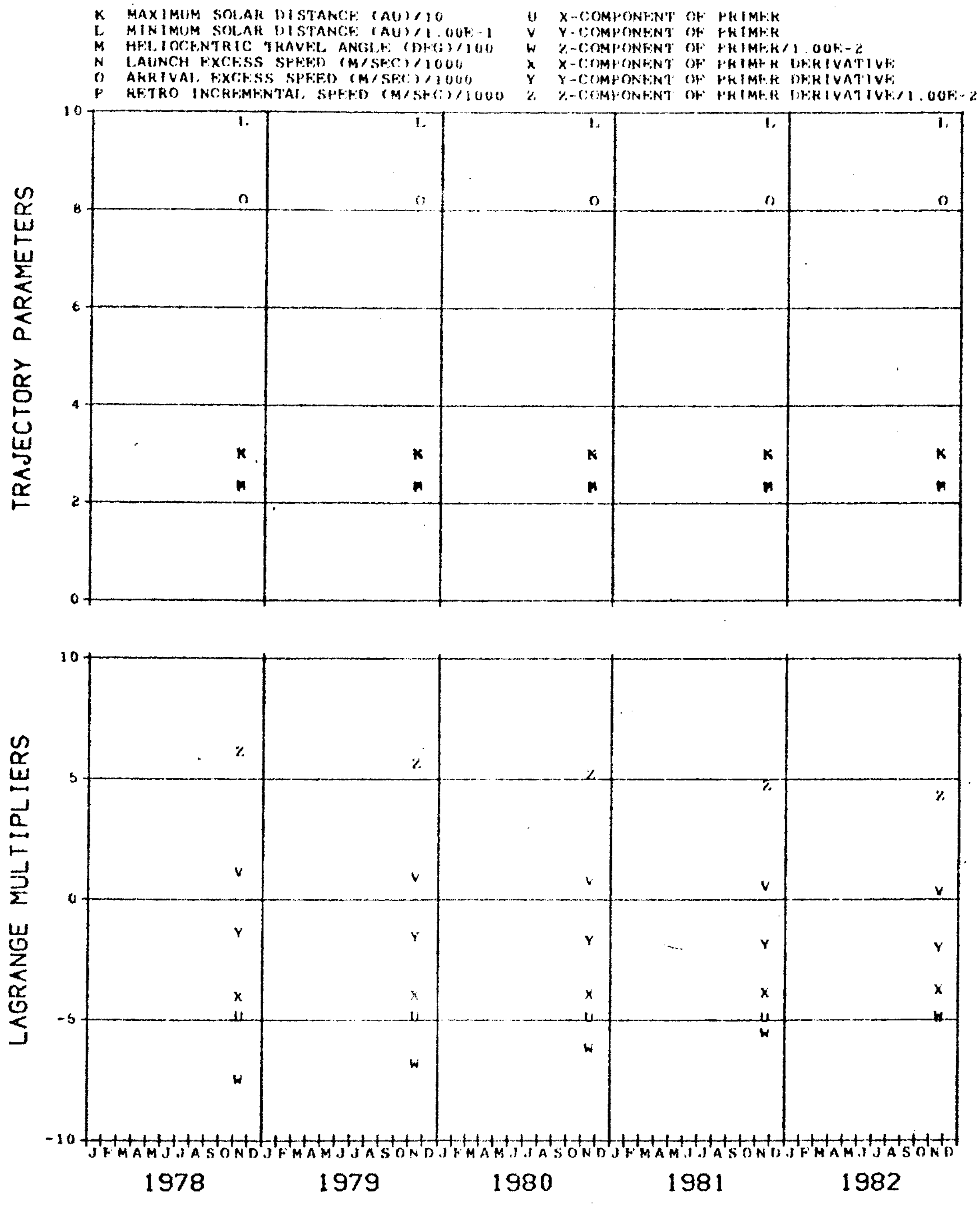

FIG. 37B. (CONCLUDED)

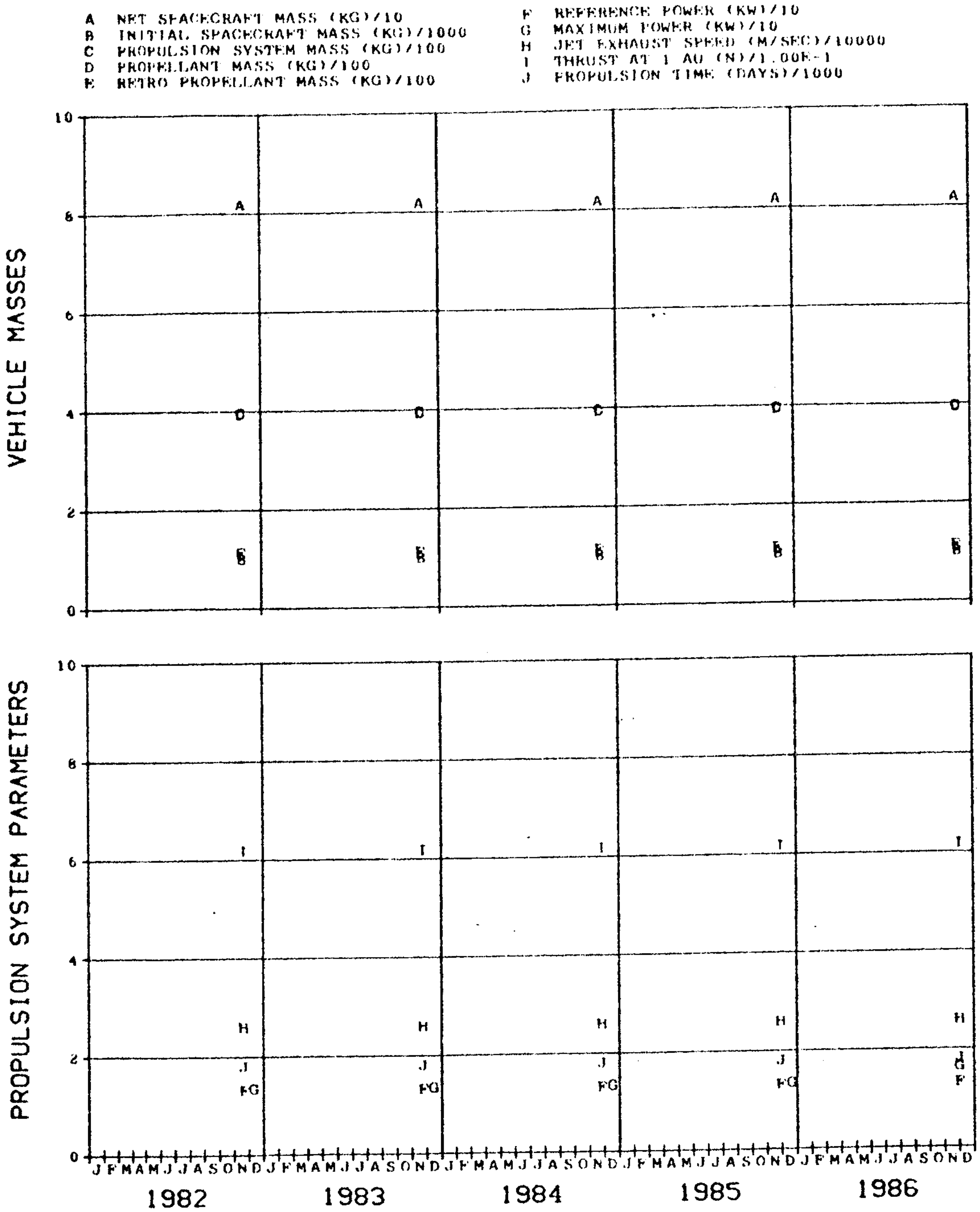

FIG. 37C. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

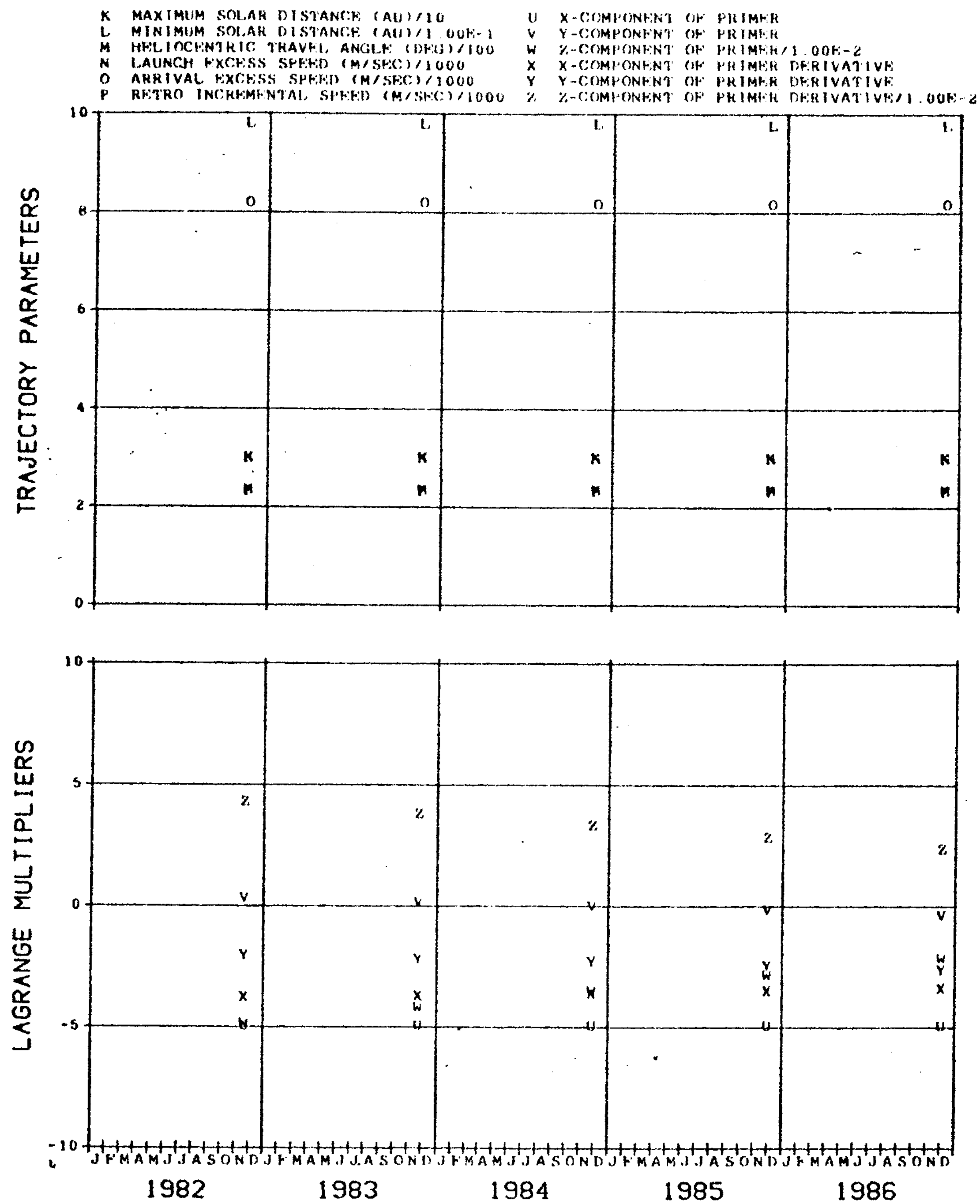

FIG. 37C. (CONCLUDED)

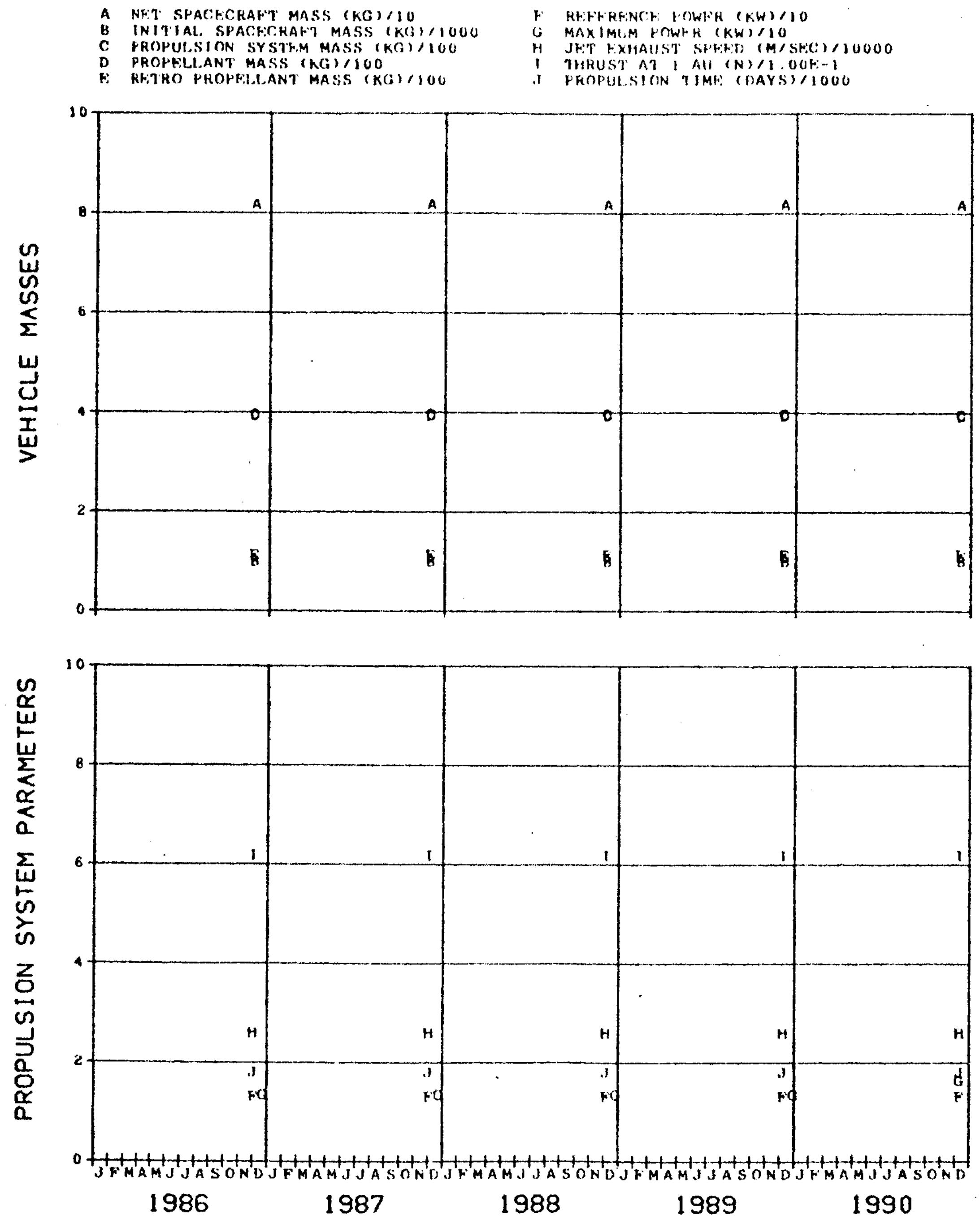

FIG. 37D. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

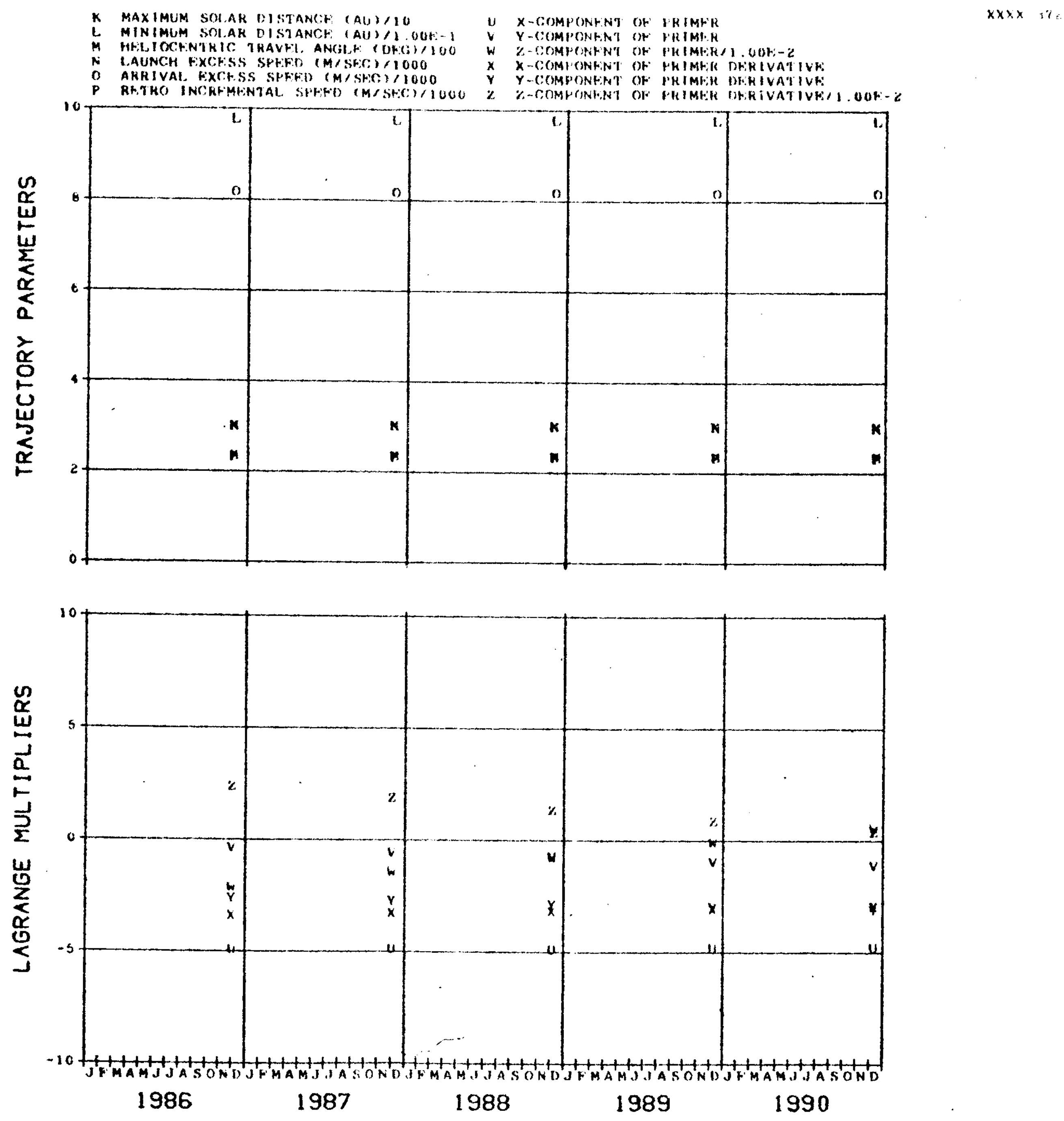

FIG. 37D. (CONCLUDED)

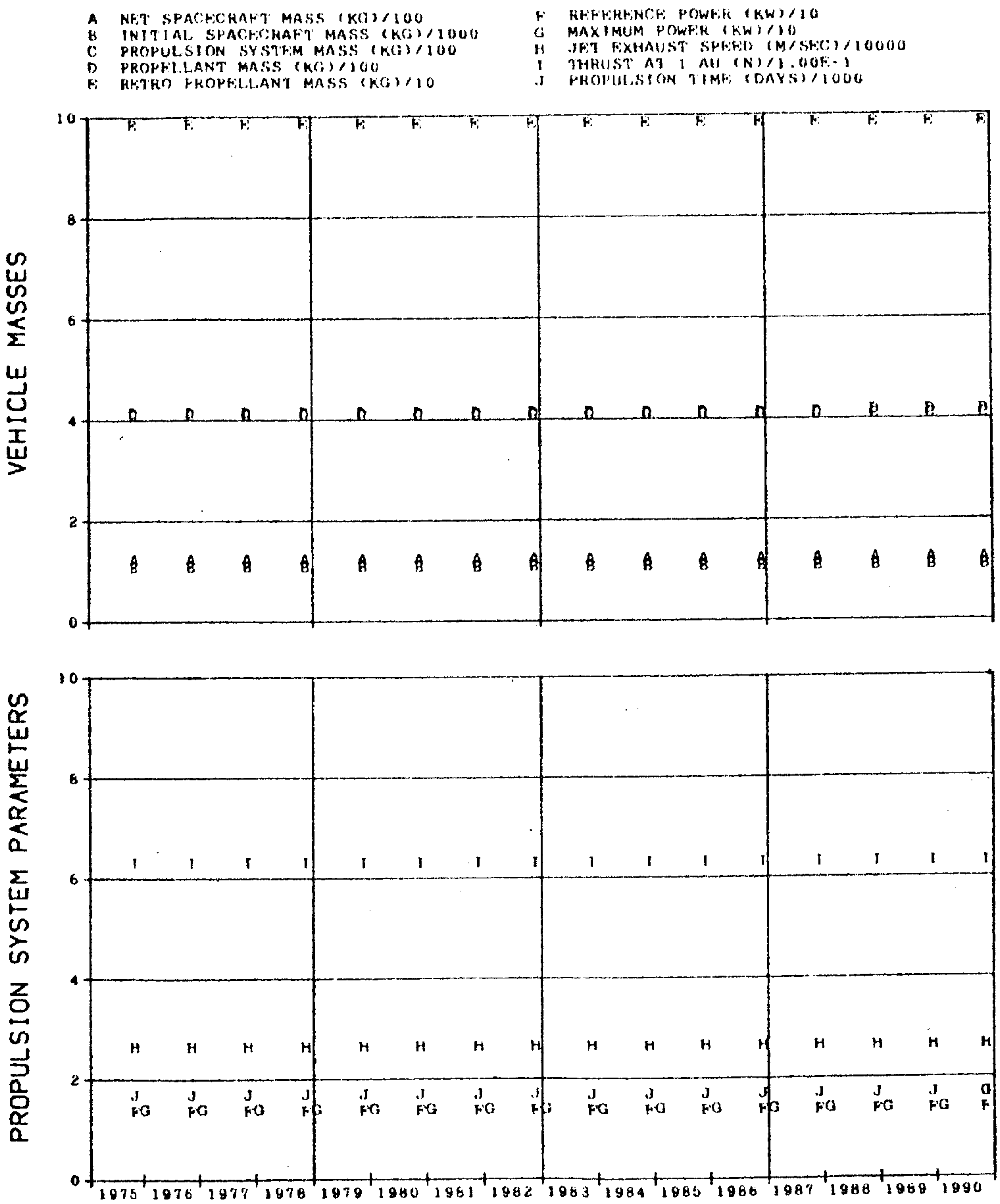

FIG. 38. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6000 DAYS

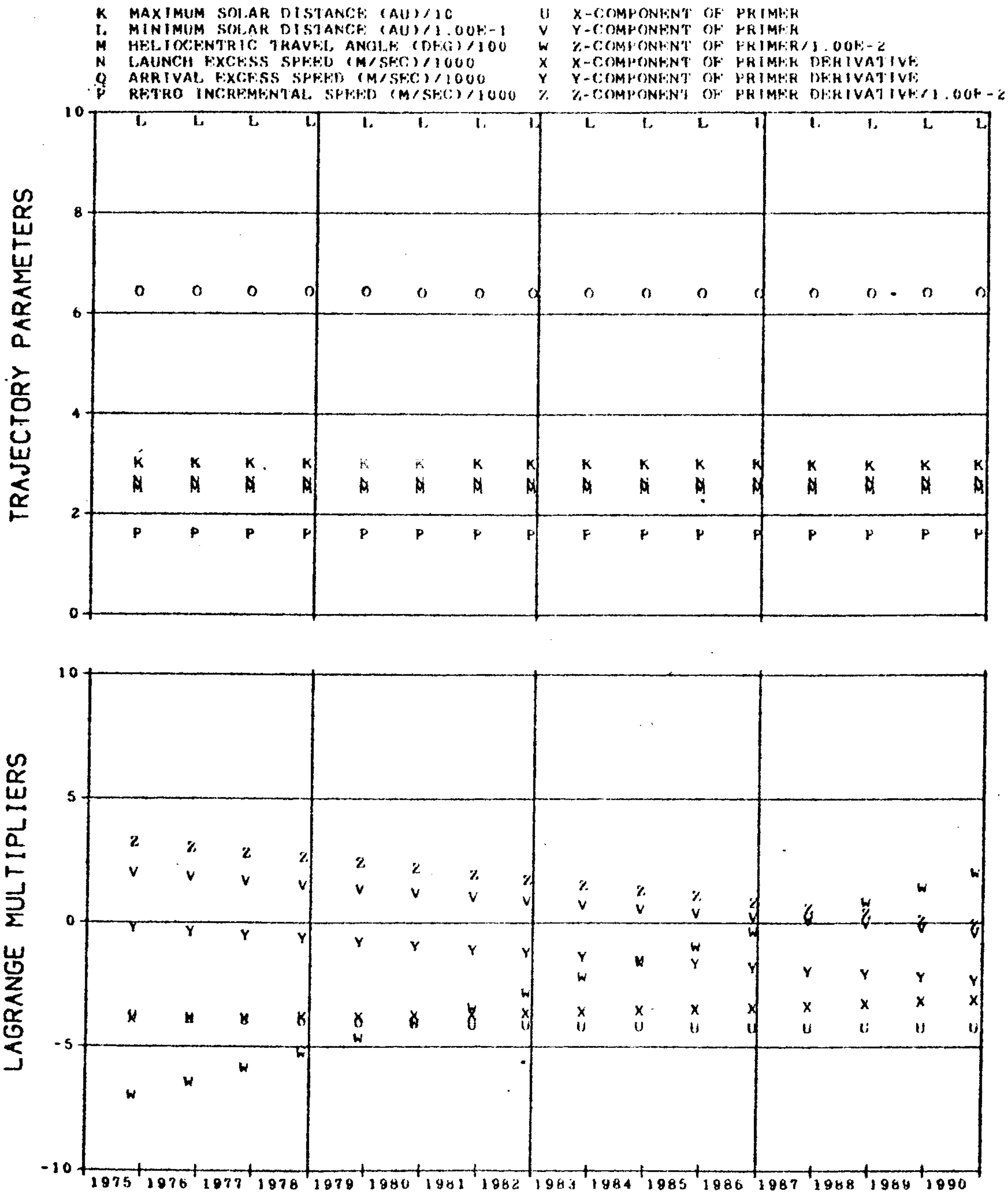

FIG. 38. (CONCLUDED)

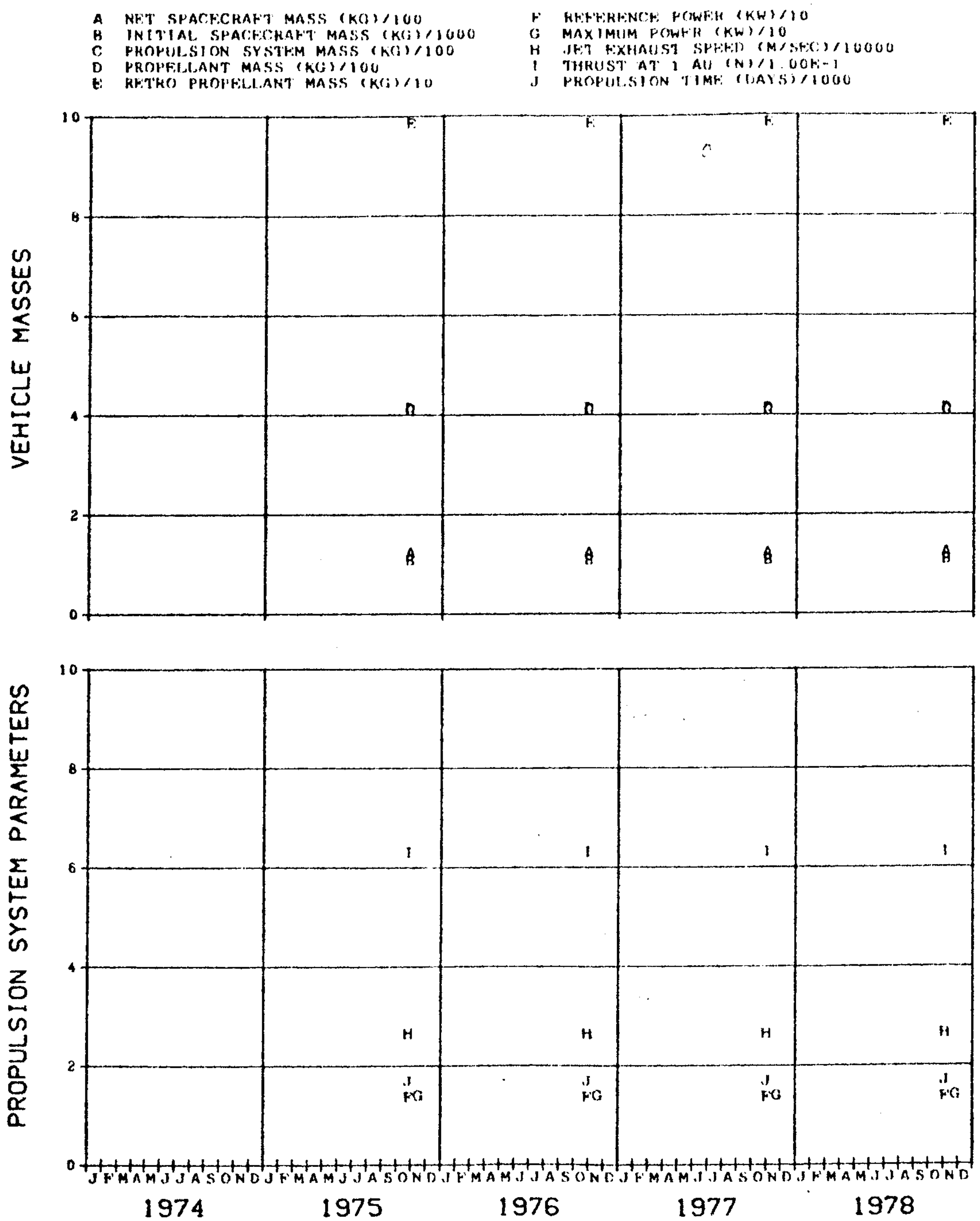

FIG. 38A. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6000 DAYS

XXX 376

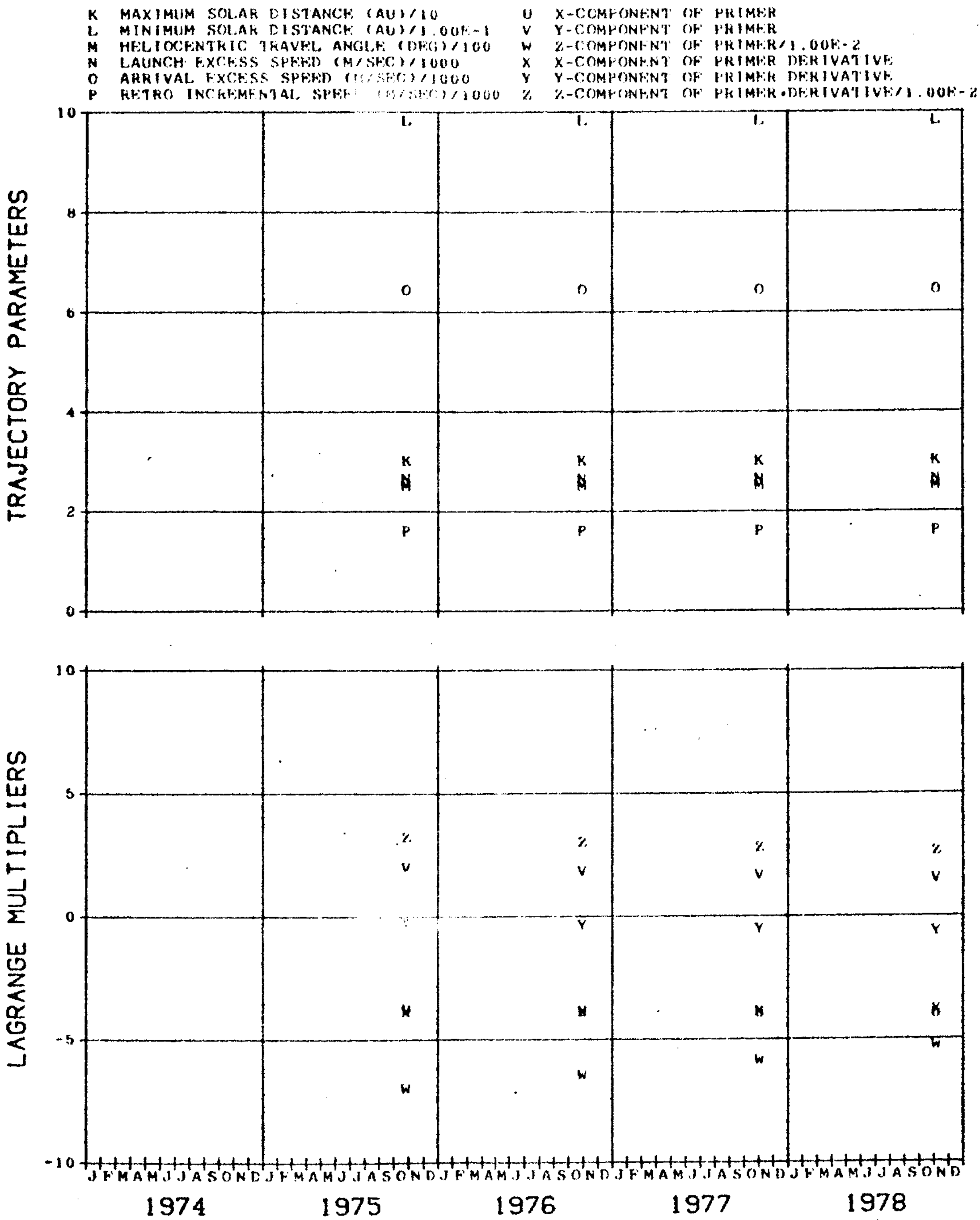

FIG. 38A. (CONCLUDED)

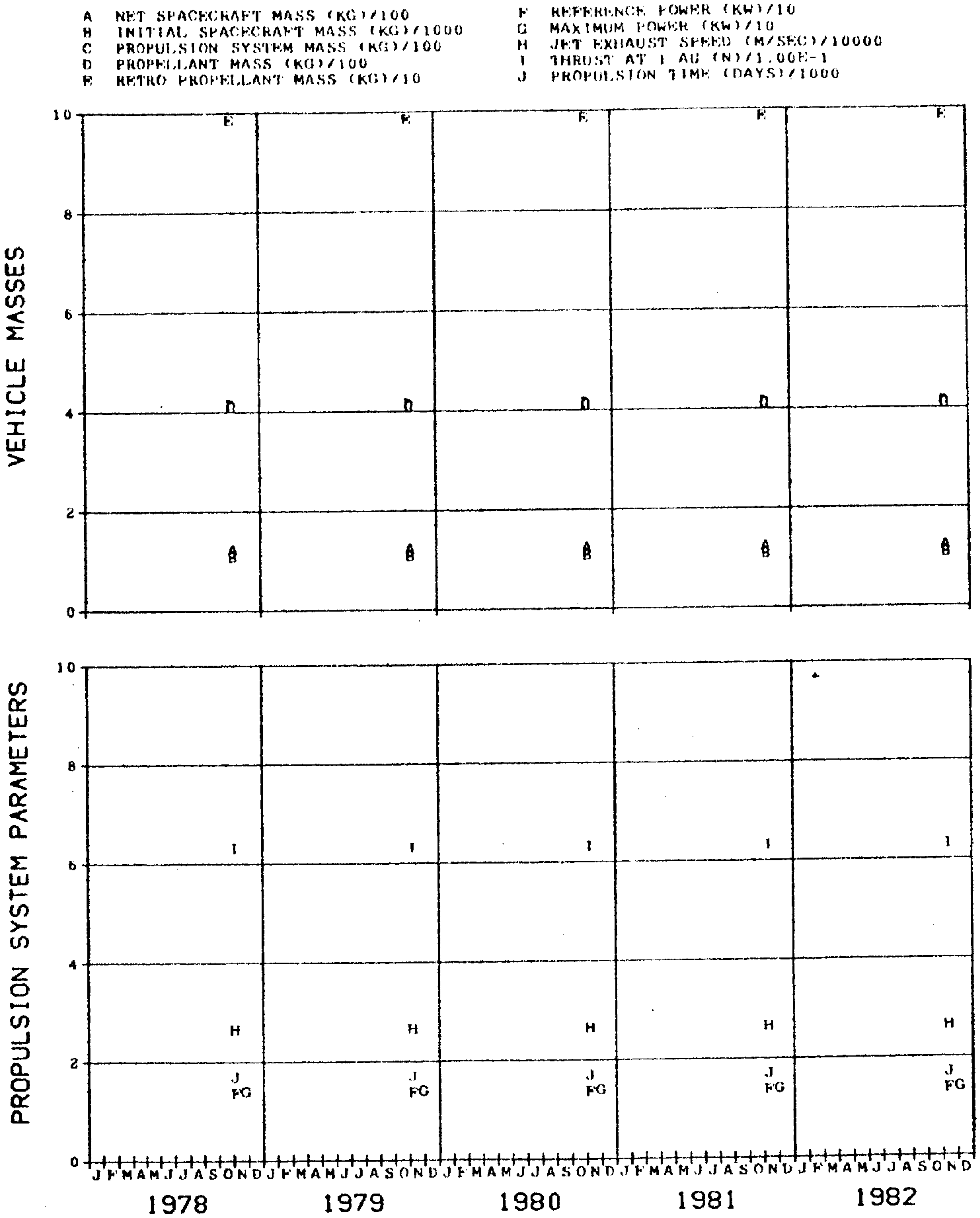

FIG. 38B. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6000 DAYS

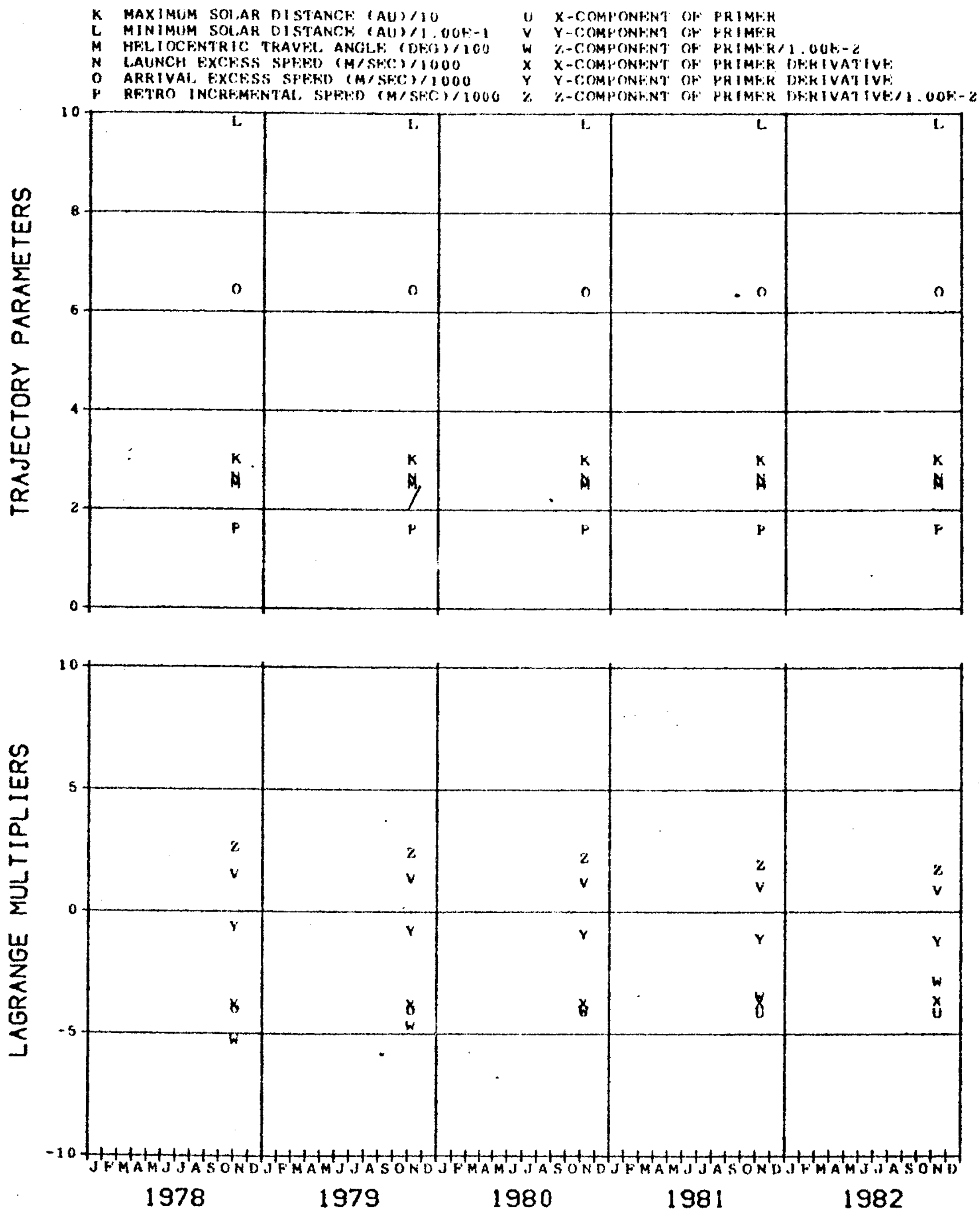

FIG. 38B. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/10
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/1000

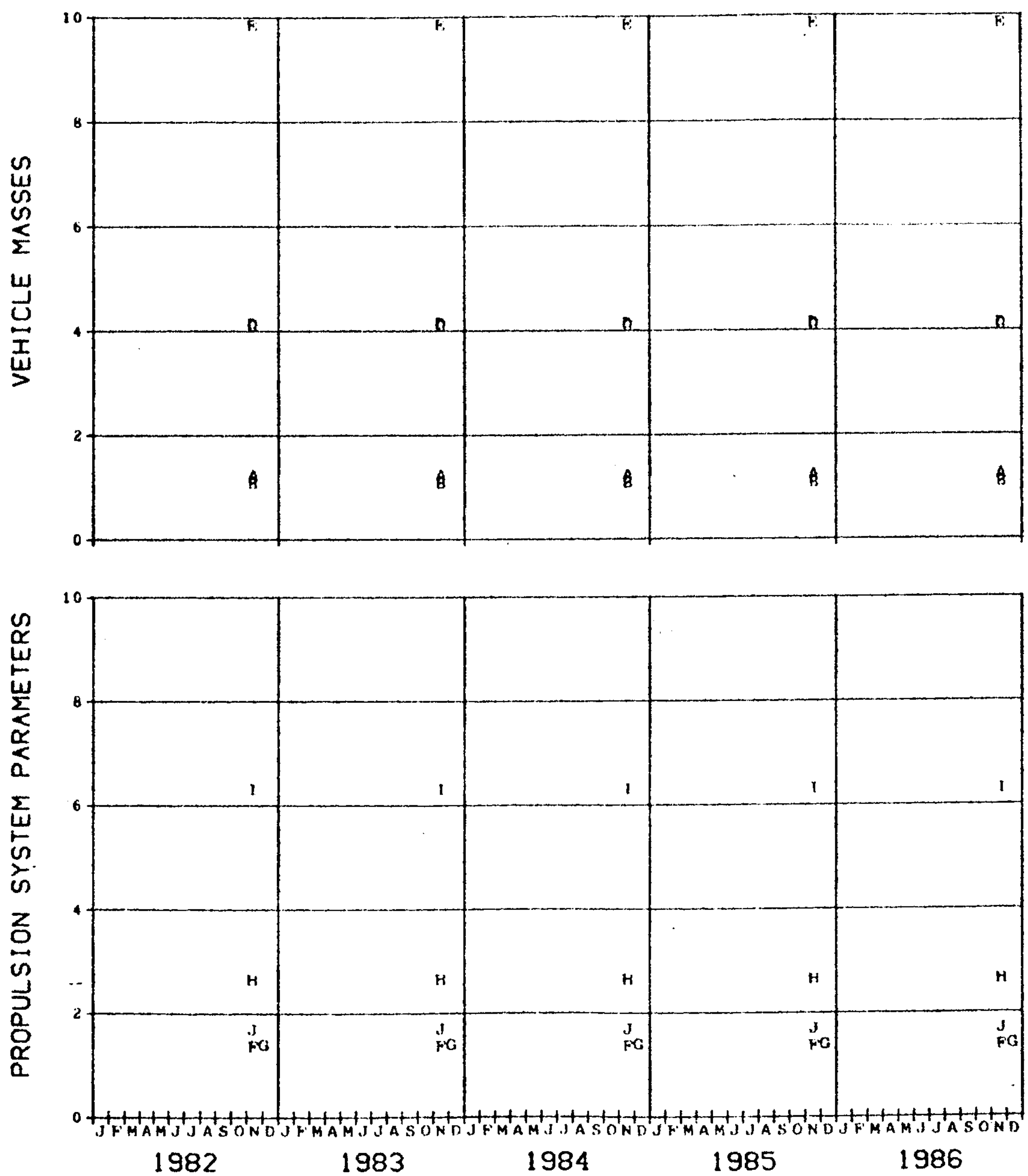

FIG. 38C. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6000 DAYS

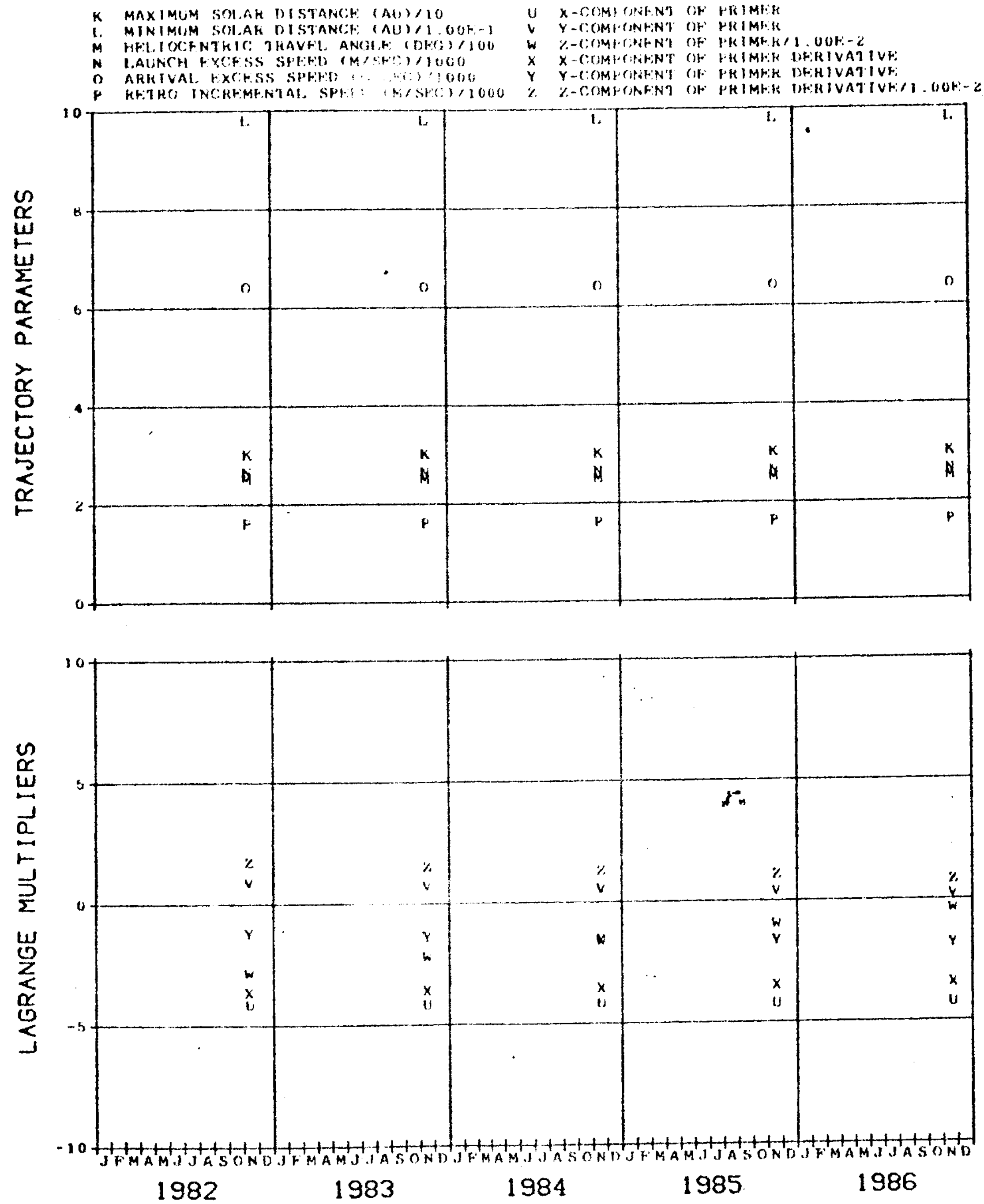

FIG. 38C. (CONCLUDED)

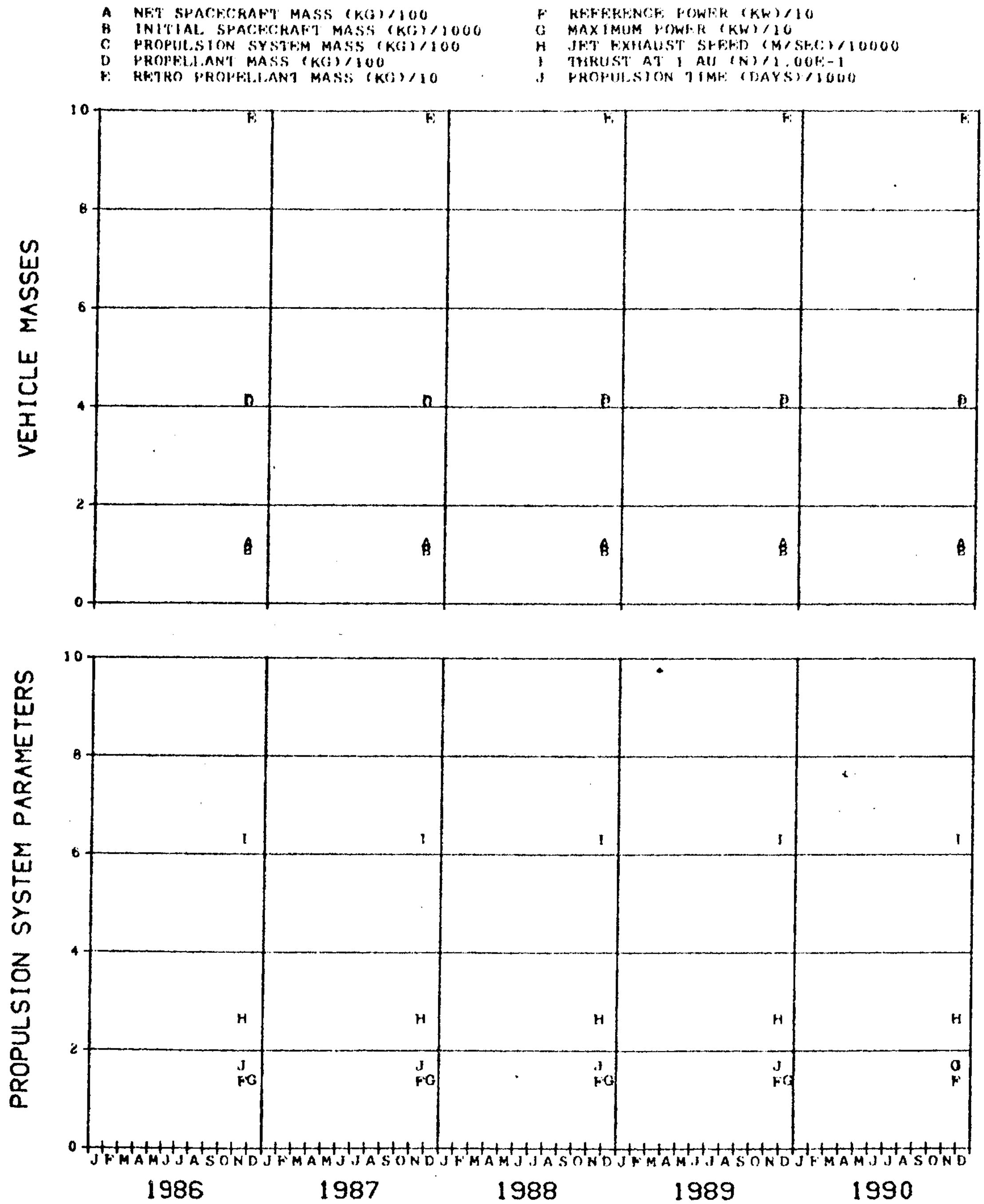

FIG. 38D. NEPTUNE MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6000 DAYS

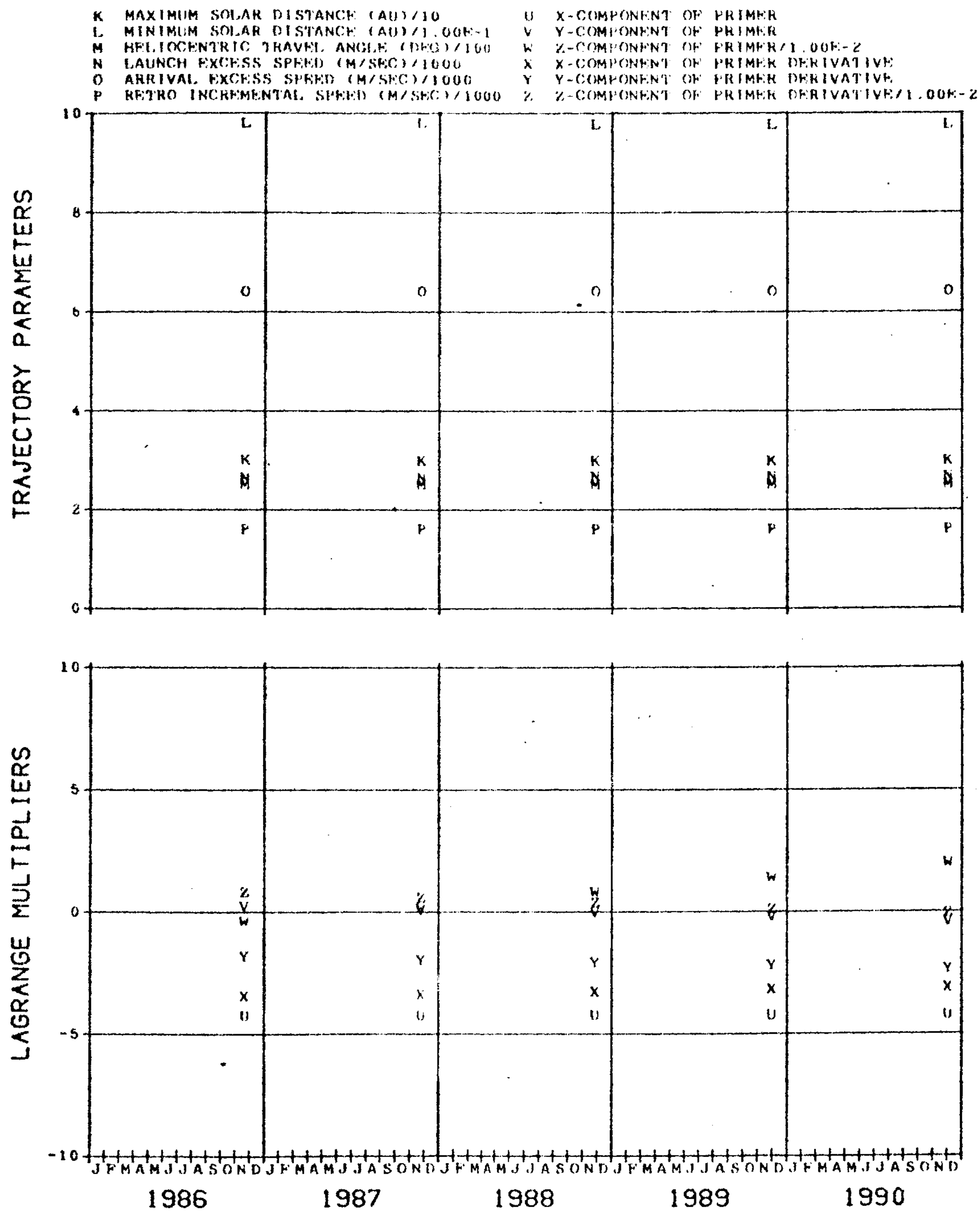

FIG. 38D. (CONCLUDED)

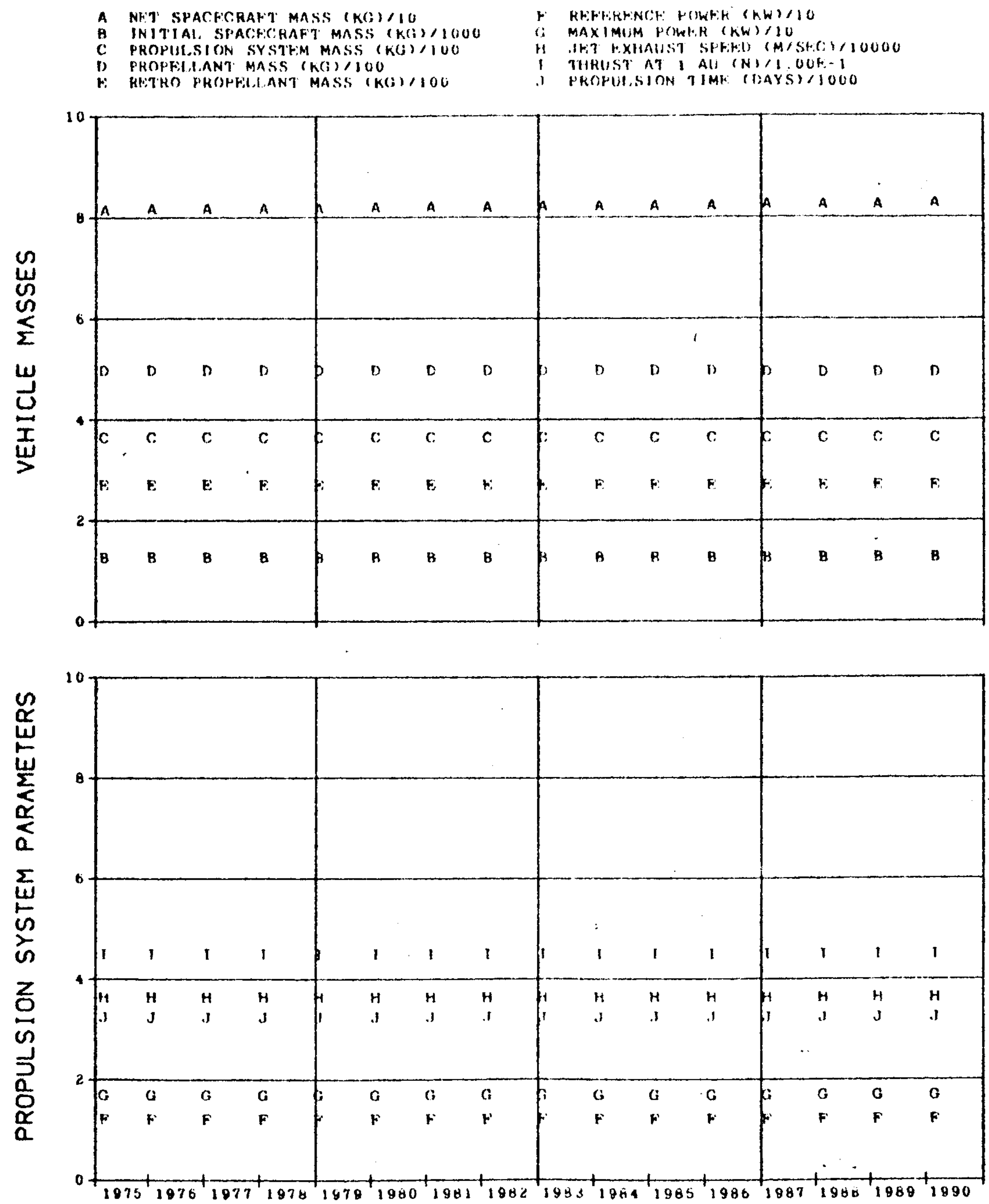

FIG. 39. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4500 DAYS

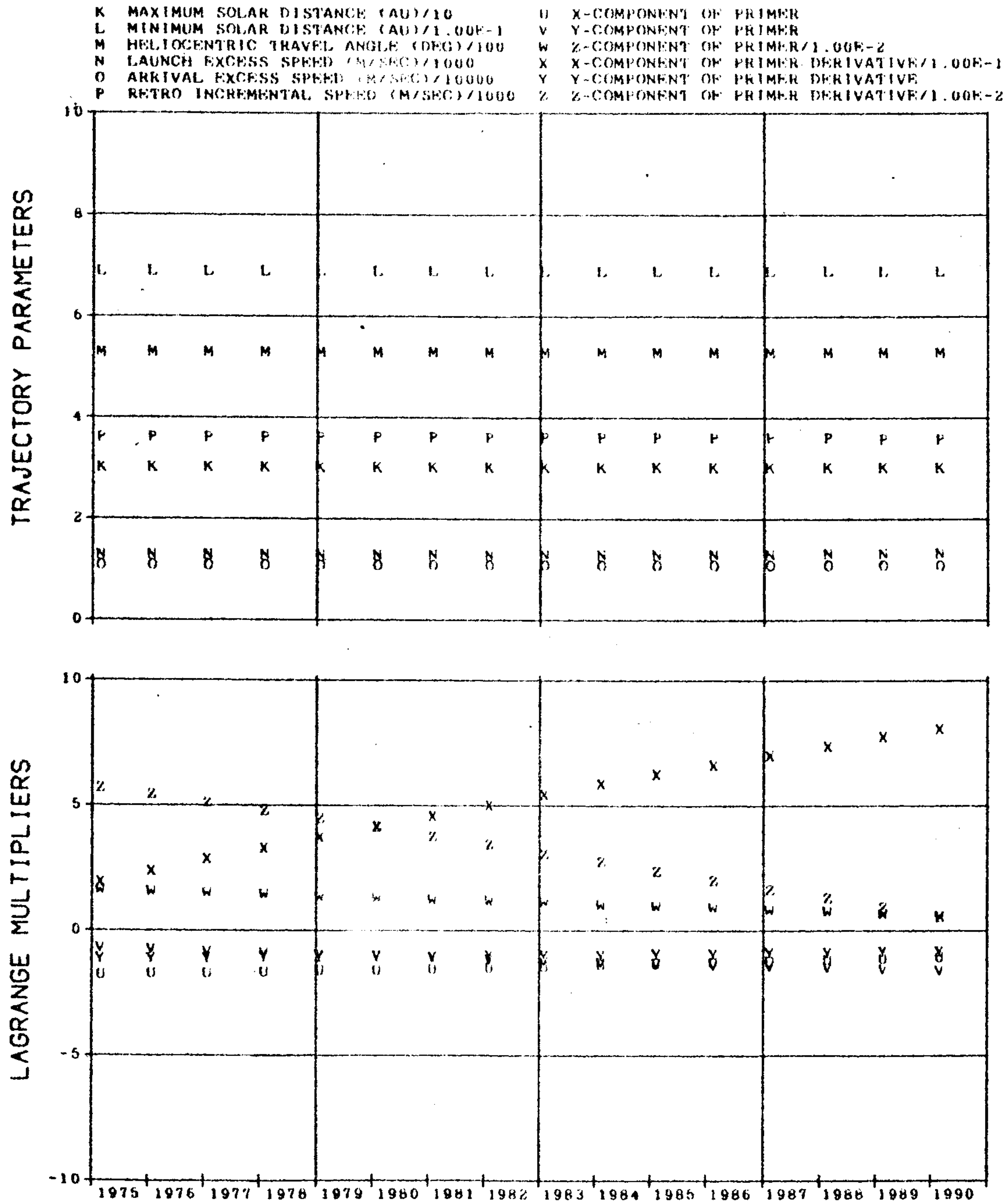

FIG. 39. (CONCLUDED)

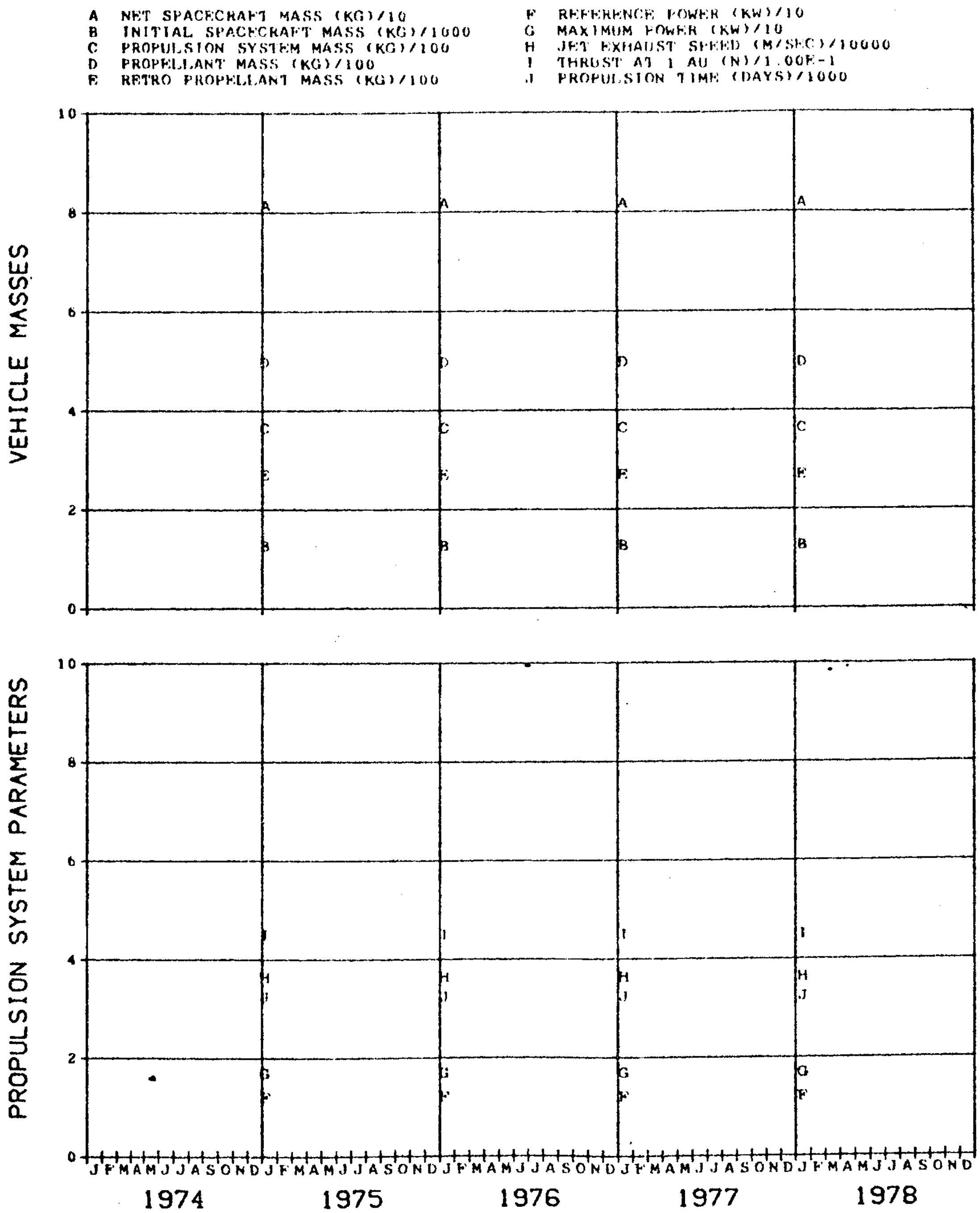

FIG. 39A. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4500 DAYS

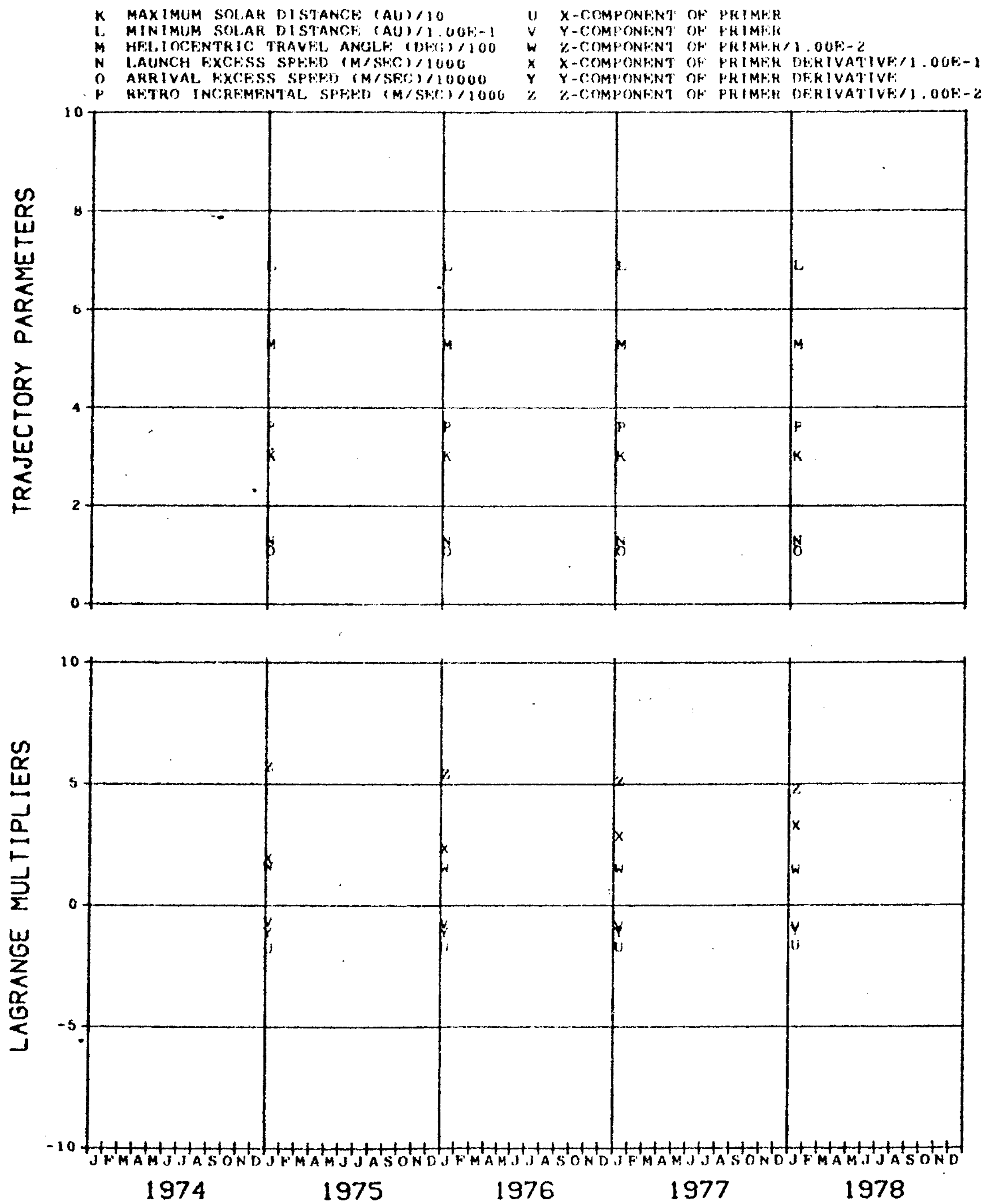

FIG. 39A. (CONCLUDED)

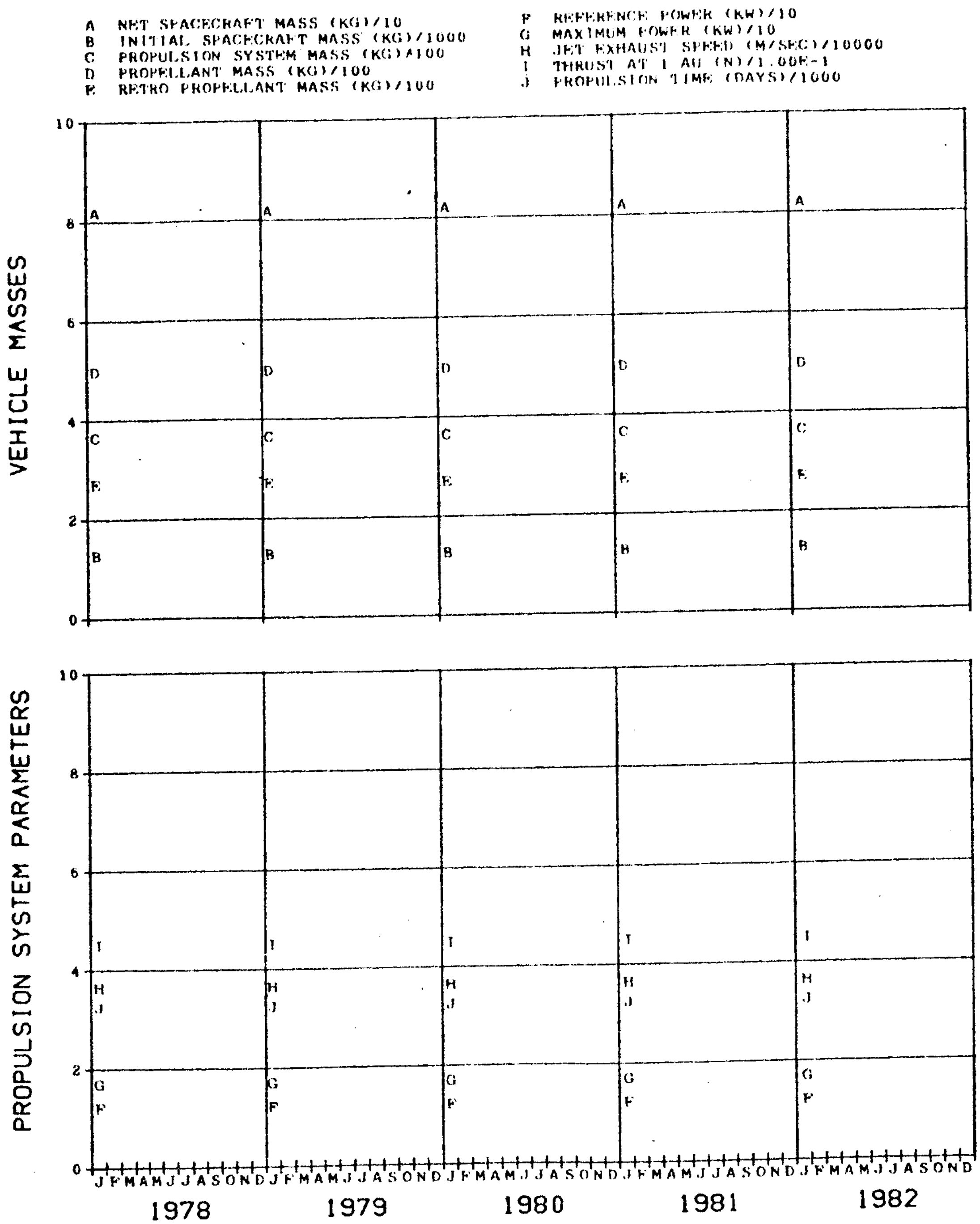

FIG. 39B. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4500 DAYS

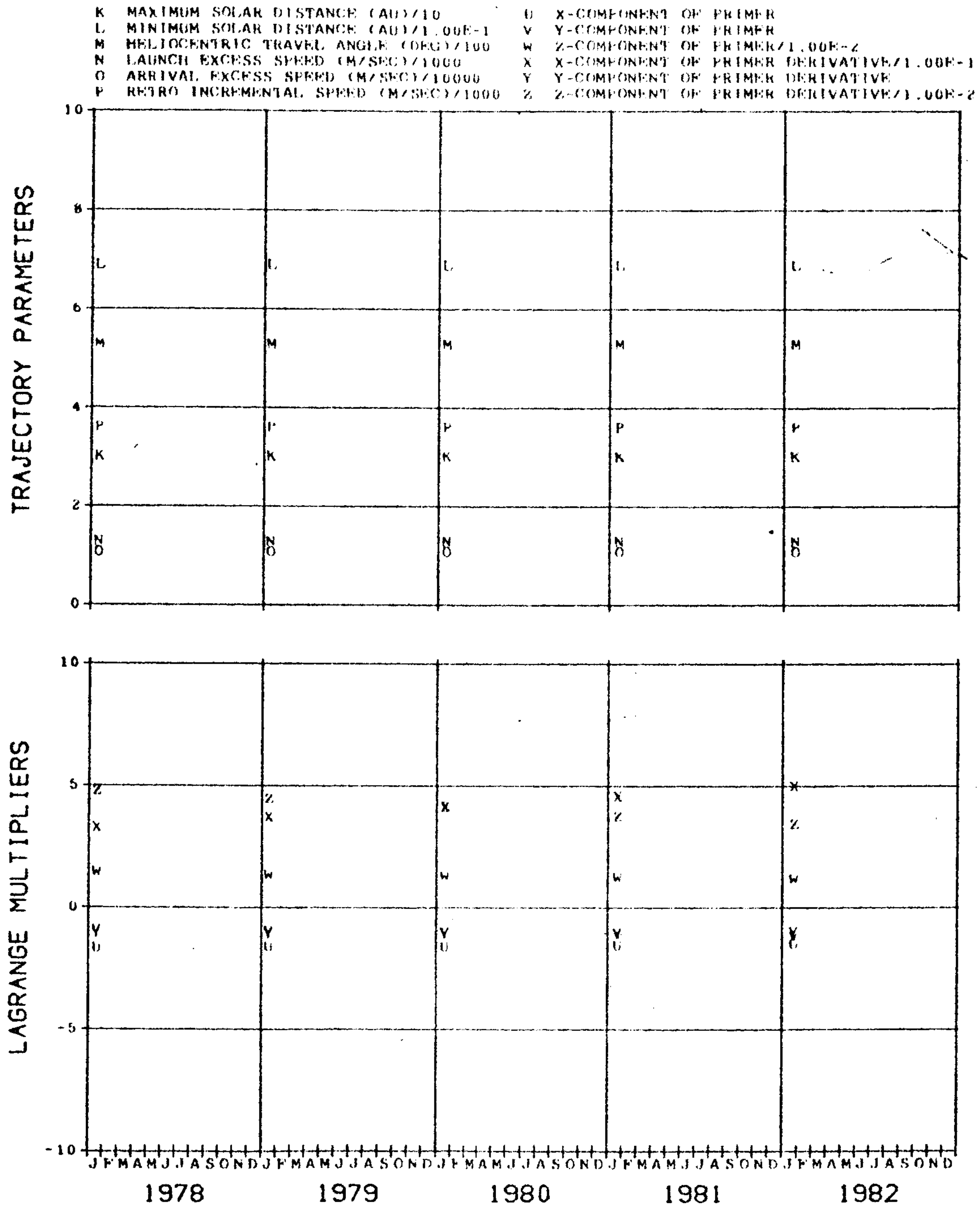

FIG. 39B. (CONCLUDED)

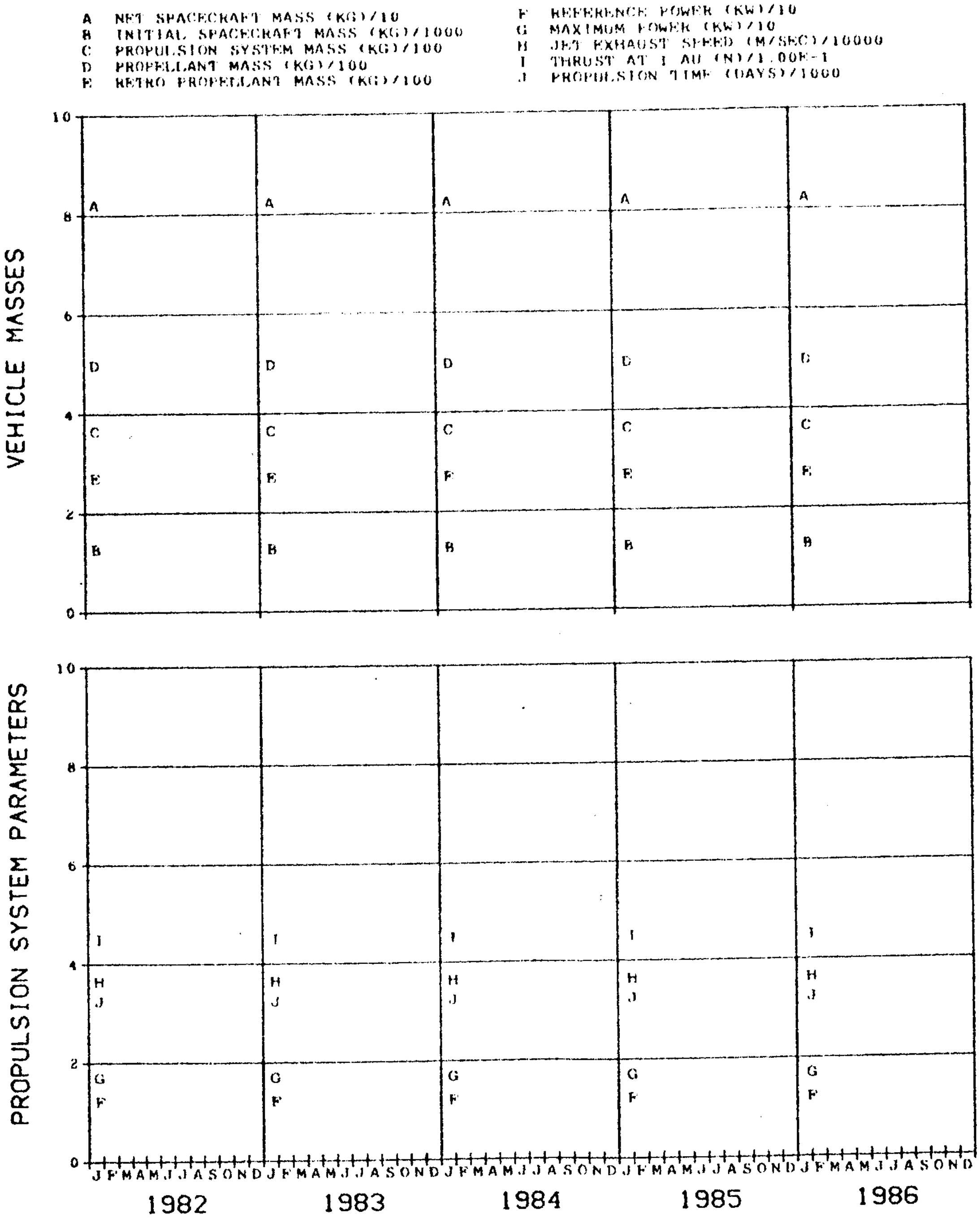

FIG. 39C. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4500 DAYS

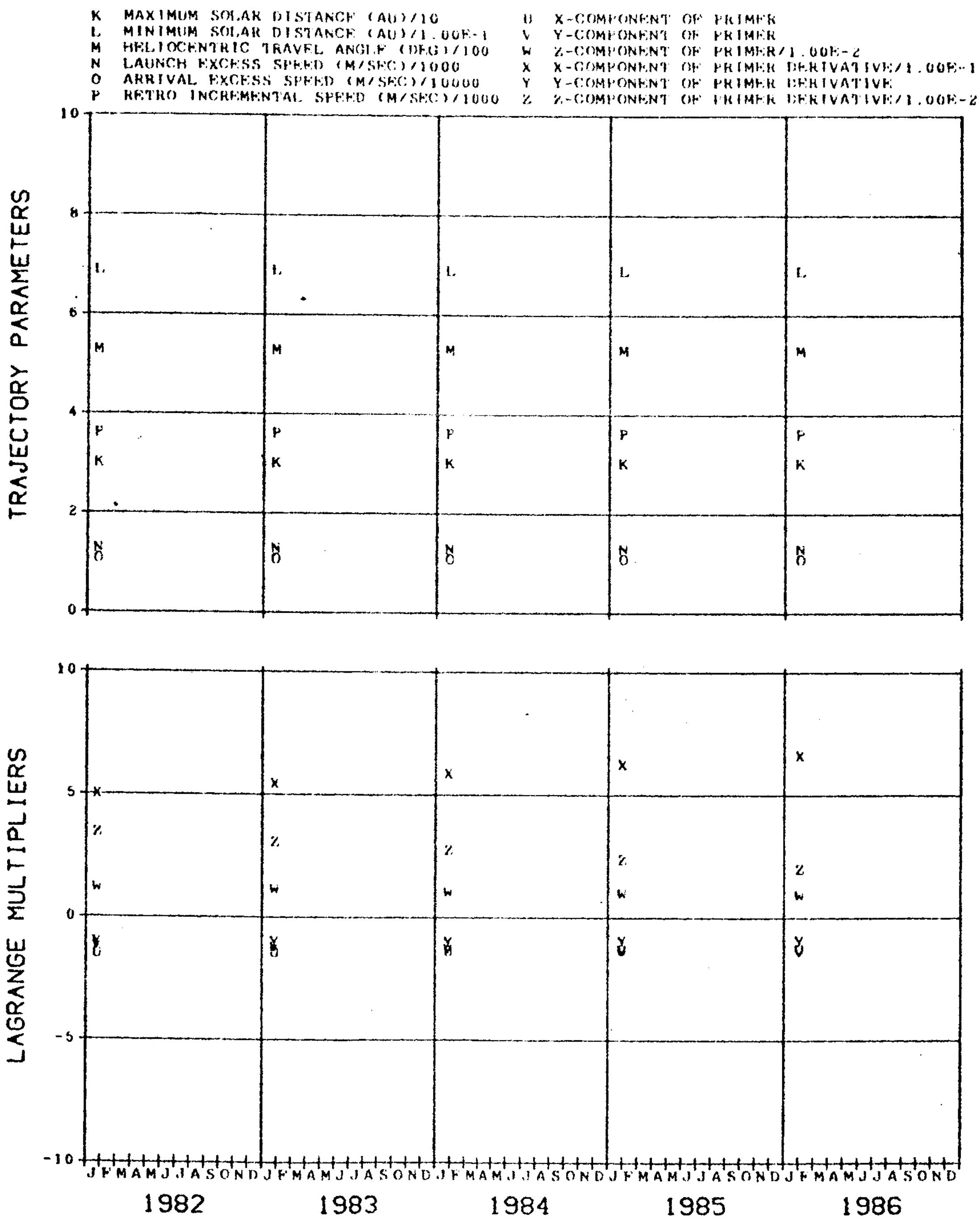

FIG. 39C. (CONCLUDED)

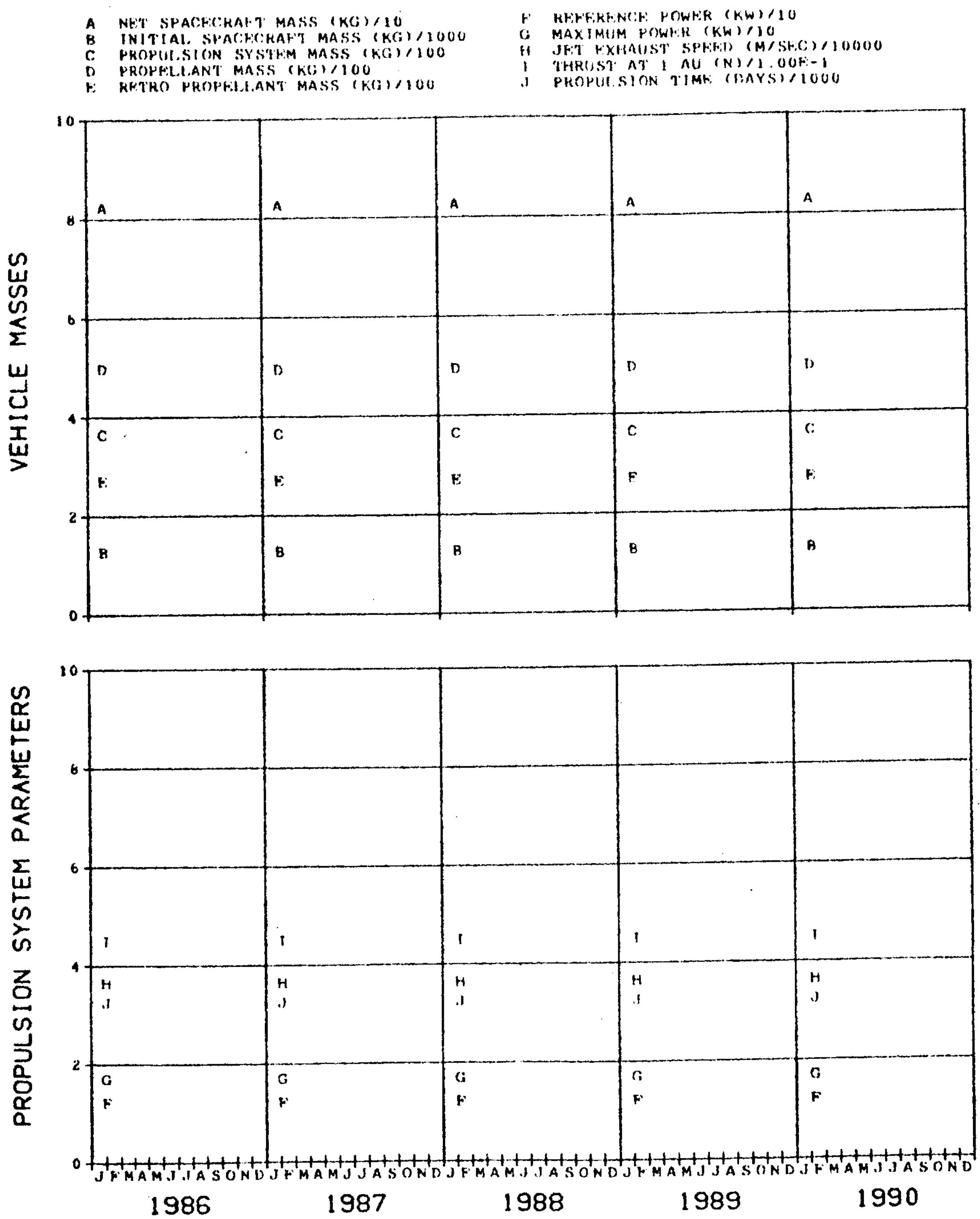

FIG. 39D. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 4500 DAYS

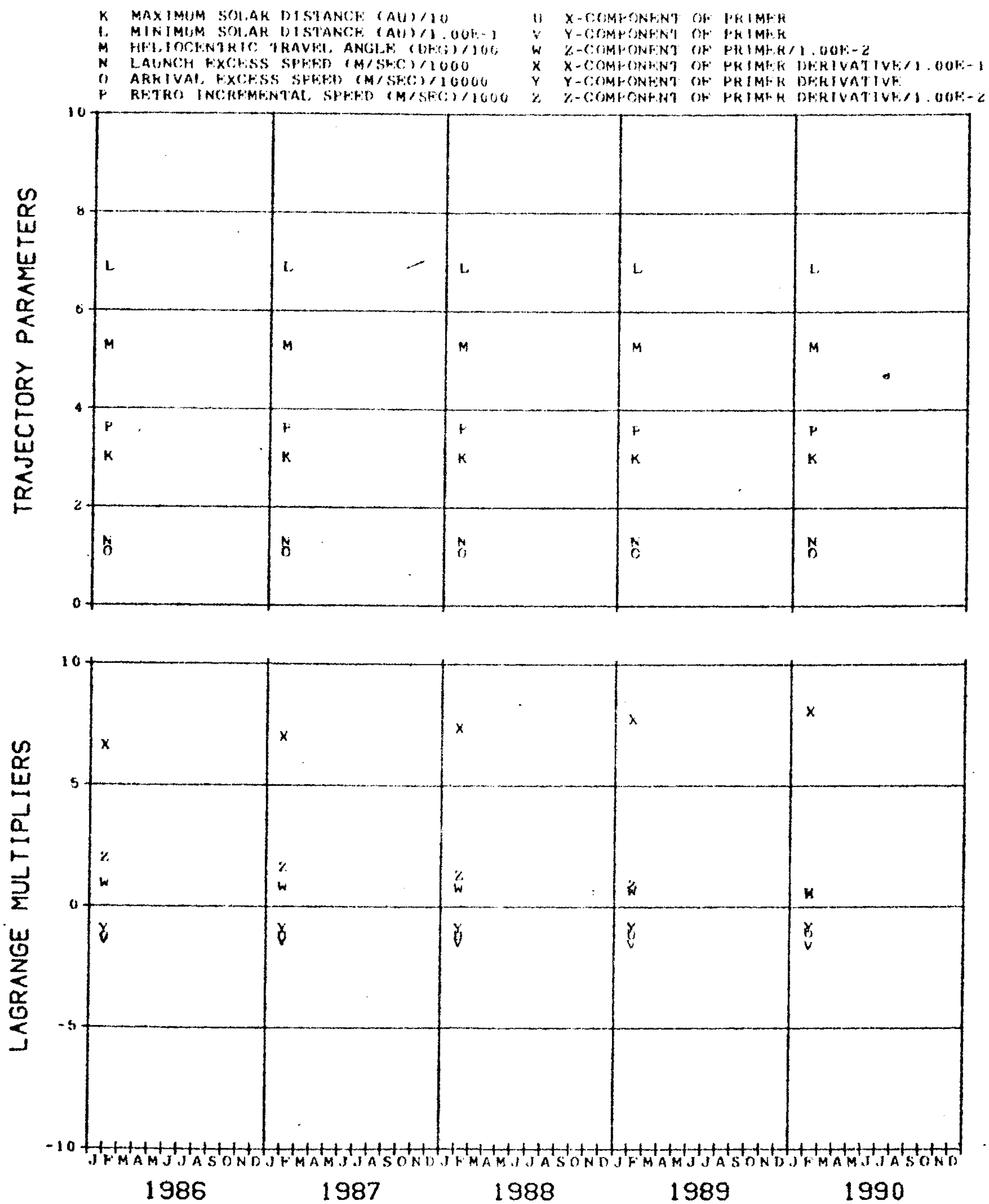

FIG. 39D. (CONCLUDED)

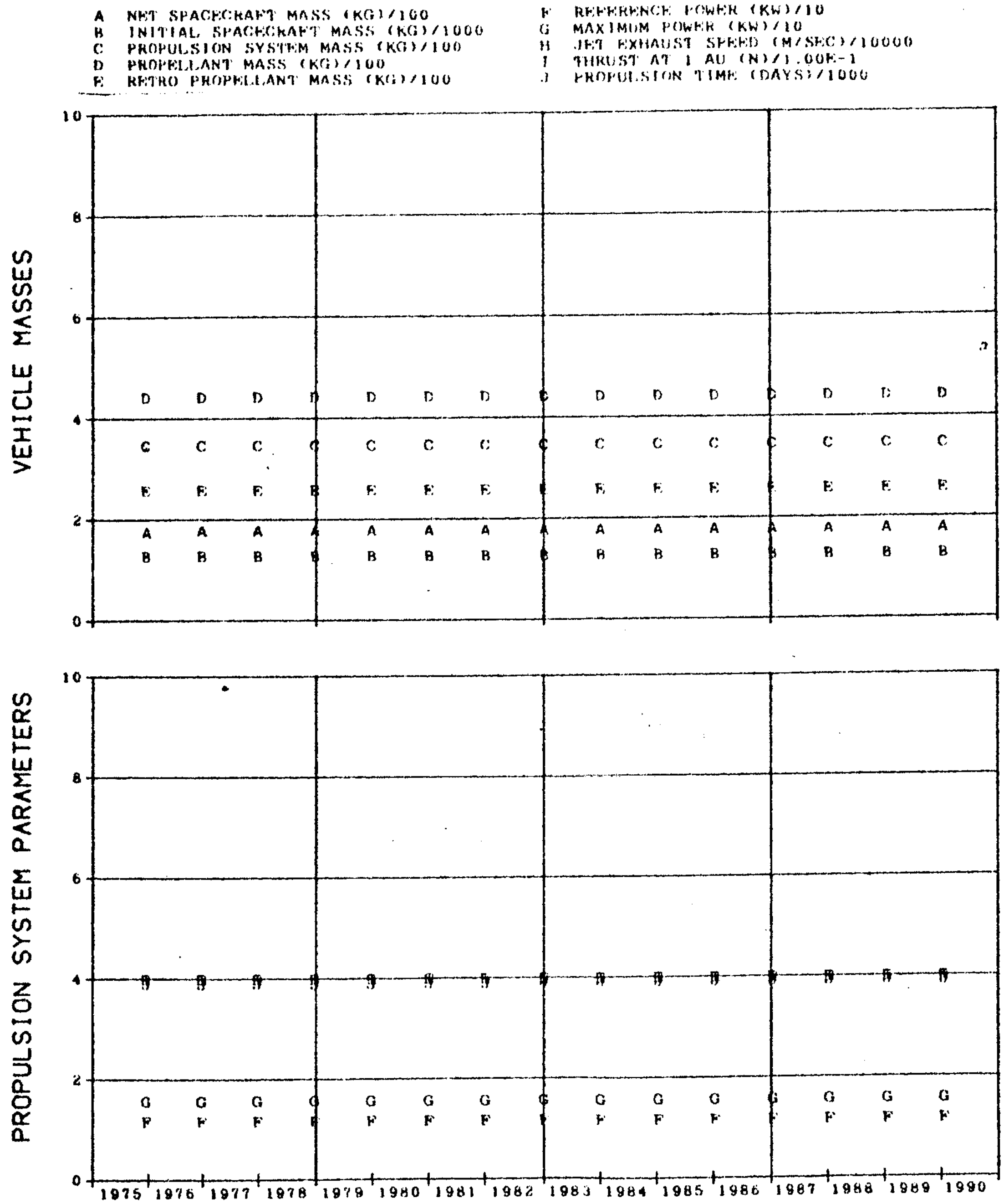

FIG. 40. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

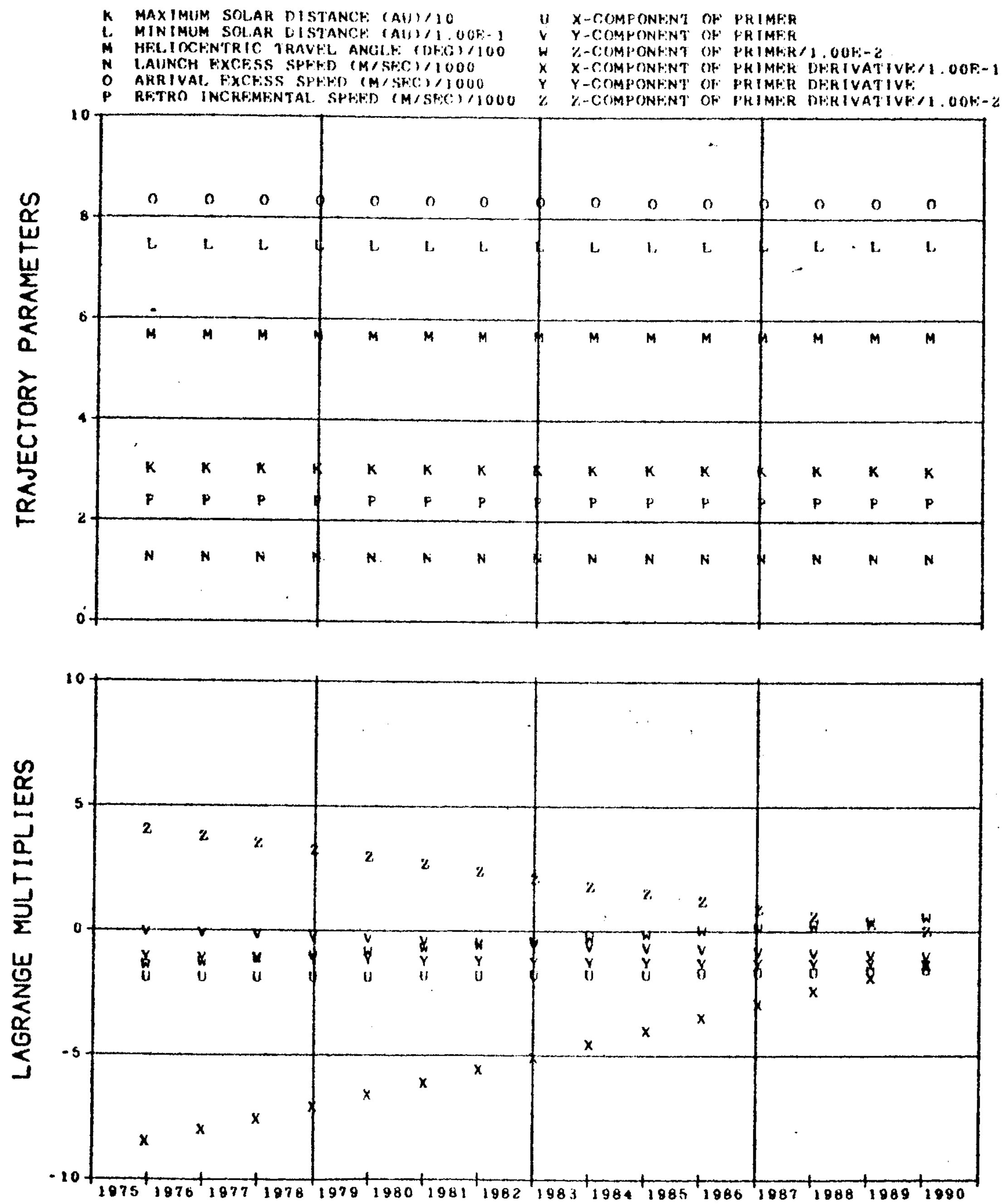

FIG. 40. (CONCLUDED)

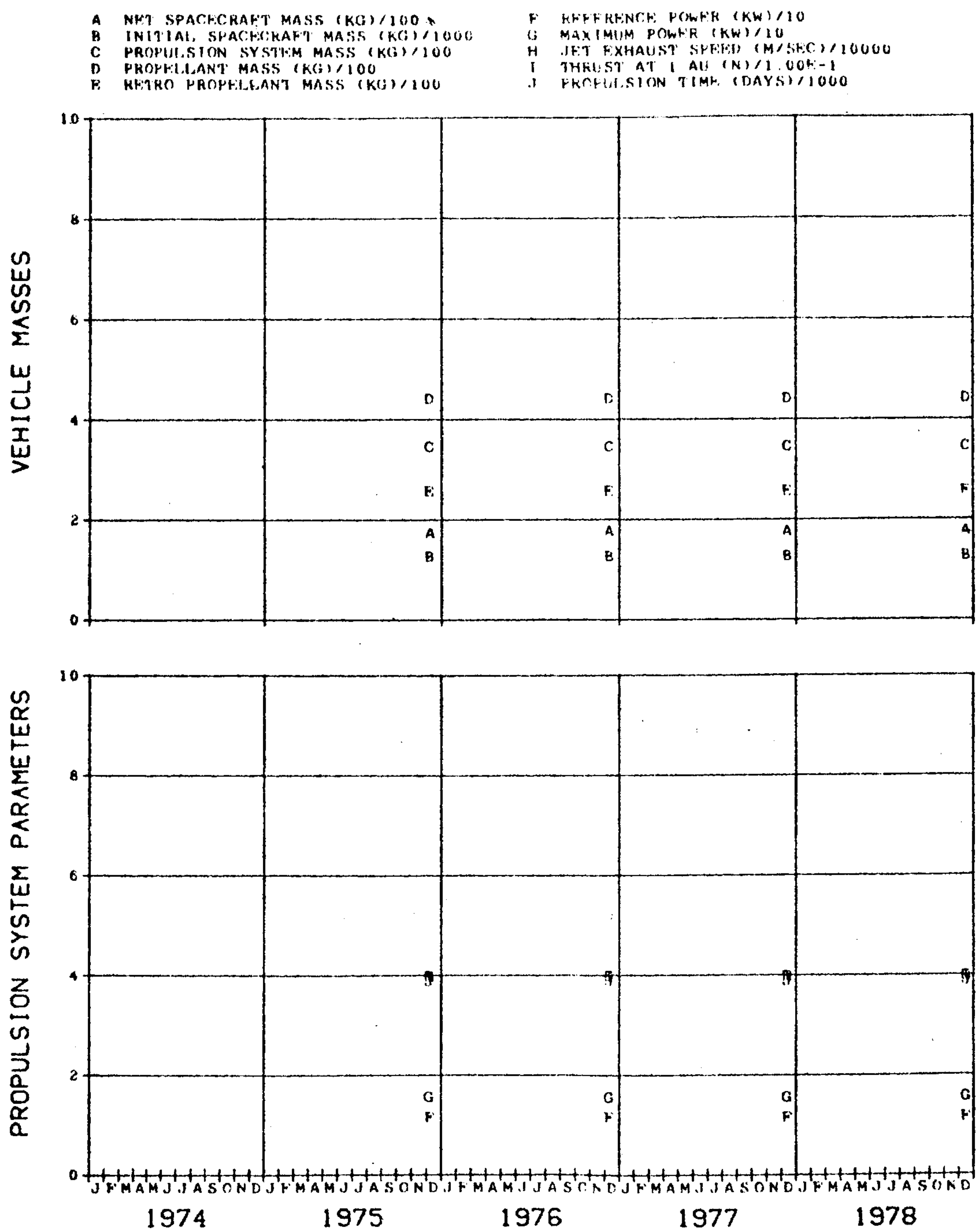

FIG. 40A. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

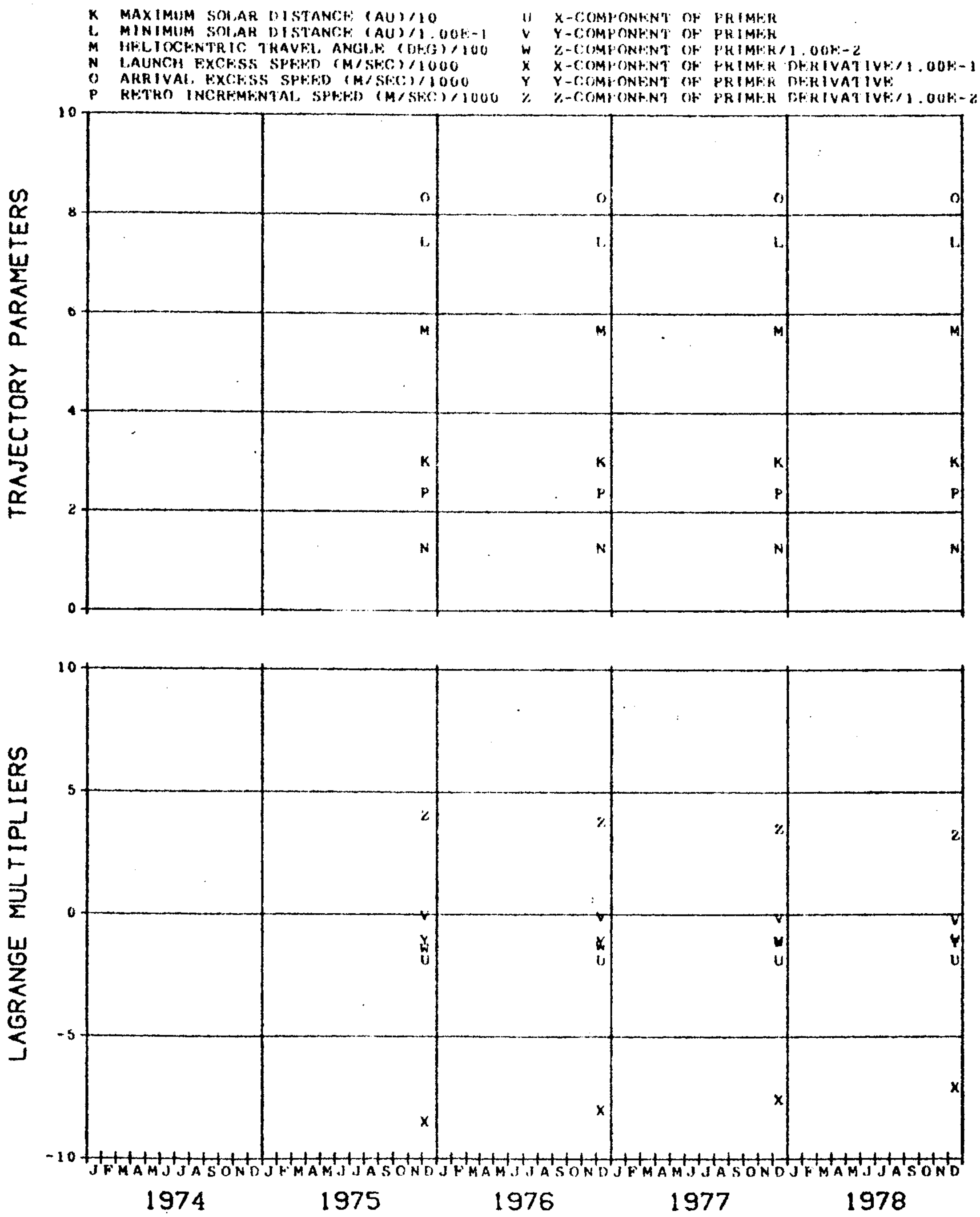

FIG. 40A. (CONCLUDED)

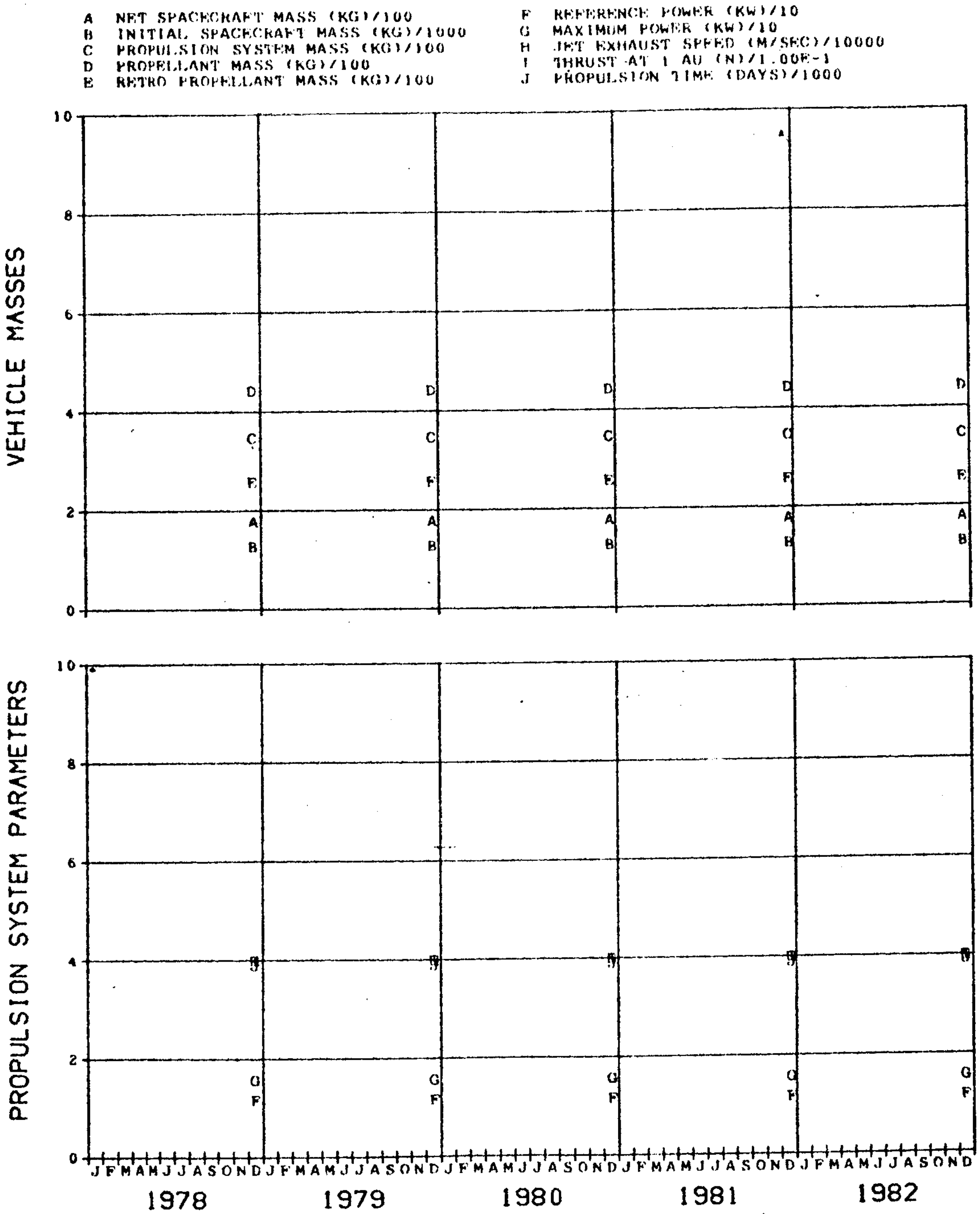

FIG. 40B. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

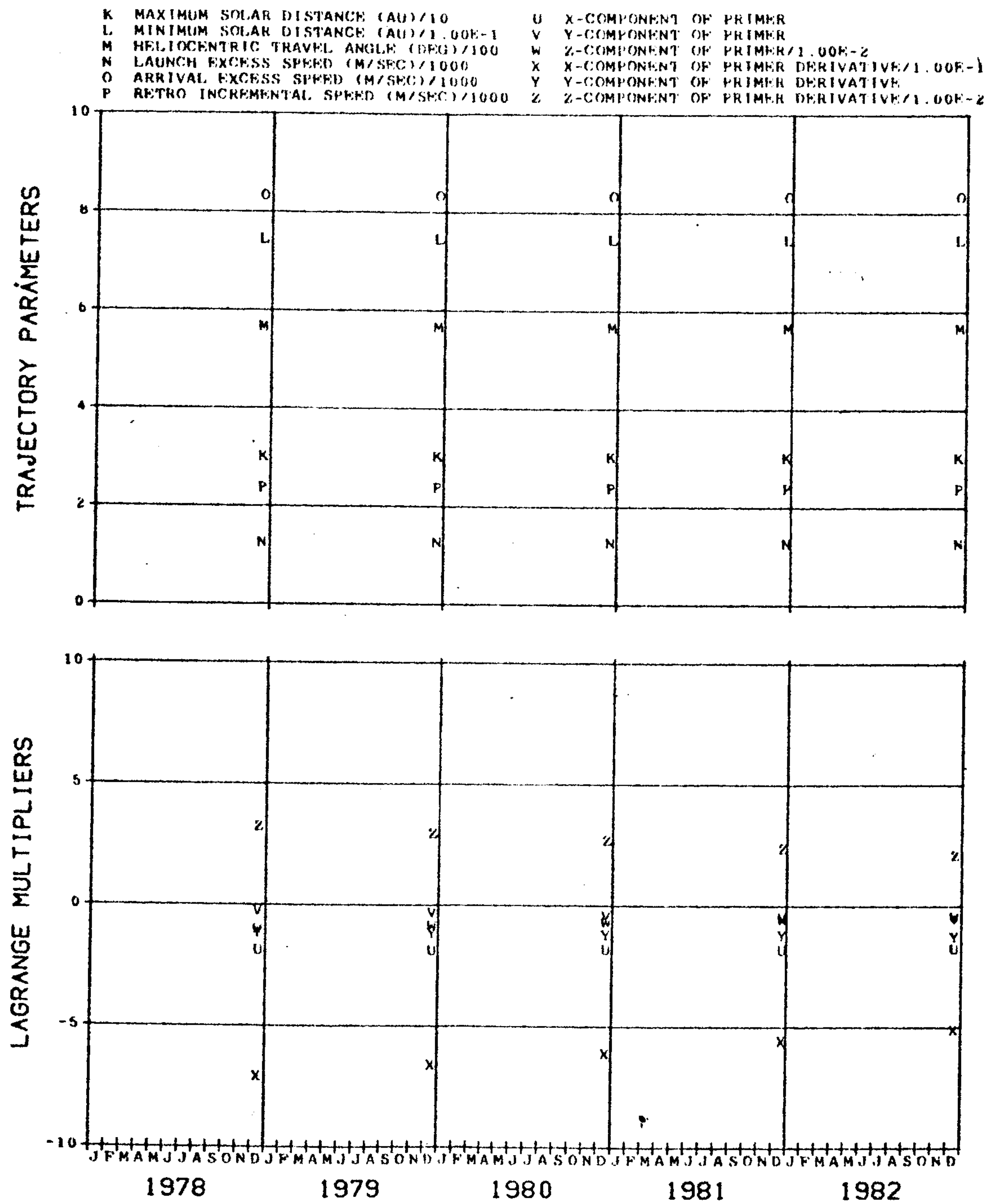

FIG. 40B. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/1000

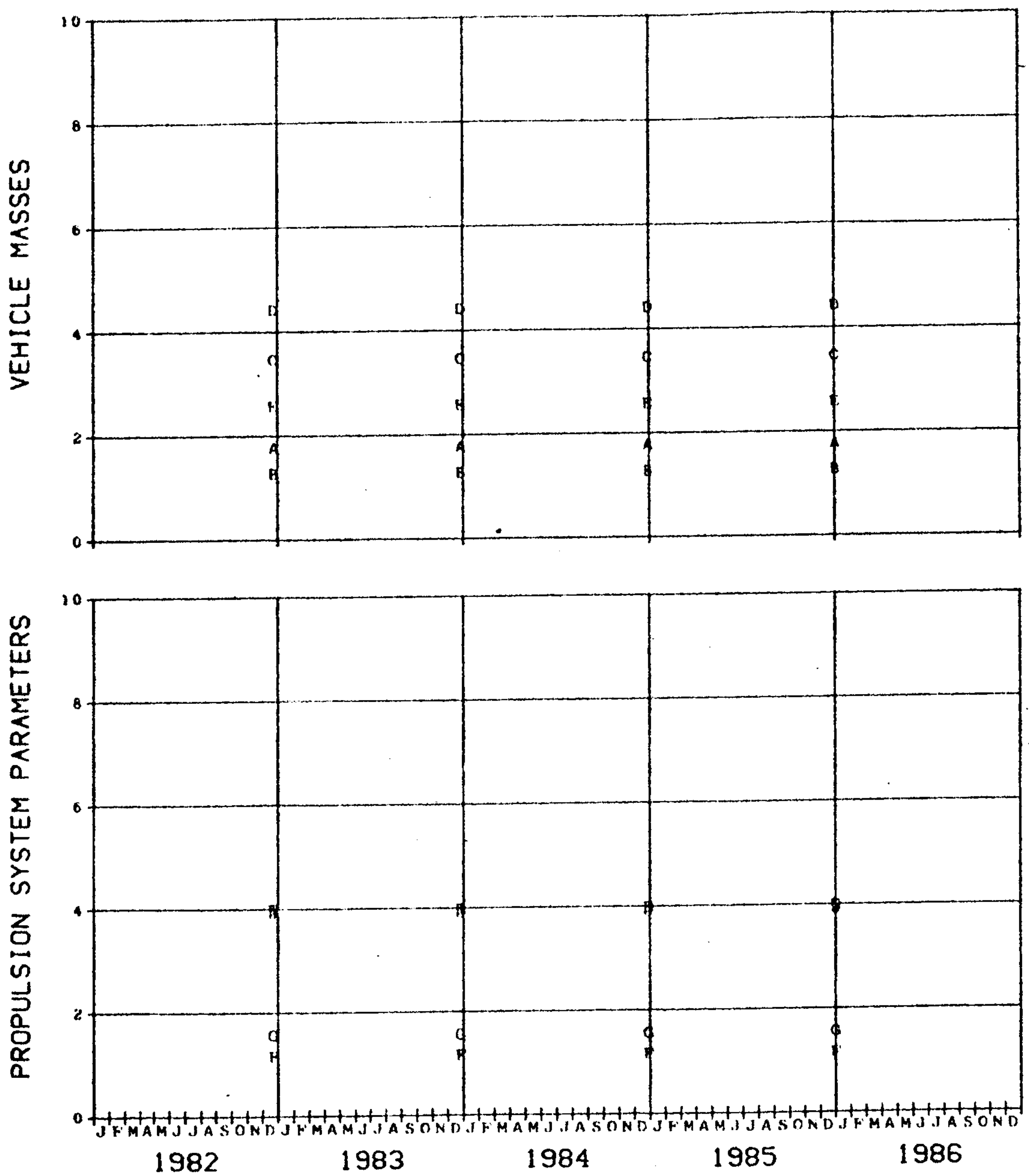

FIG. 40C. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

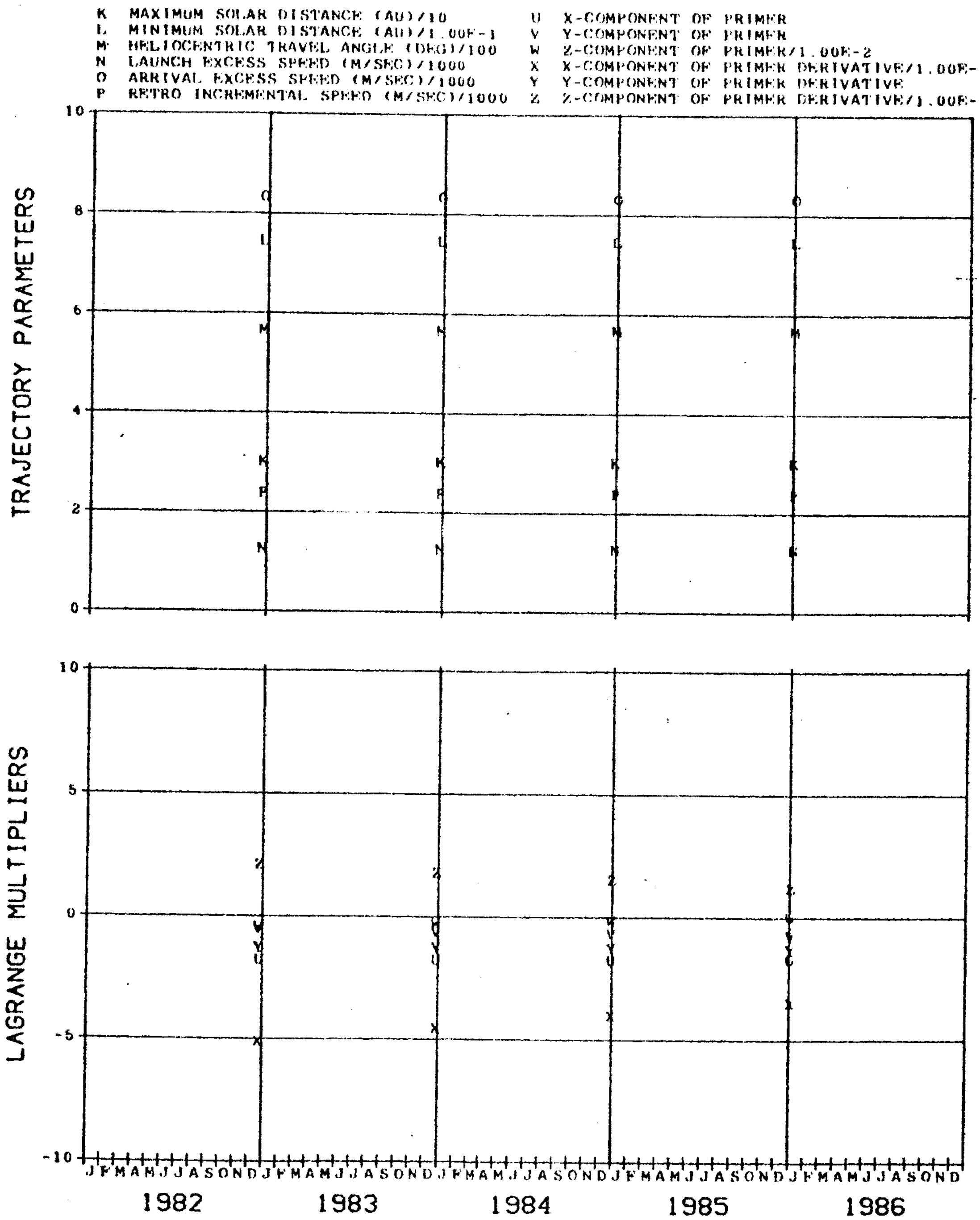

FIG. 40C. (CONCLUDED)

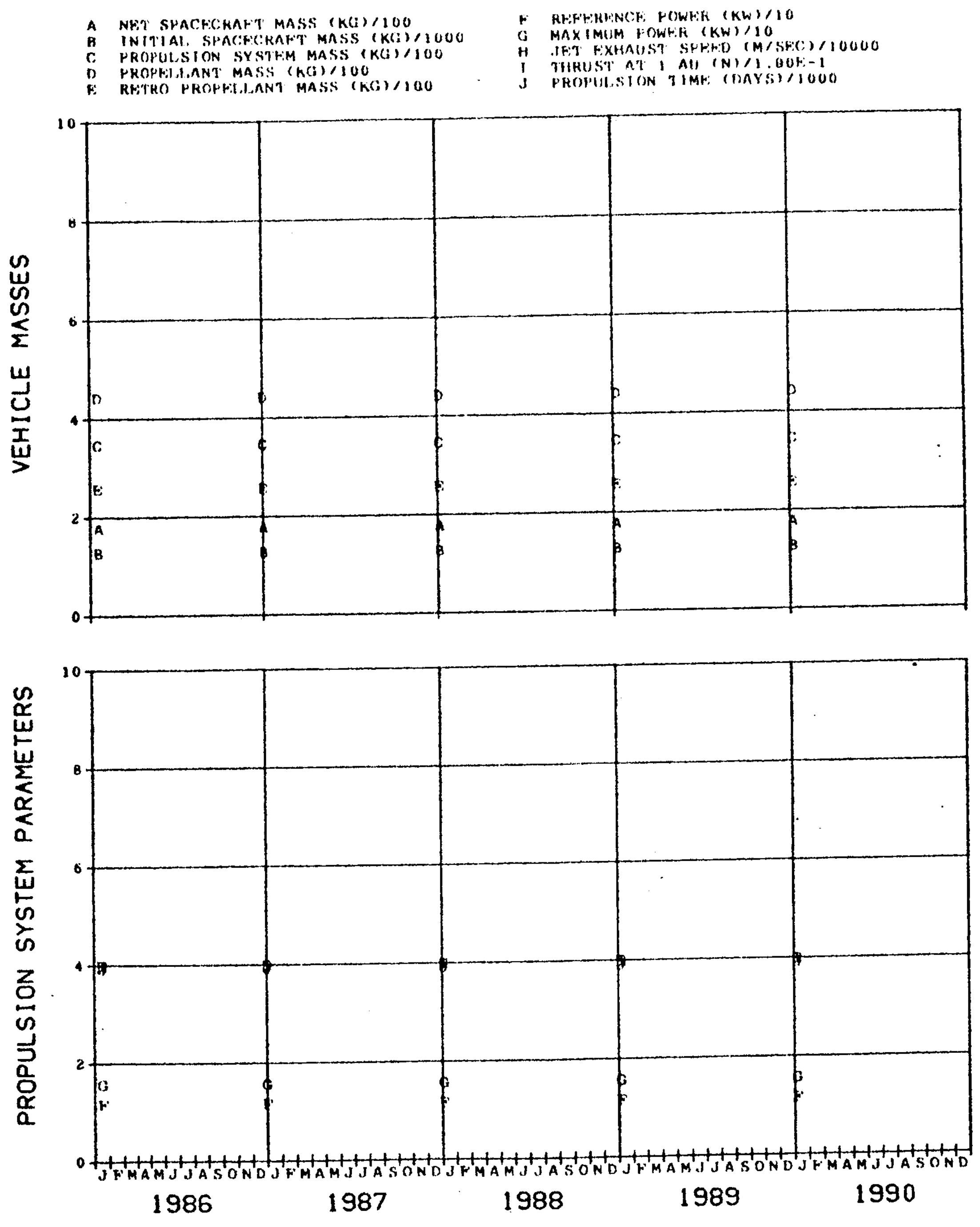

FIG. 40D. NEPTUNE MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

XXXX 402

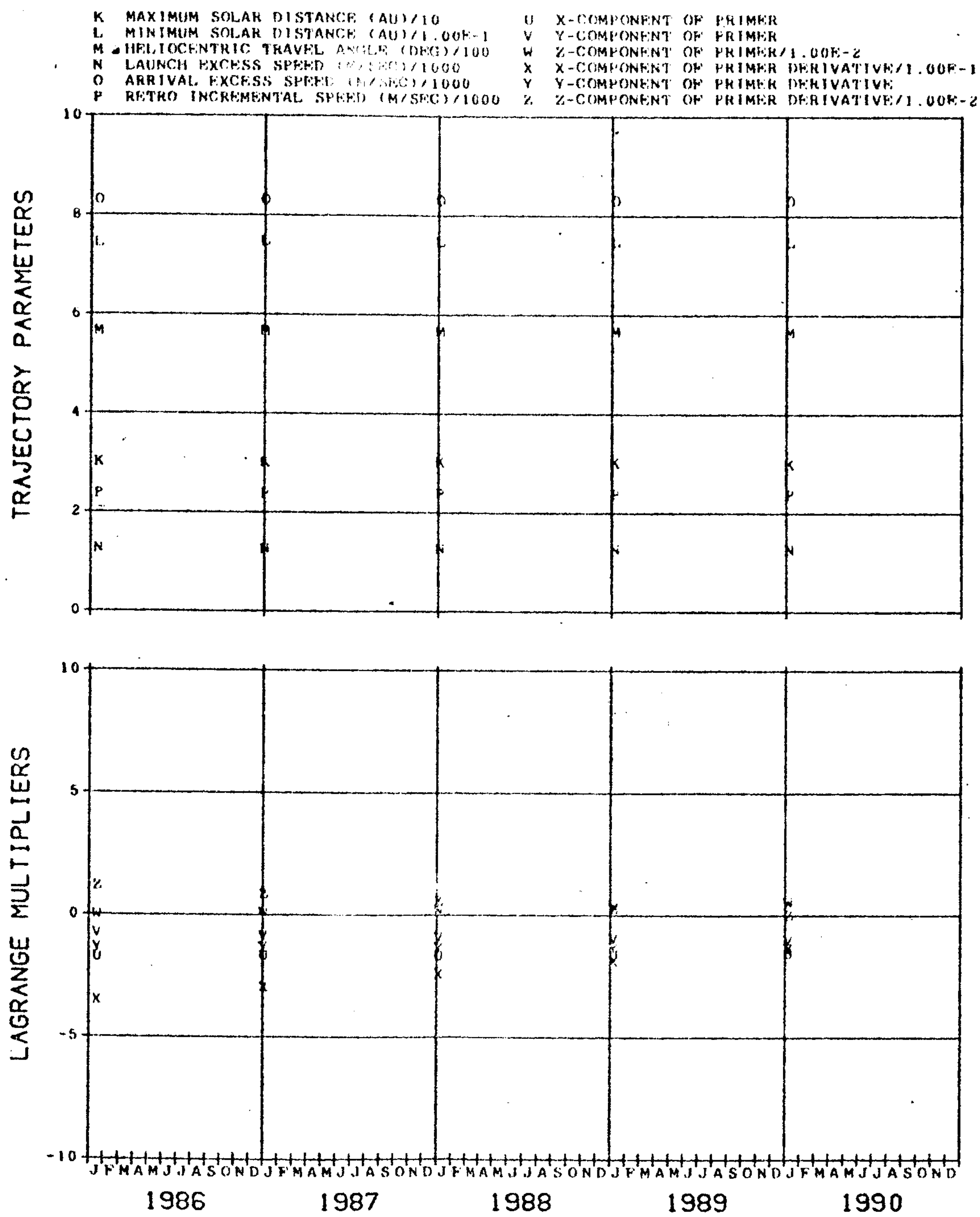

FIG. 40D. (CONCLUDED)

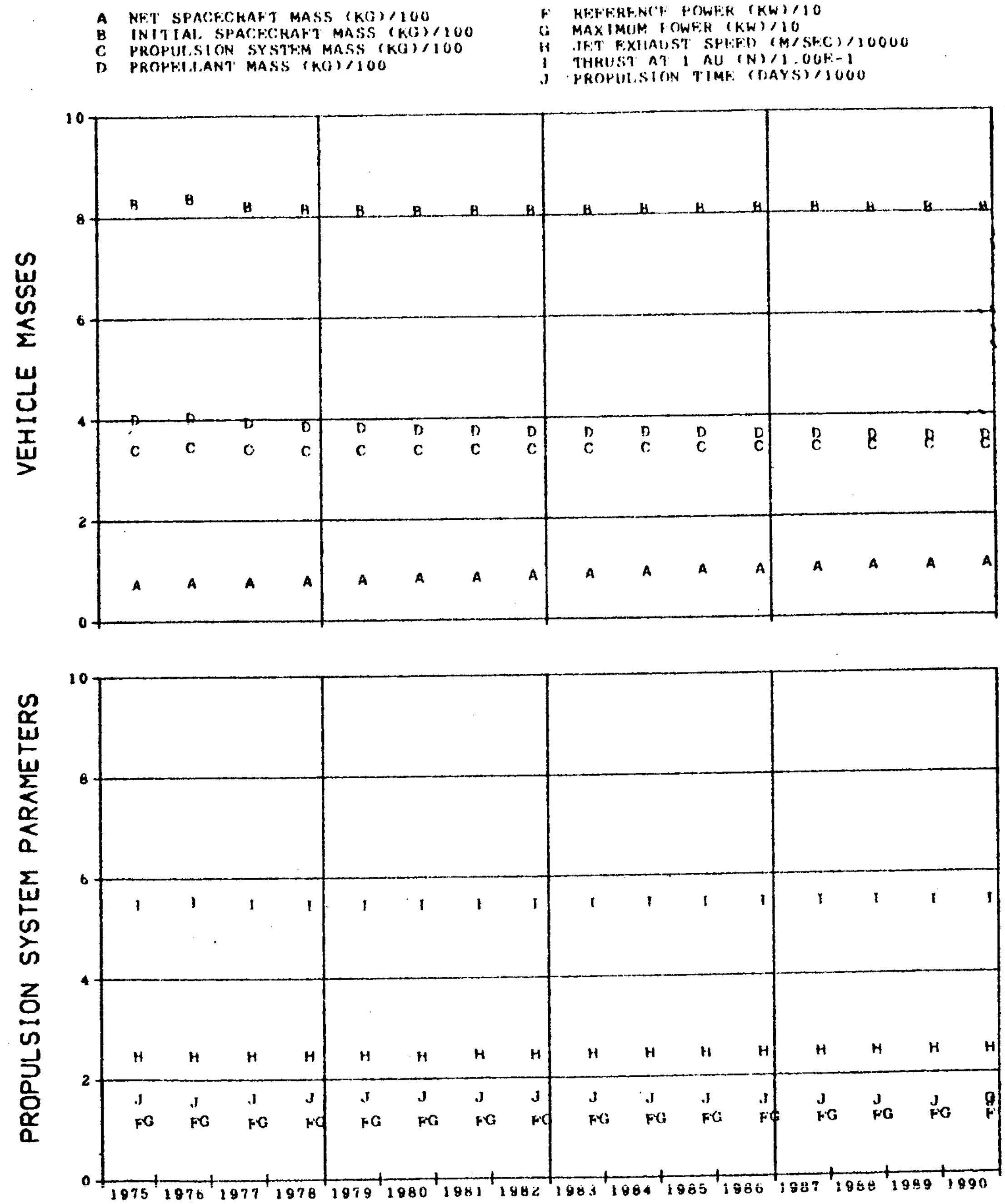

FIG. 41. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3500 DAYS

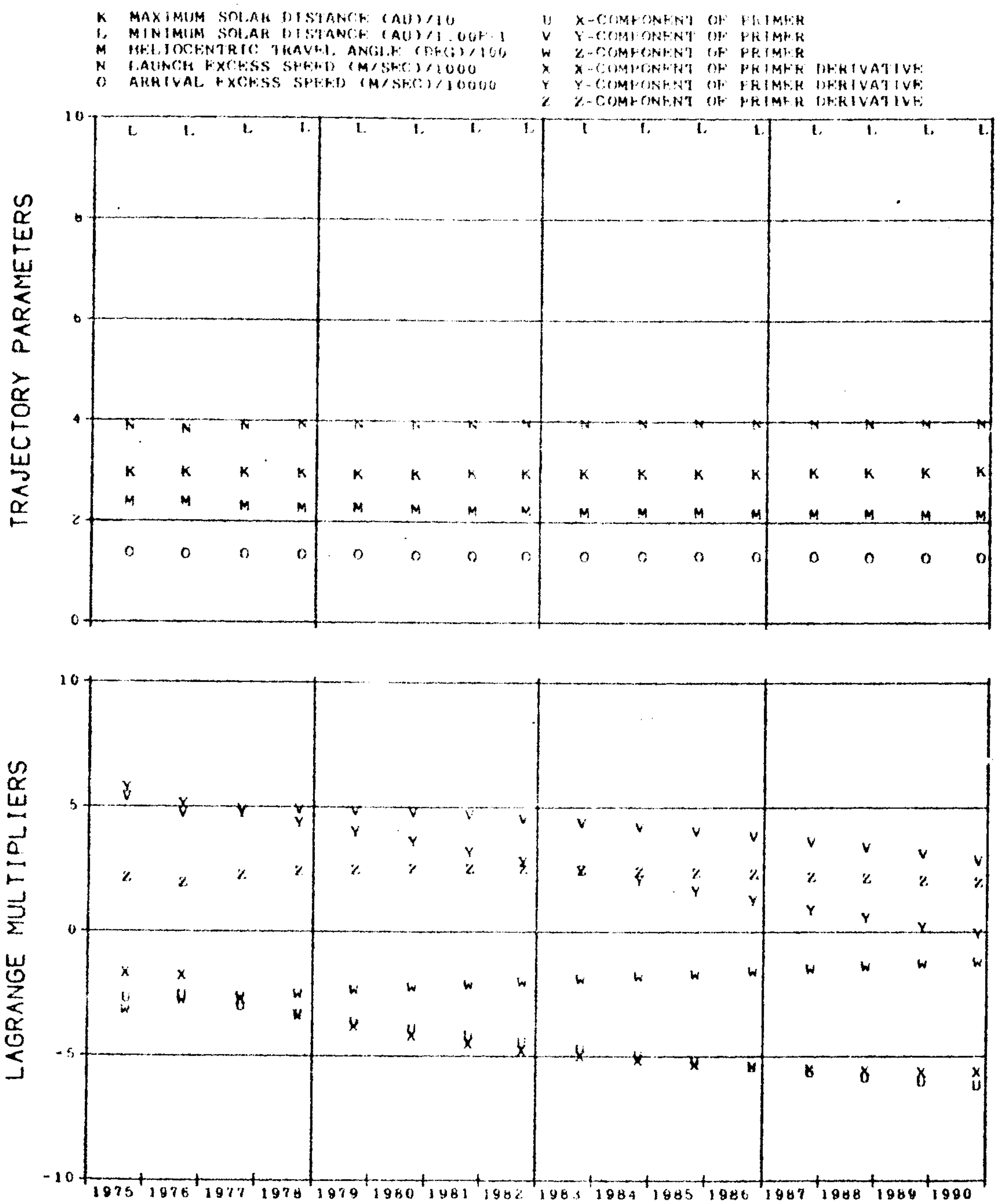

FIG. 41. (CONCLUDED)

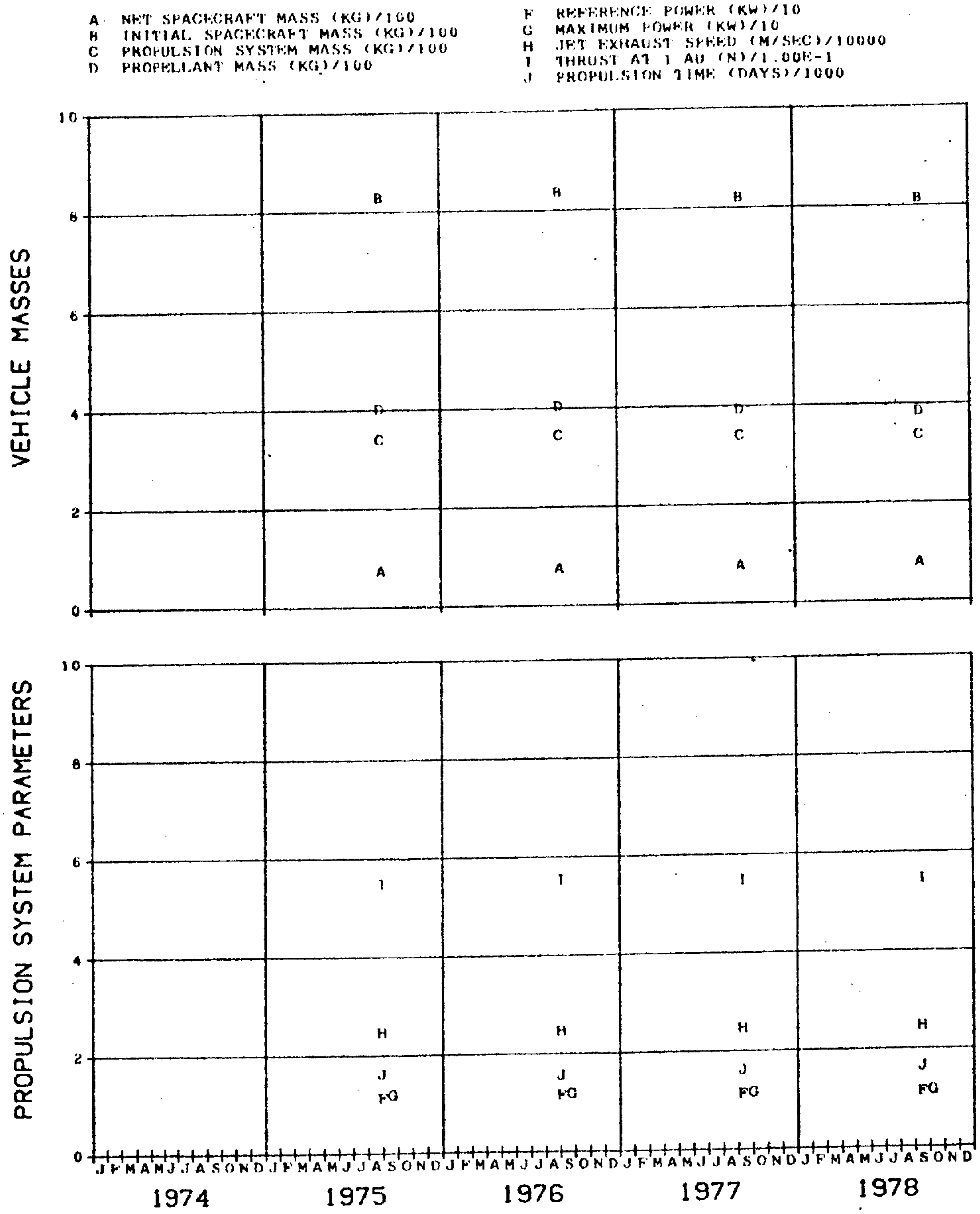

FIG. 41A. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3500 DAYS

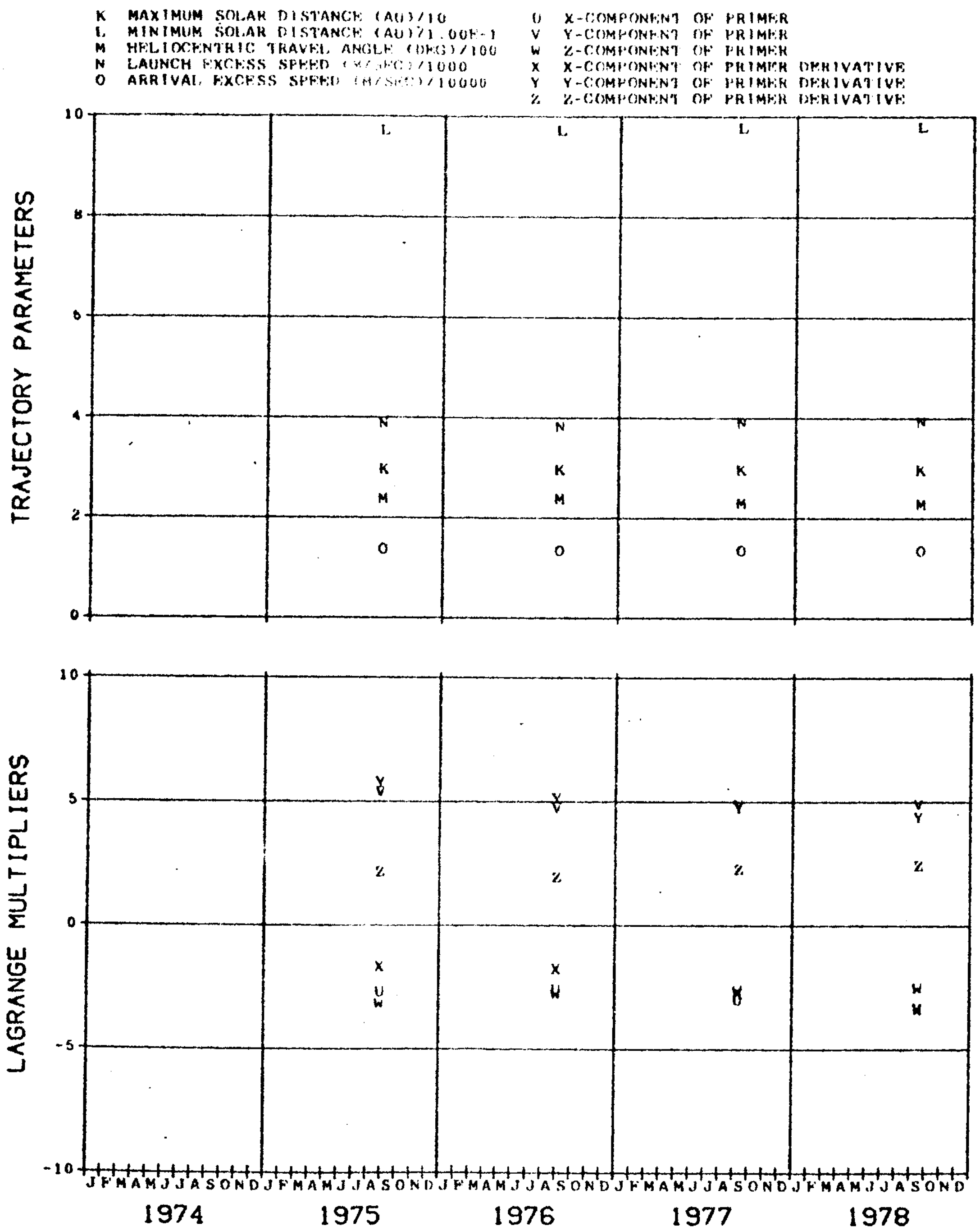

FIG. 41A. (CONCLUDED)

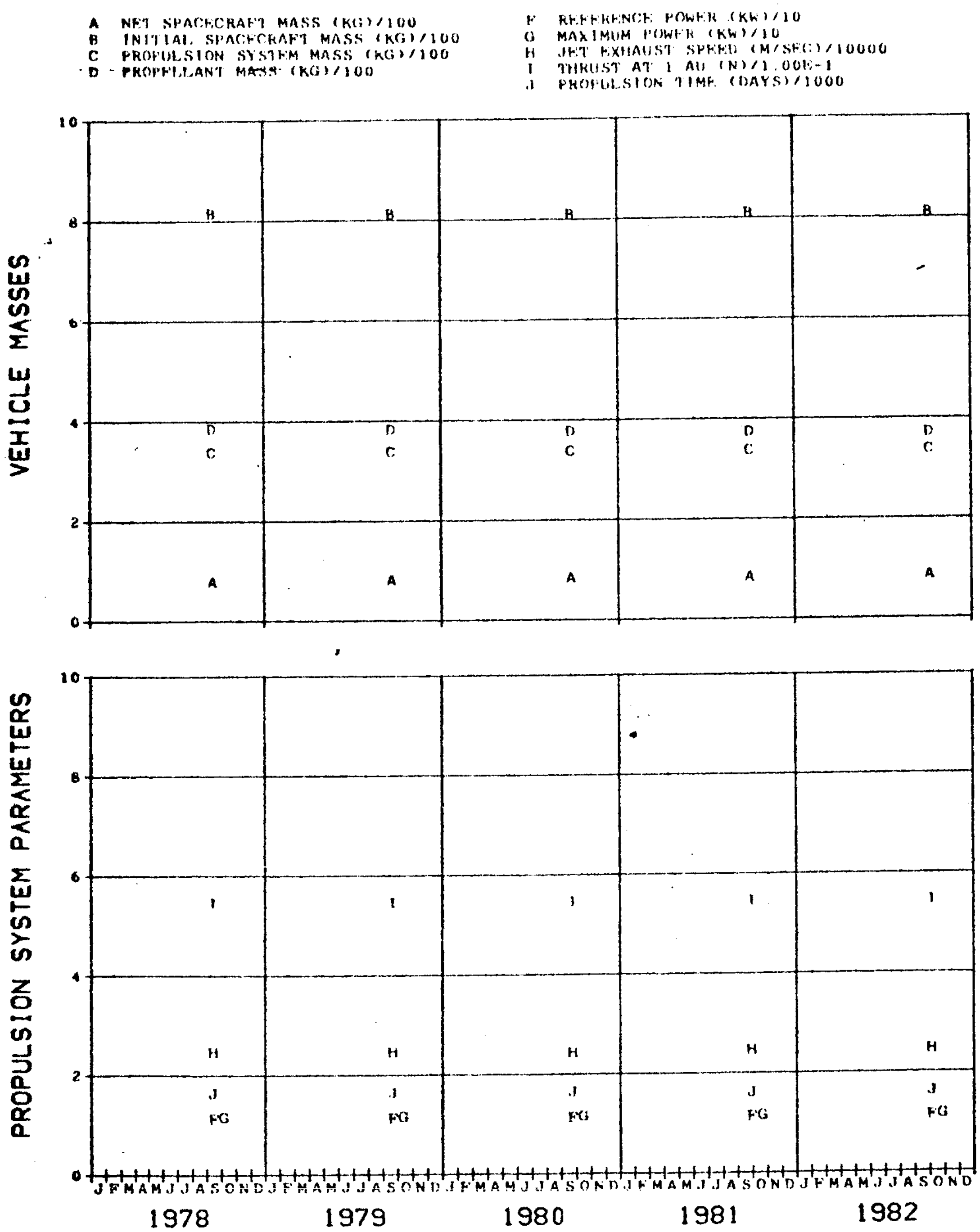

FIG. 41B. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3500 DAYS

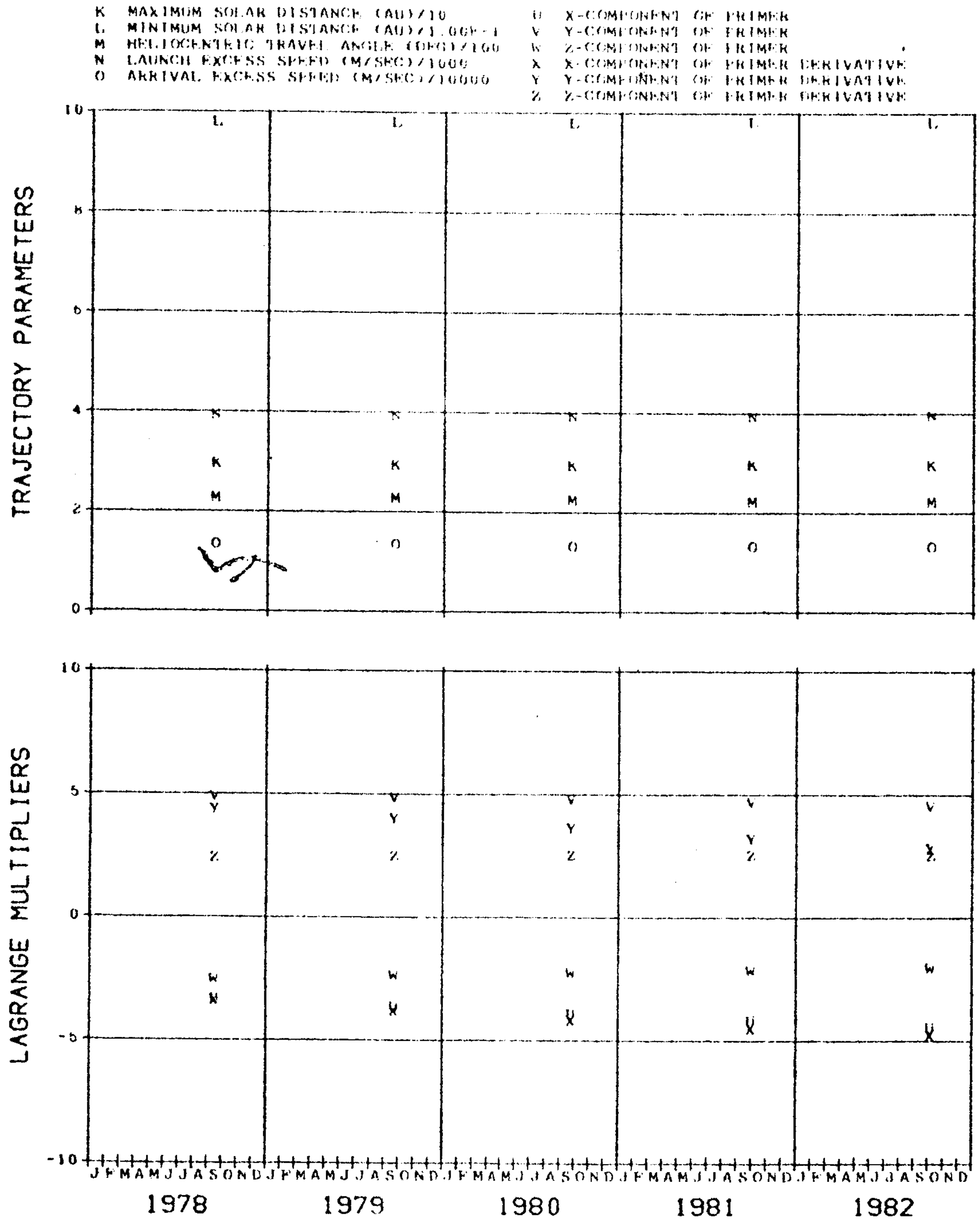

FIG. 41B. (CONCLUDED)

XXXX 409

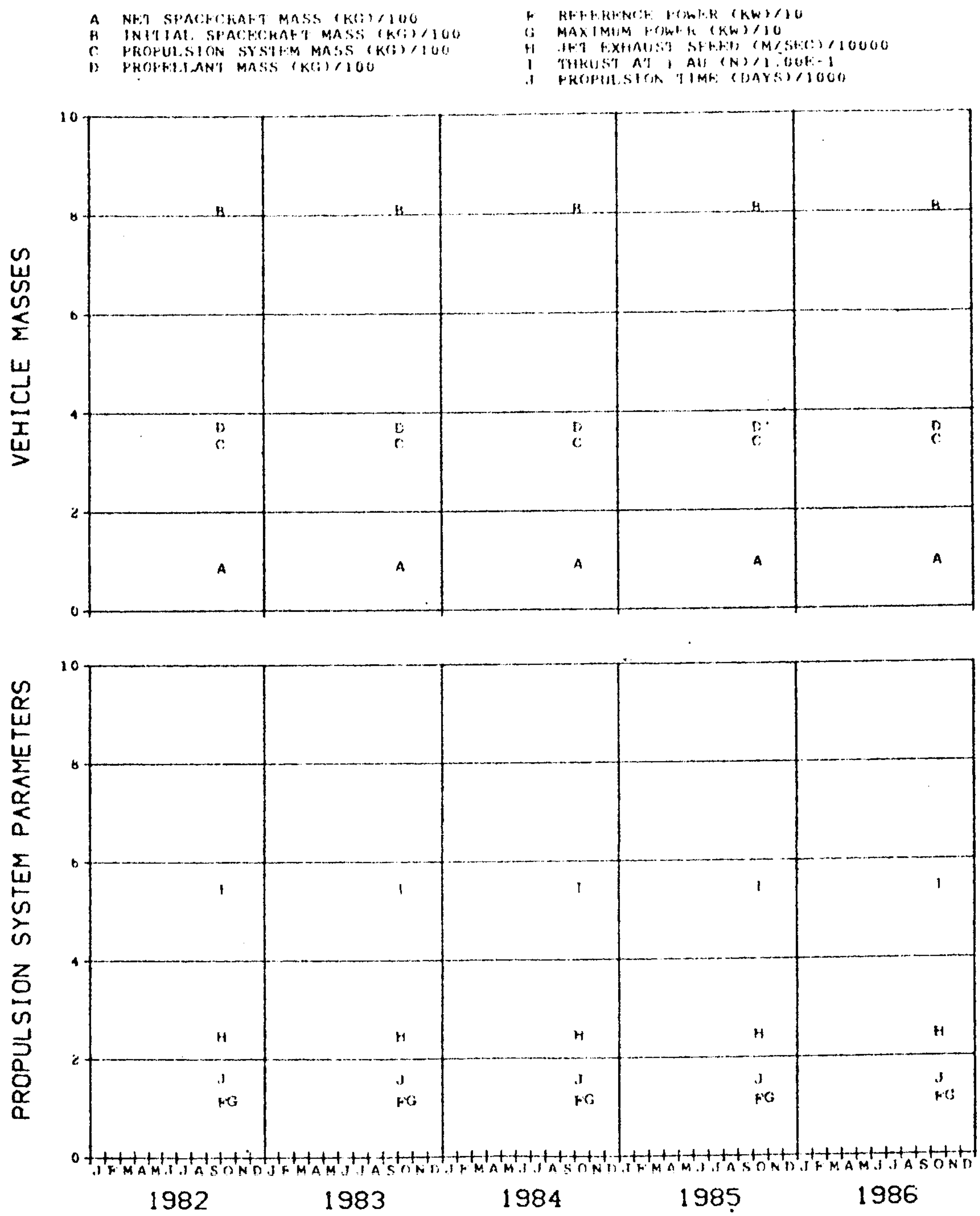

FIG. 41C. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3500 DAYS

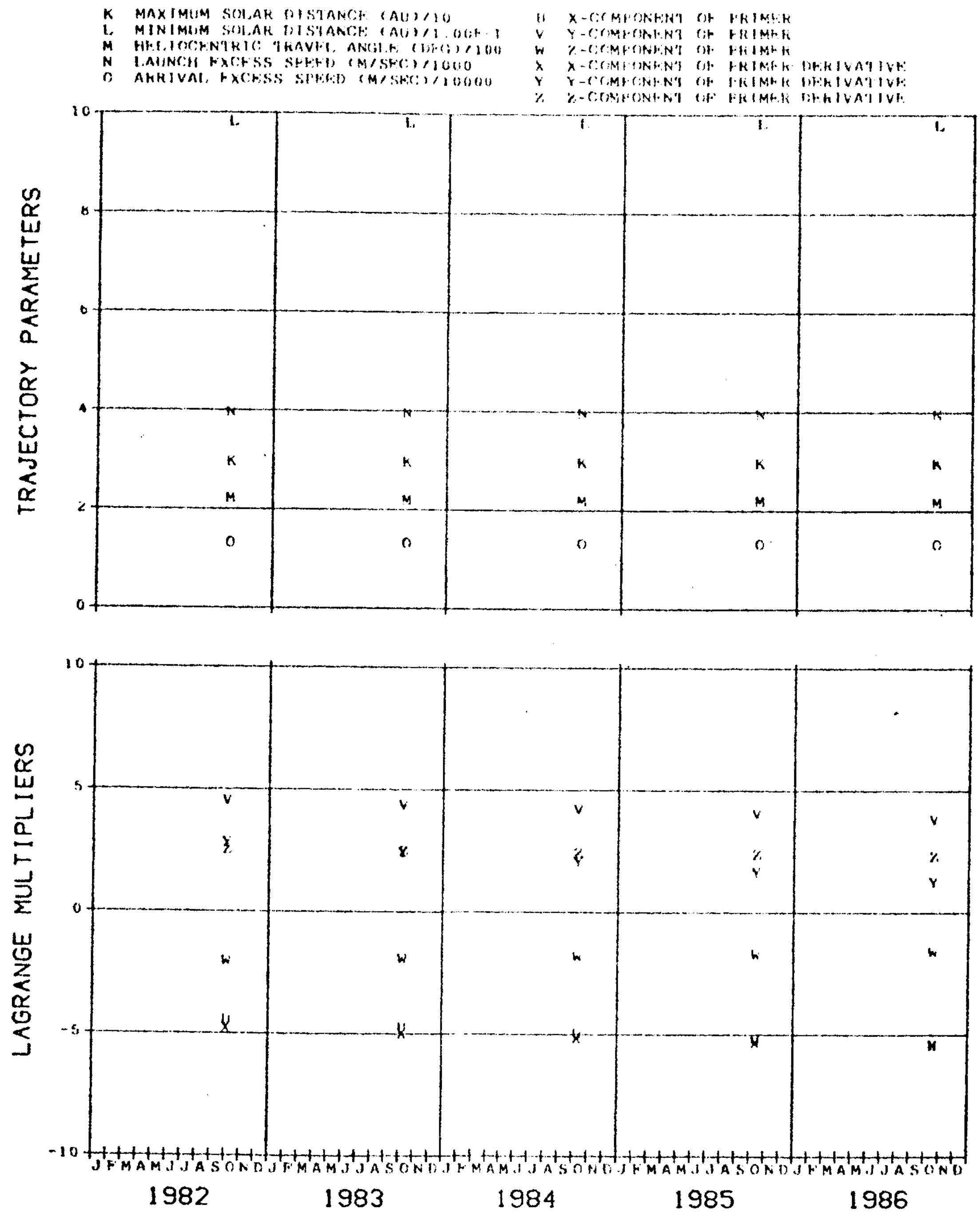

FIG. 41C. (CONCLUDED)

XXXX 411

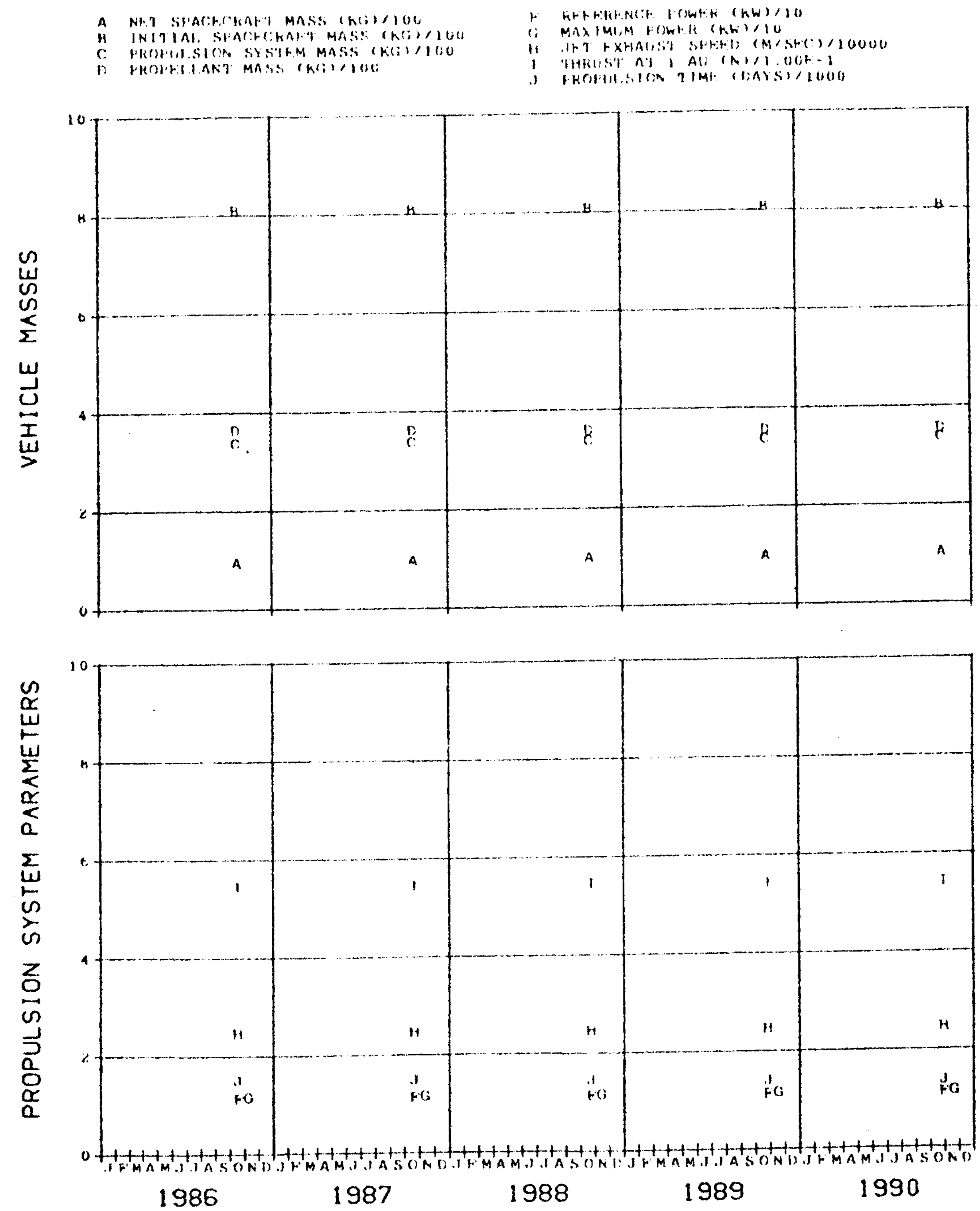

FIG. 41D. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 3500 DAYS

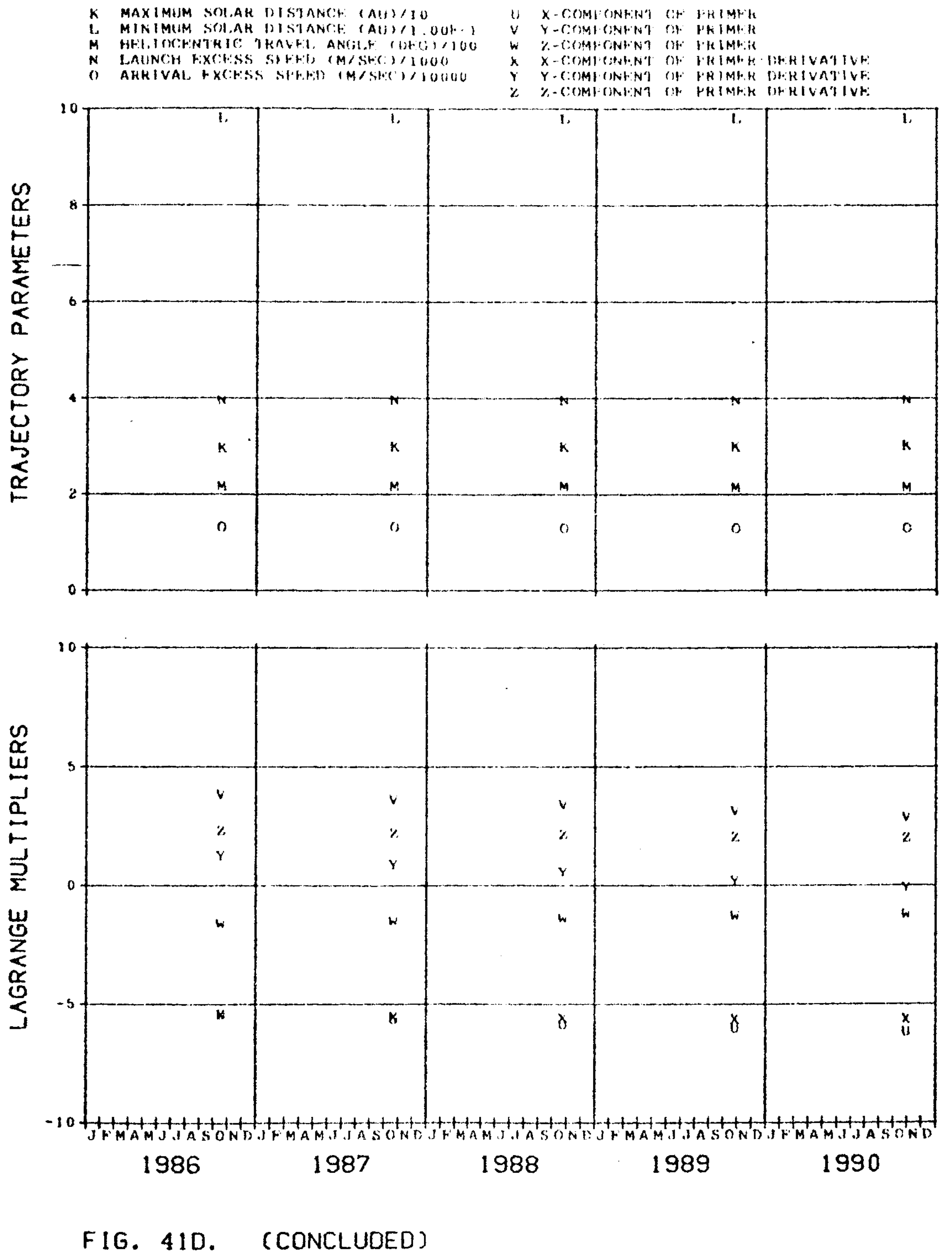

FIG. 41D. (CONCLUDED)

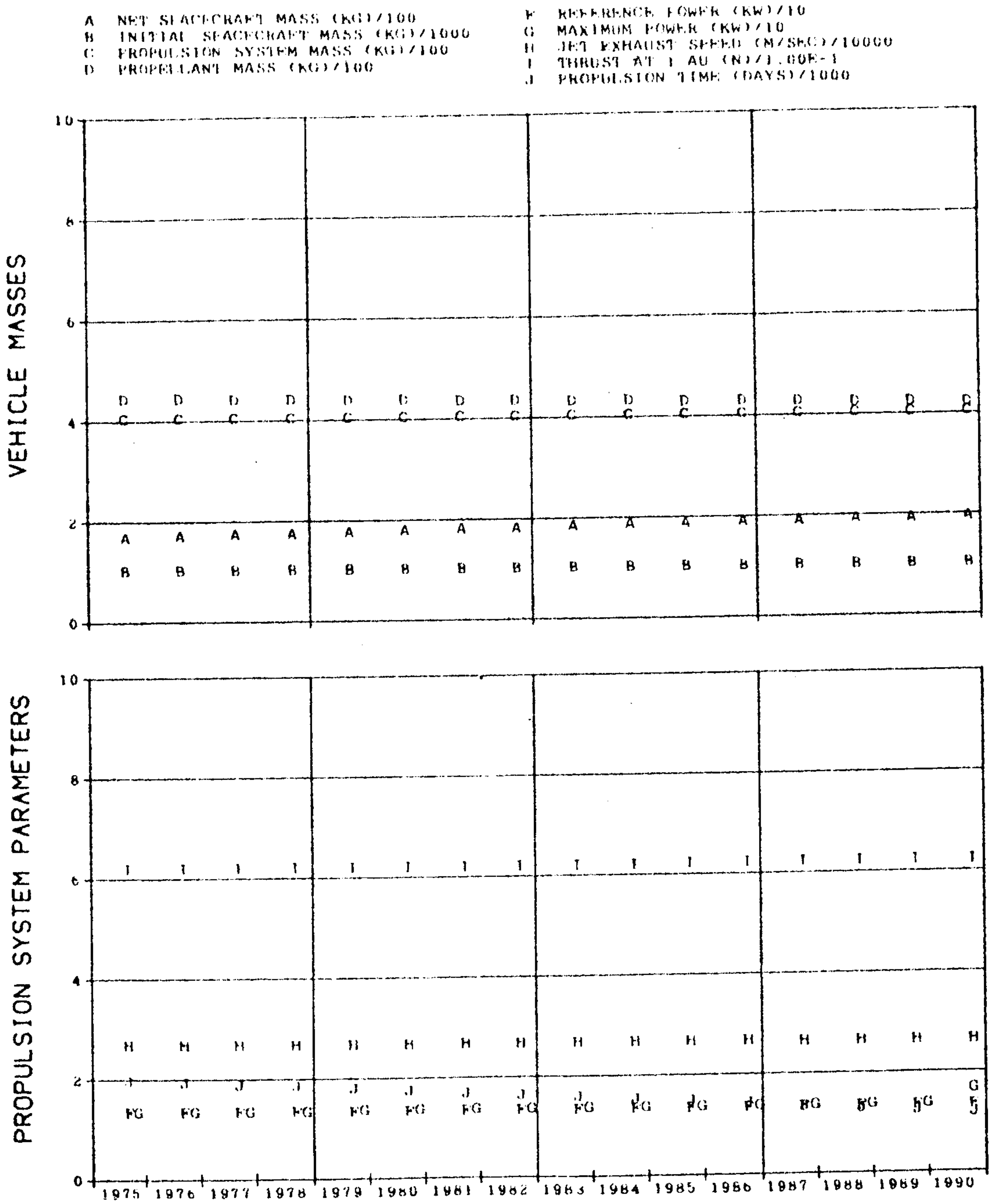

FIG. 42. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

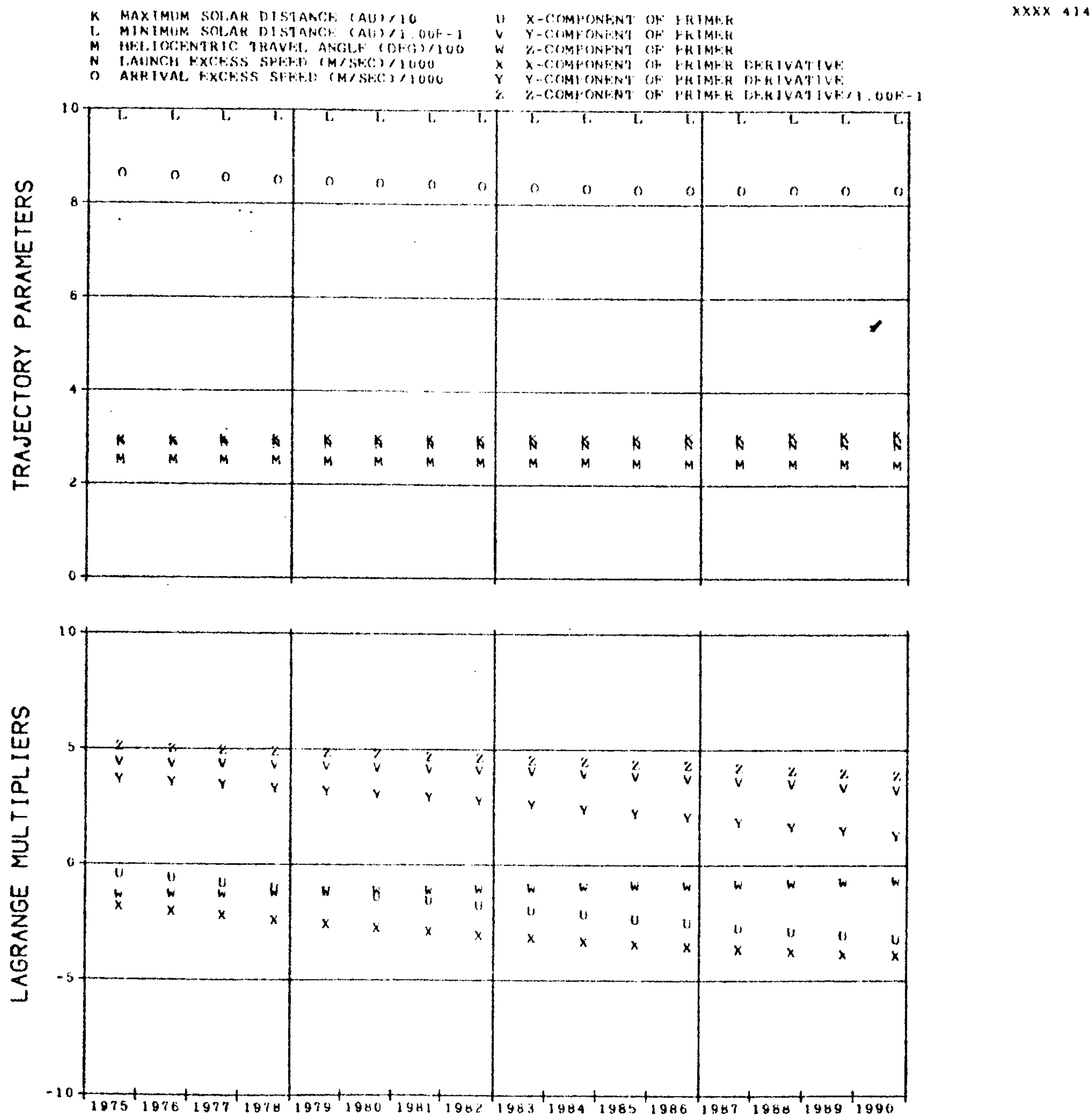

FIG. 42. (CONCLUDED)

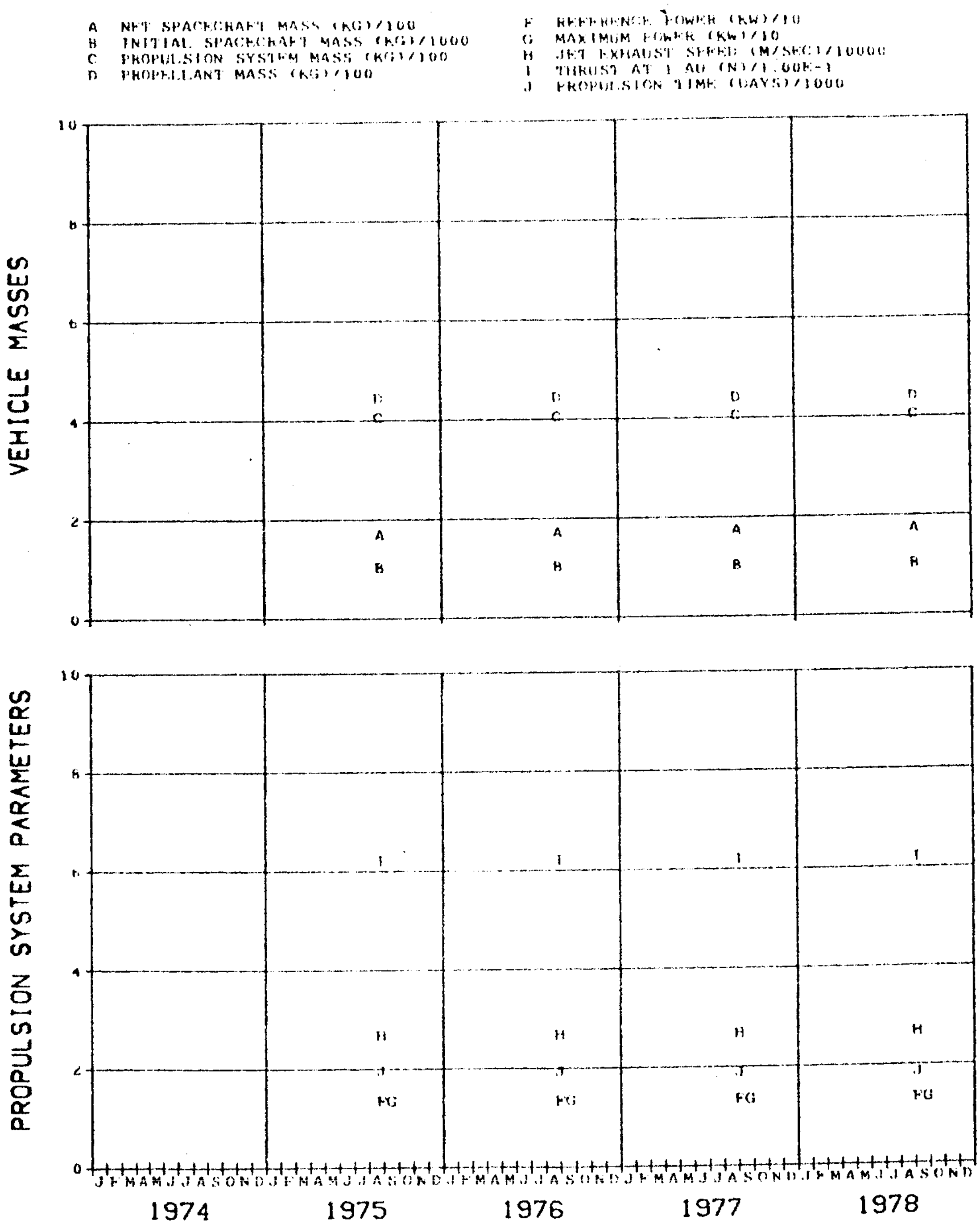

FIG. 42A. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

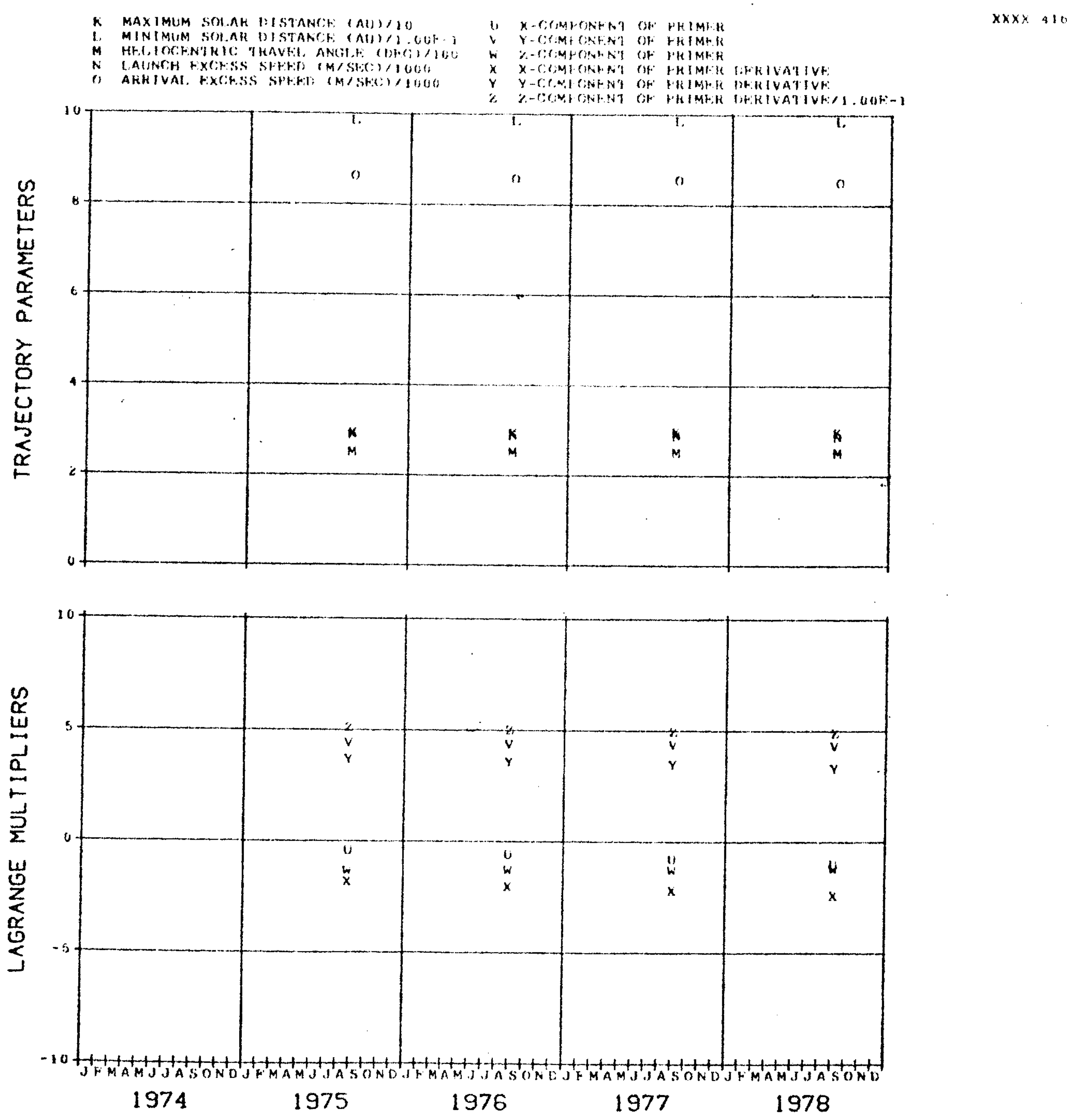

FIG. 42A. (CONCLUDED)

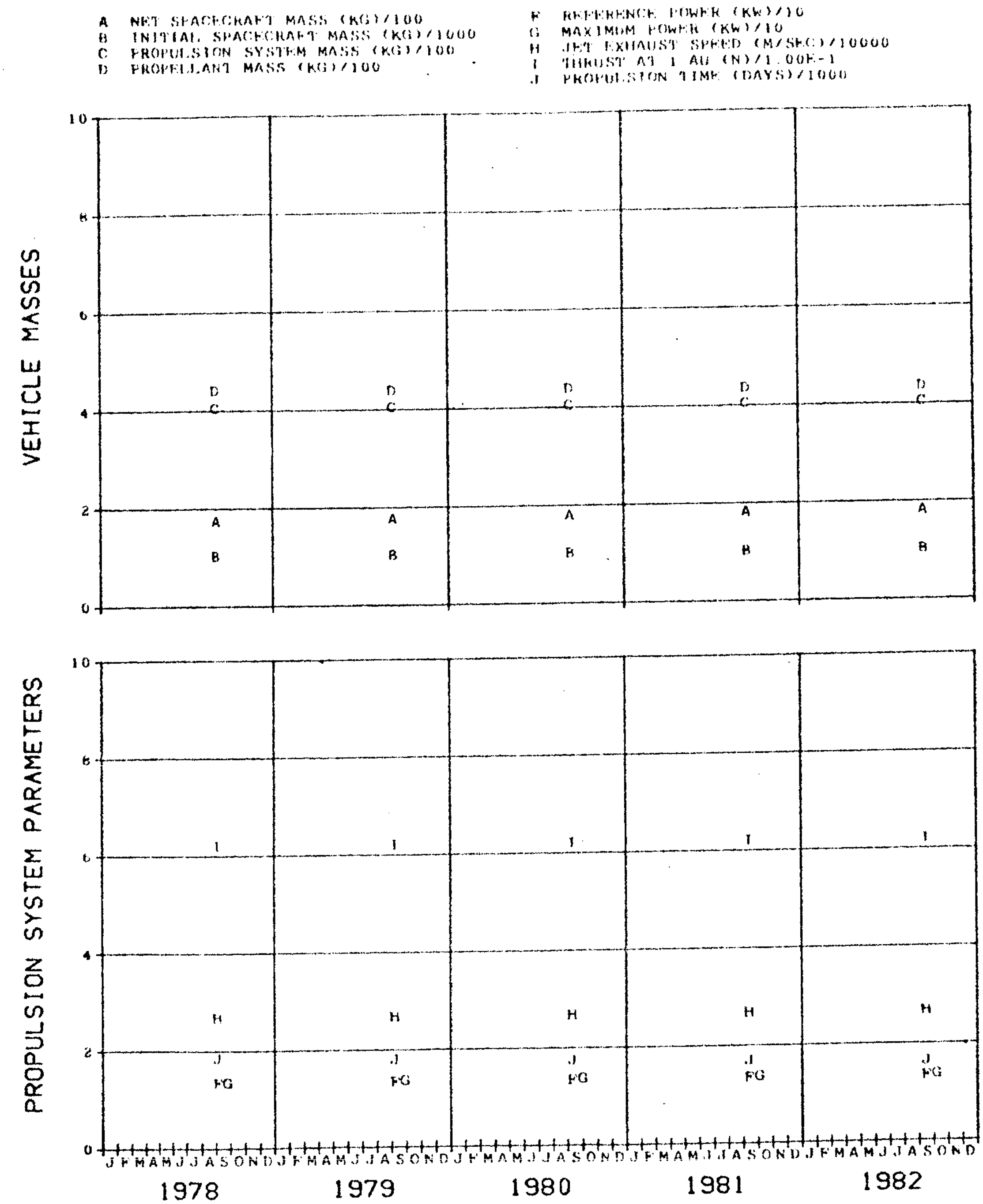

FIG. 42B. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

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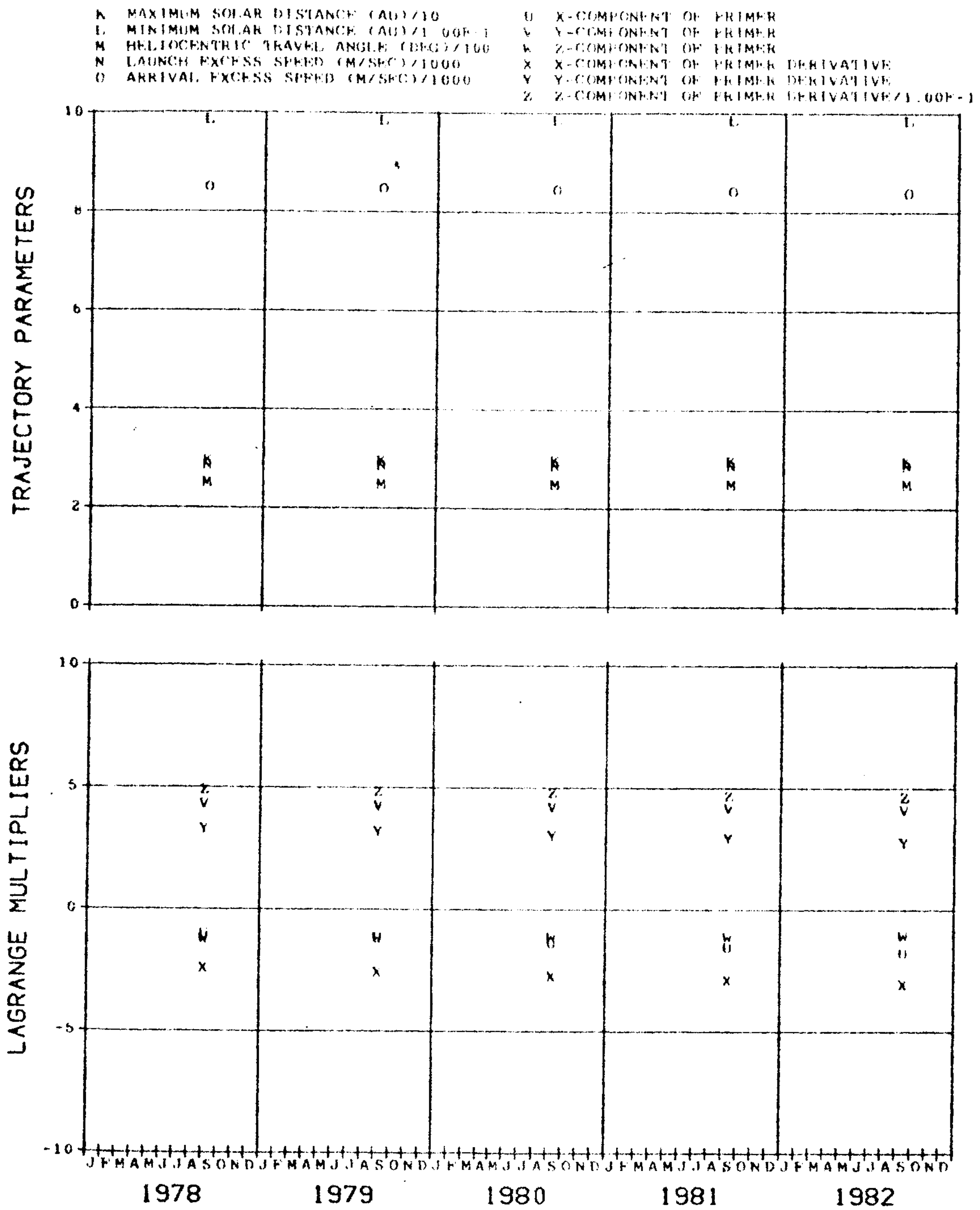

FIG. 42B. (CONCLUDED)

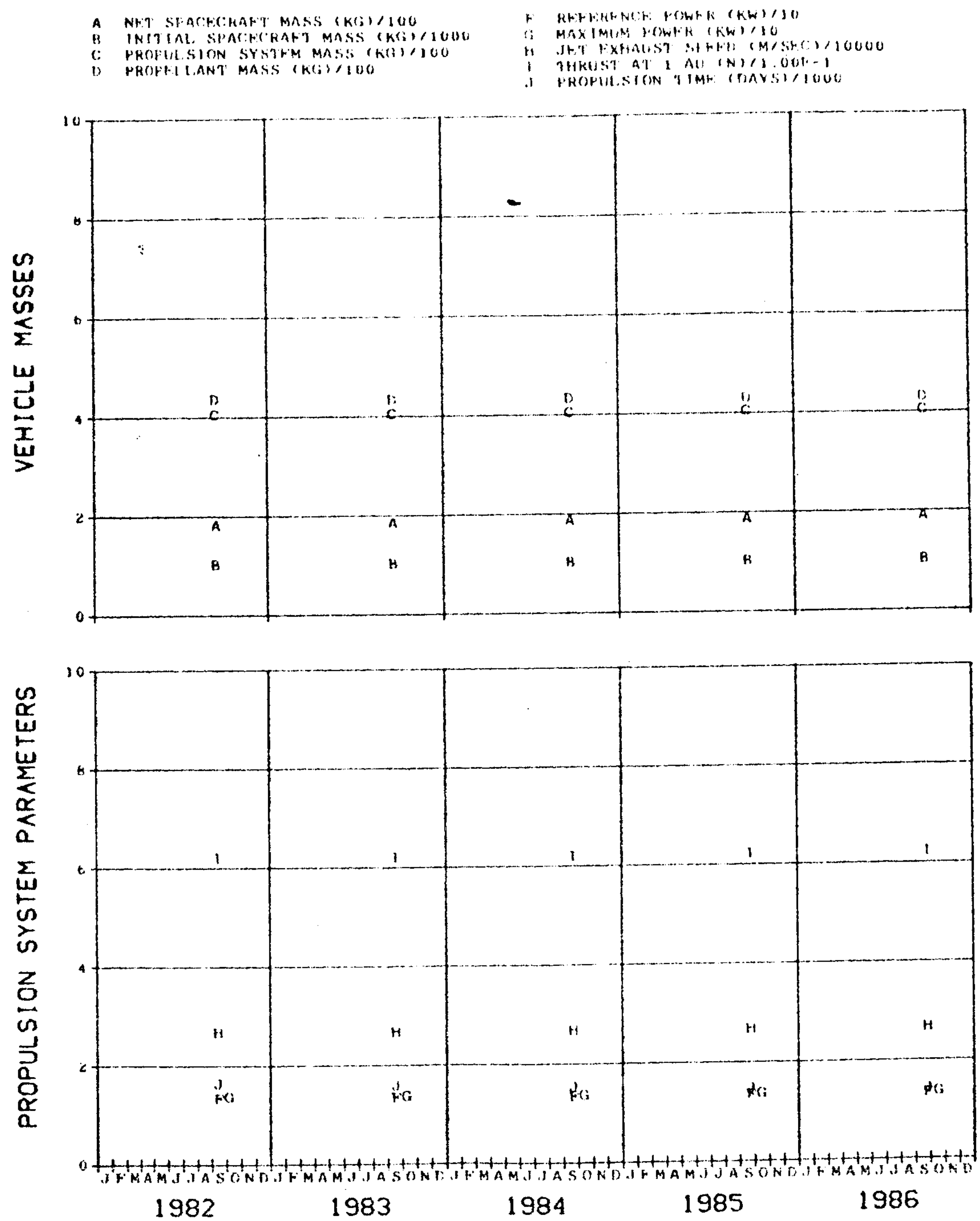

FIG. 42C. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

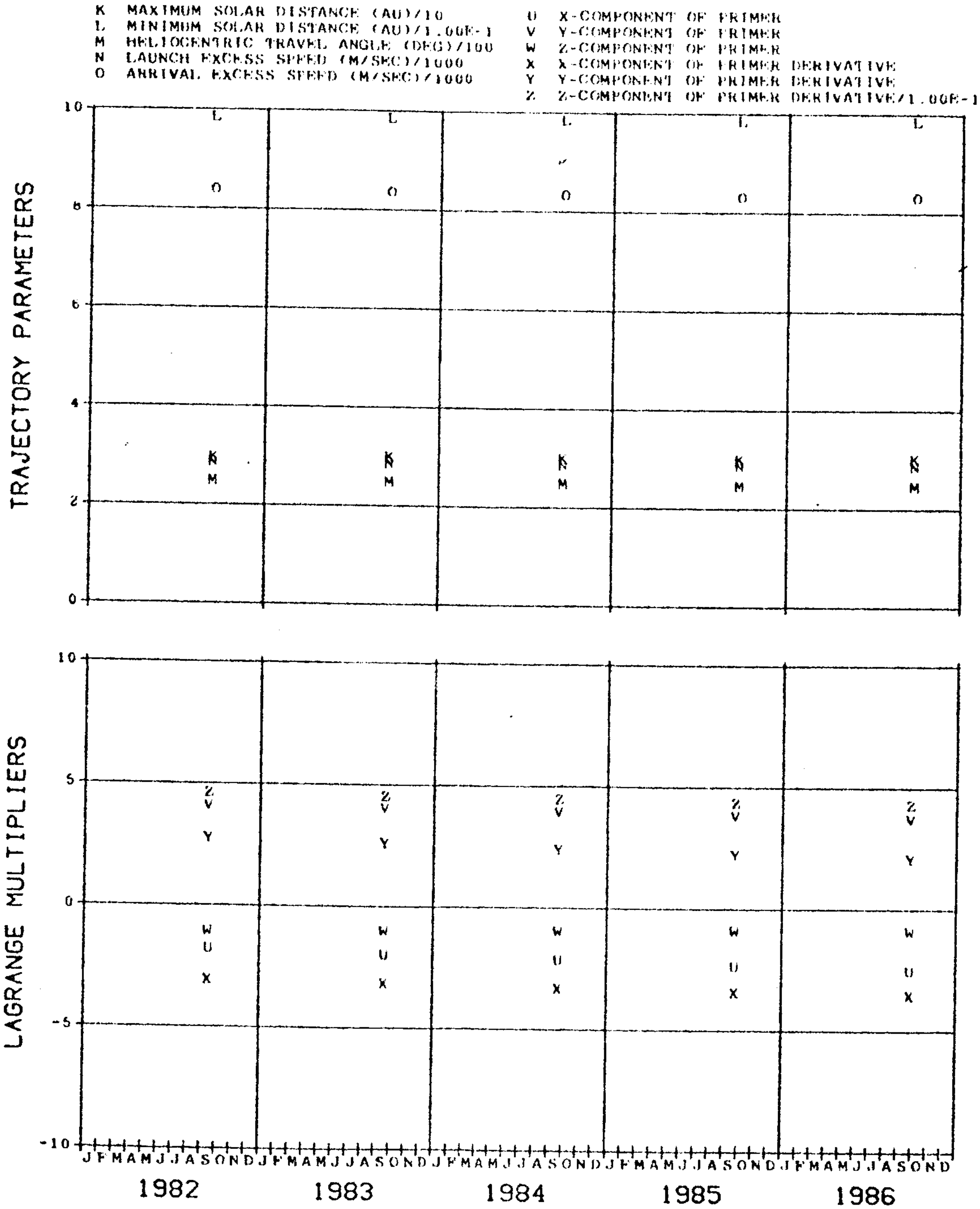

FIG. 42C. (CONCLUDED)

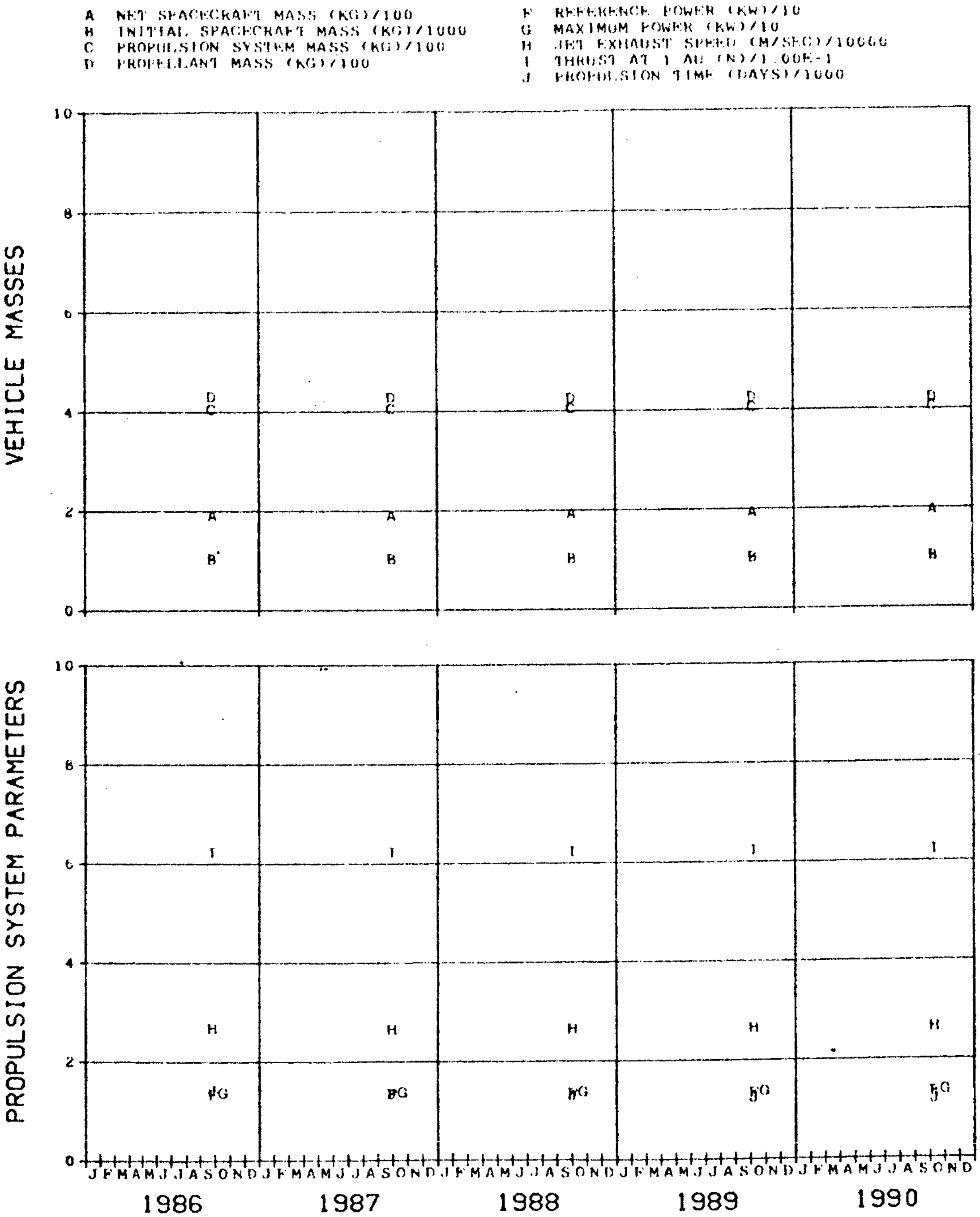

FIG. 42D. PLUTO MODE A FLYBY OPPORTUNITIES
FLIGHT TIME 5000 DAYS

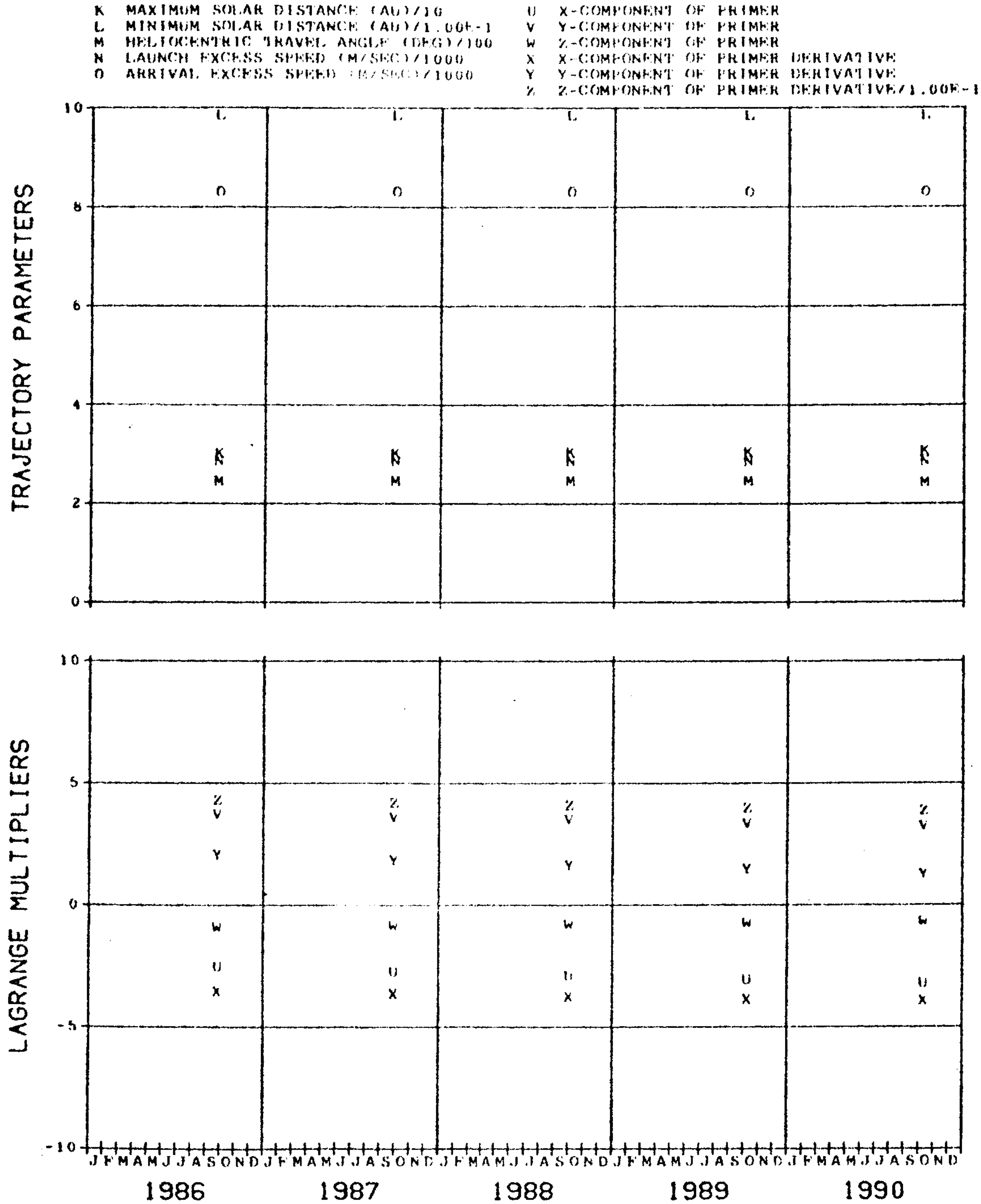

FIG. 42D. (CONCLUDED)

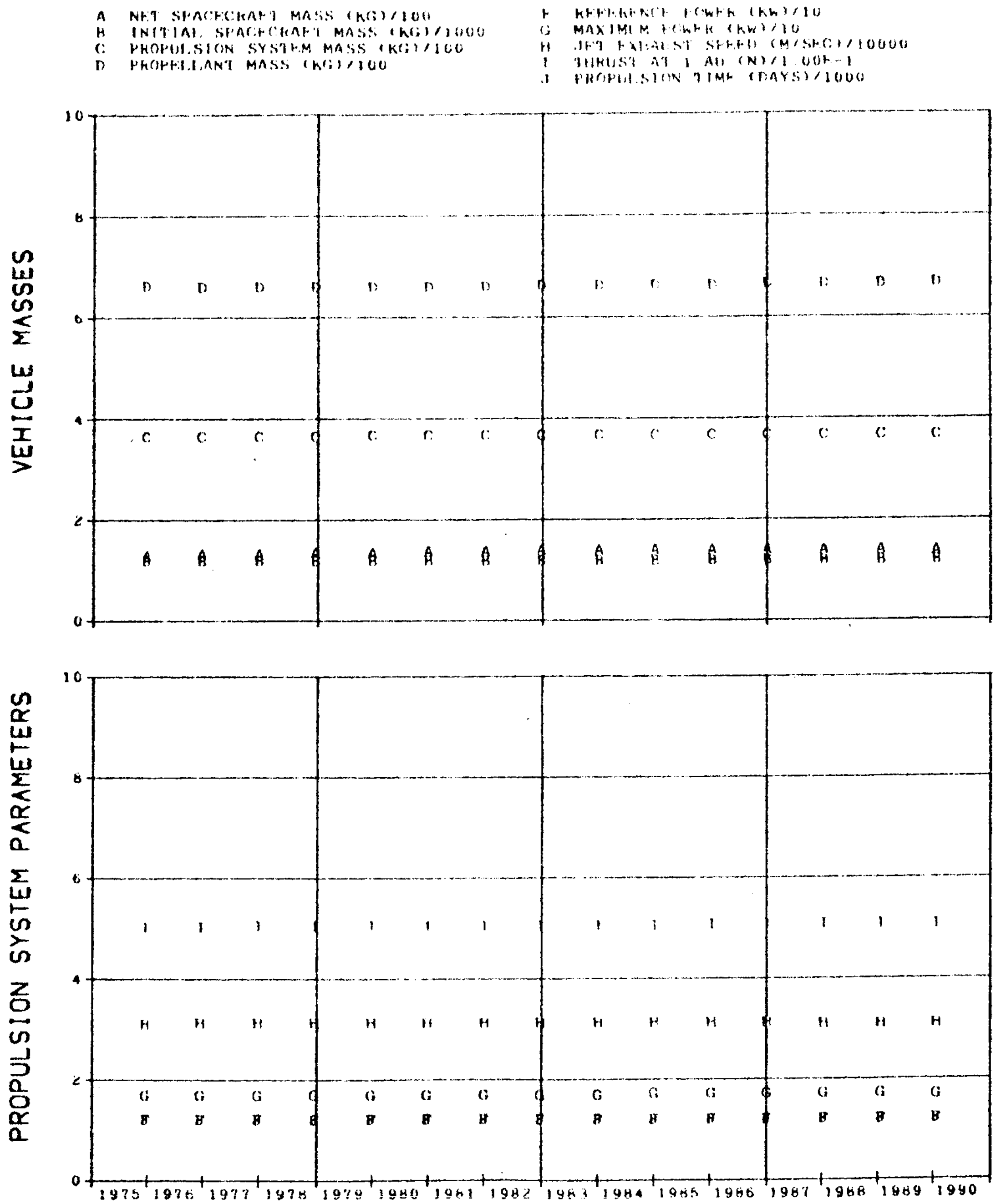

FIG. 43. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2600 DAYS

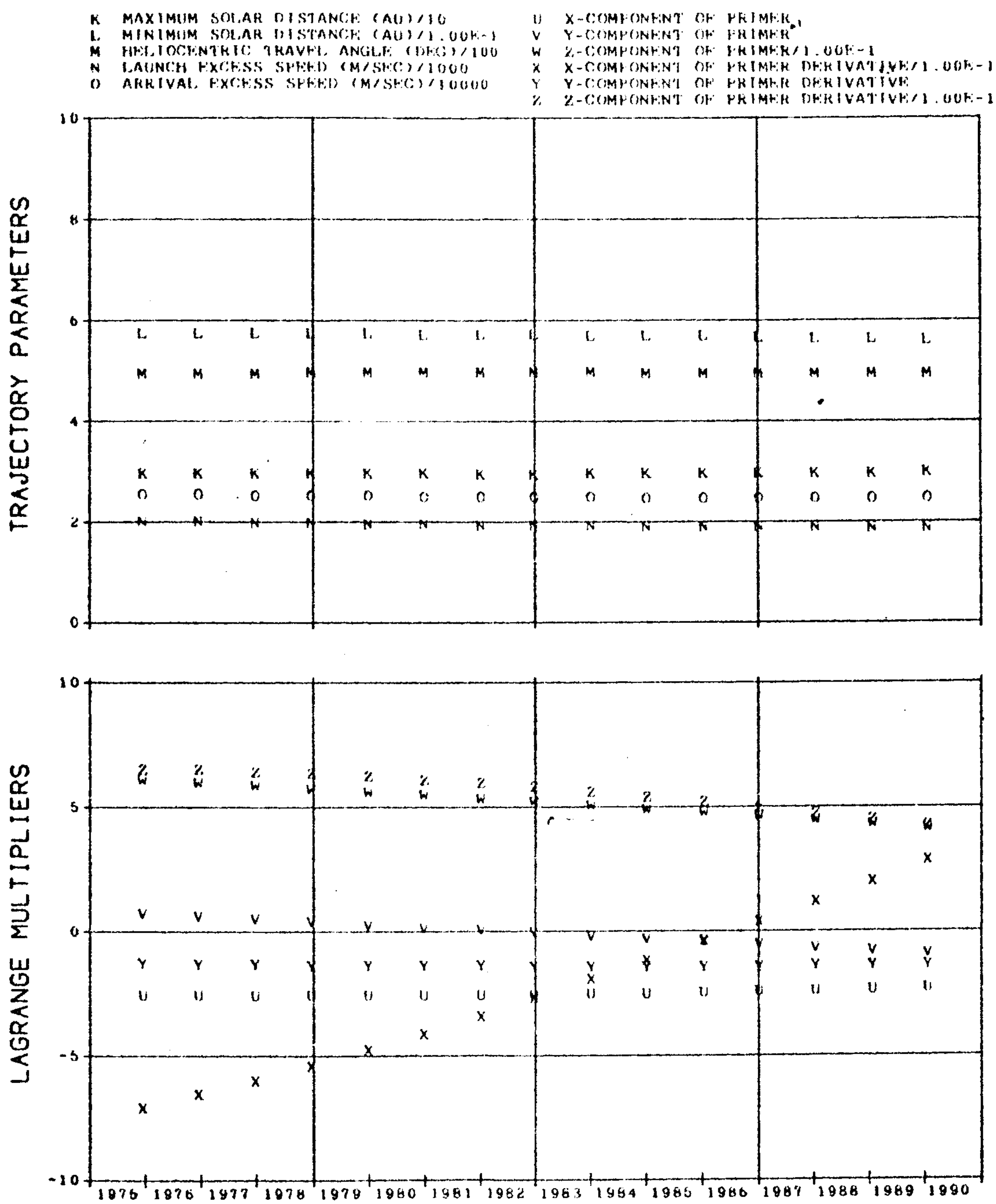

FIG. 43. (CONCLUDED)

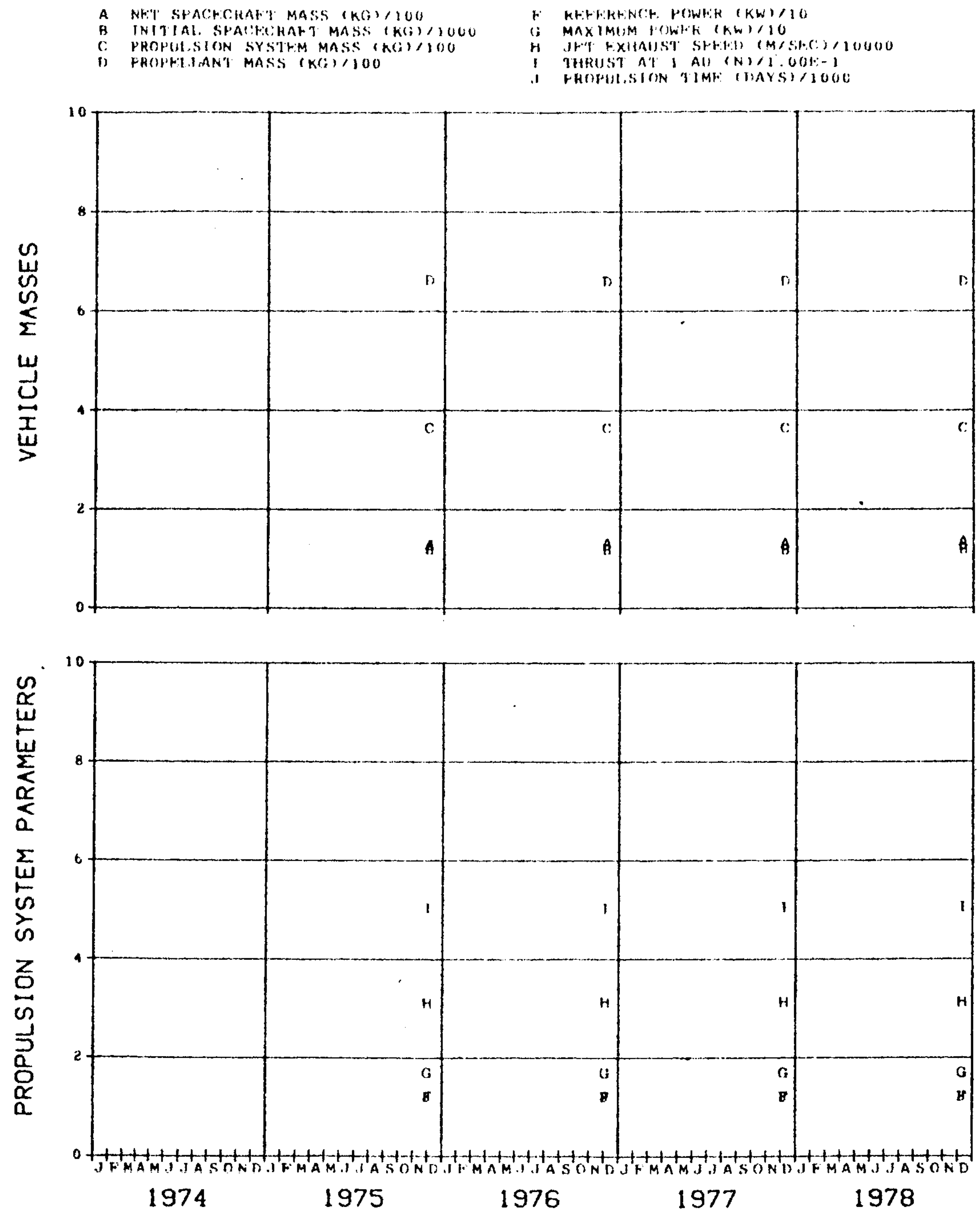

FIG. 43A. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2600 DAYS

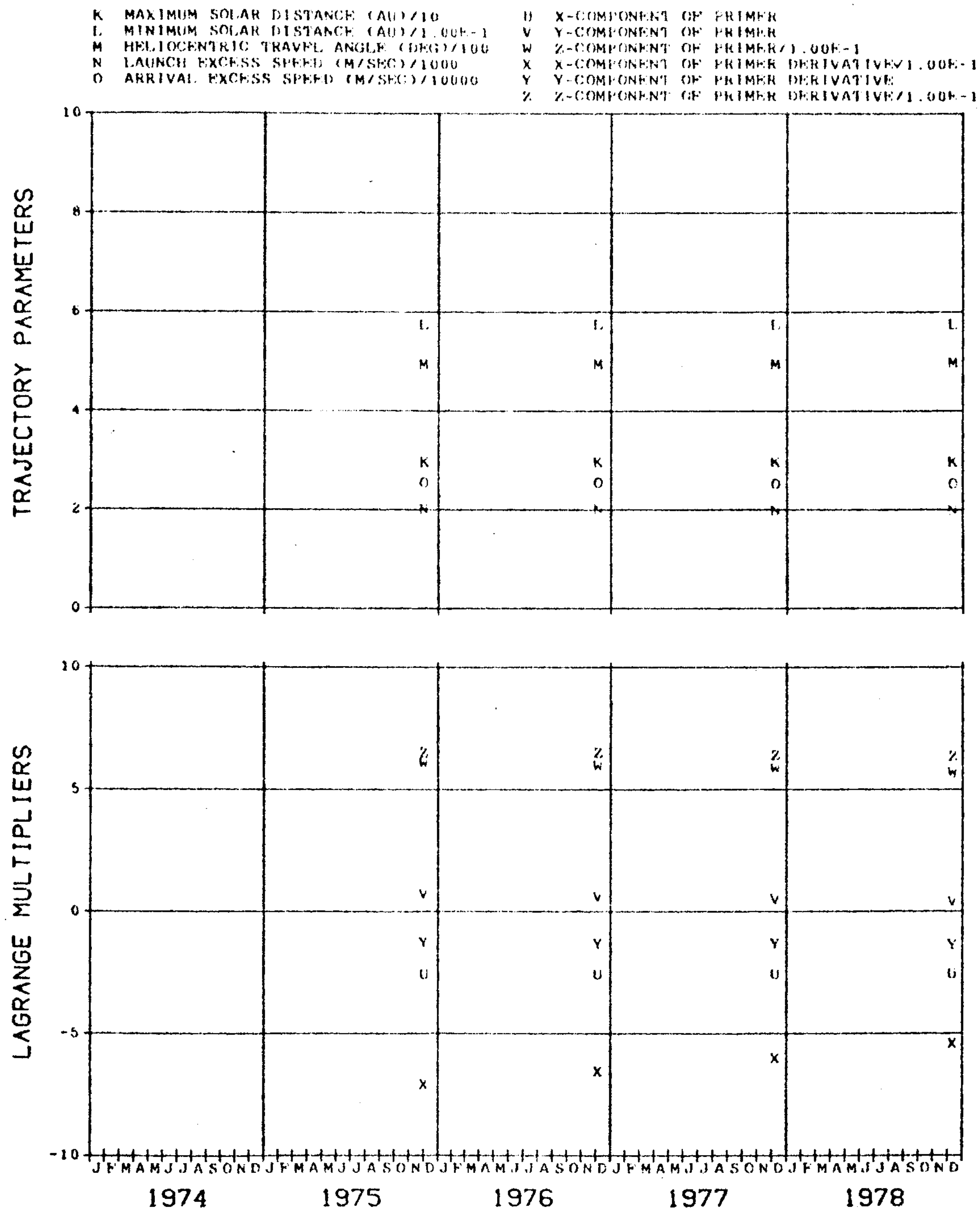

FIG. 43A. (CONCLUDED)

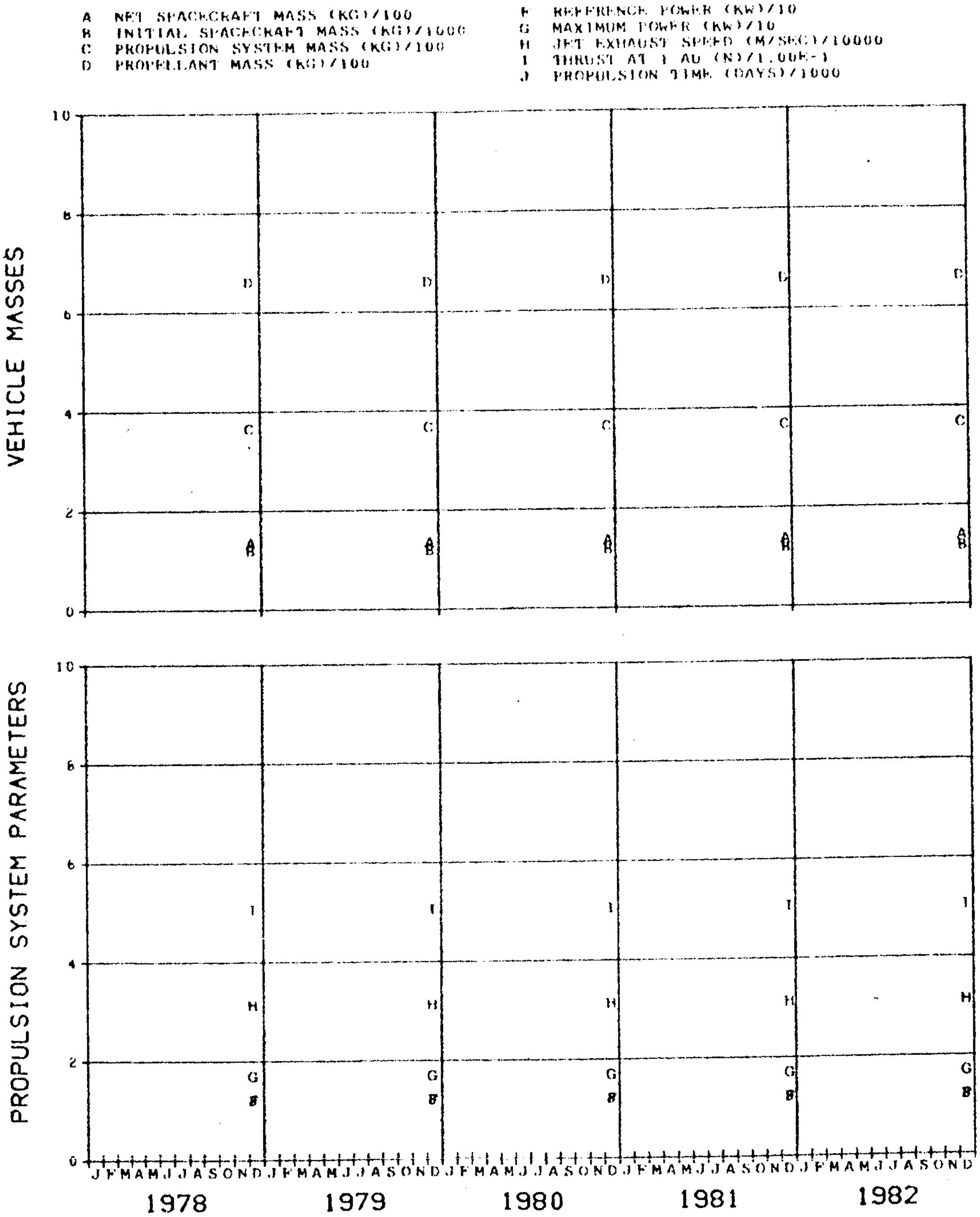

FIG. 43B. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2600 DAYS

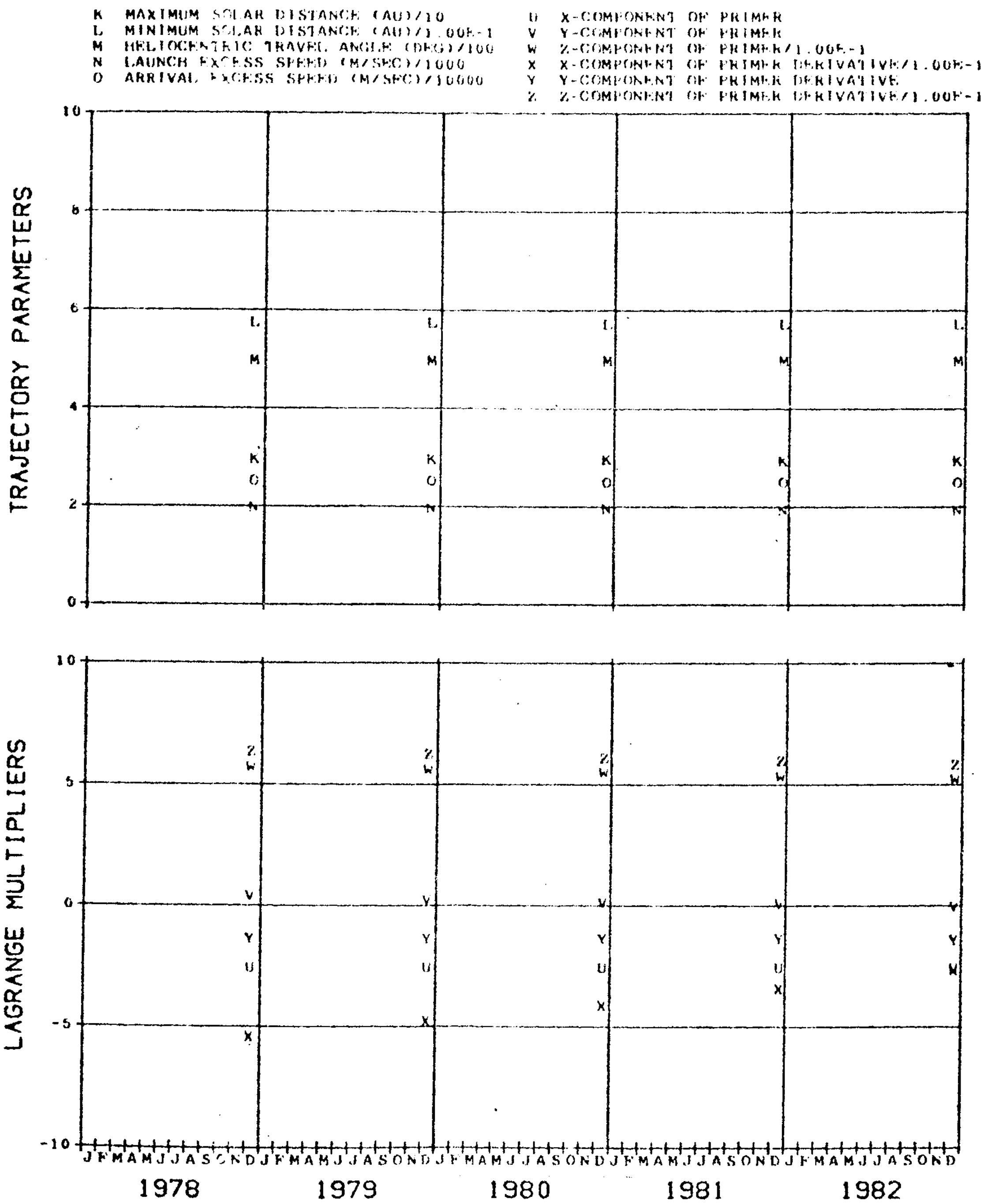

FIG. 43B. (CONCLUDED)

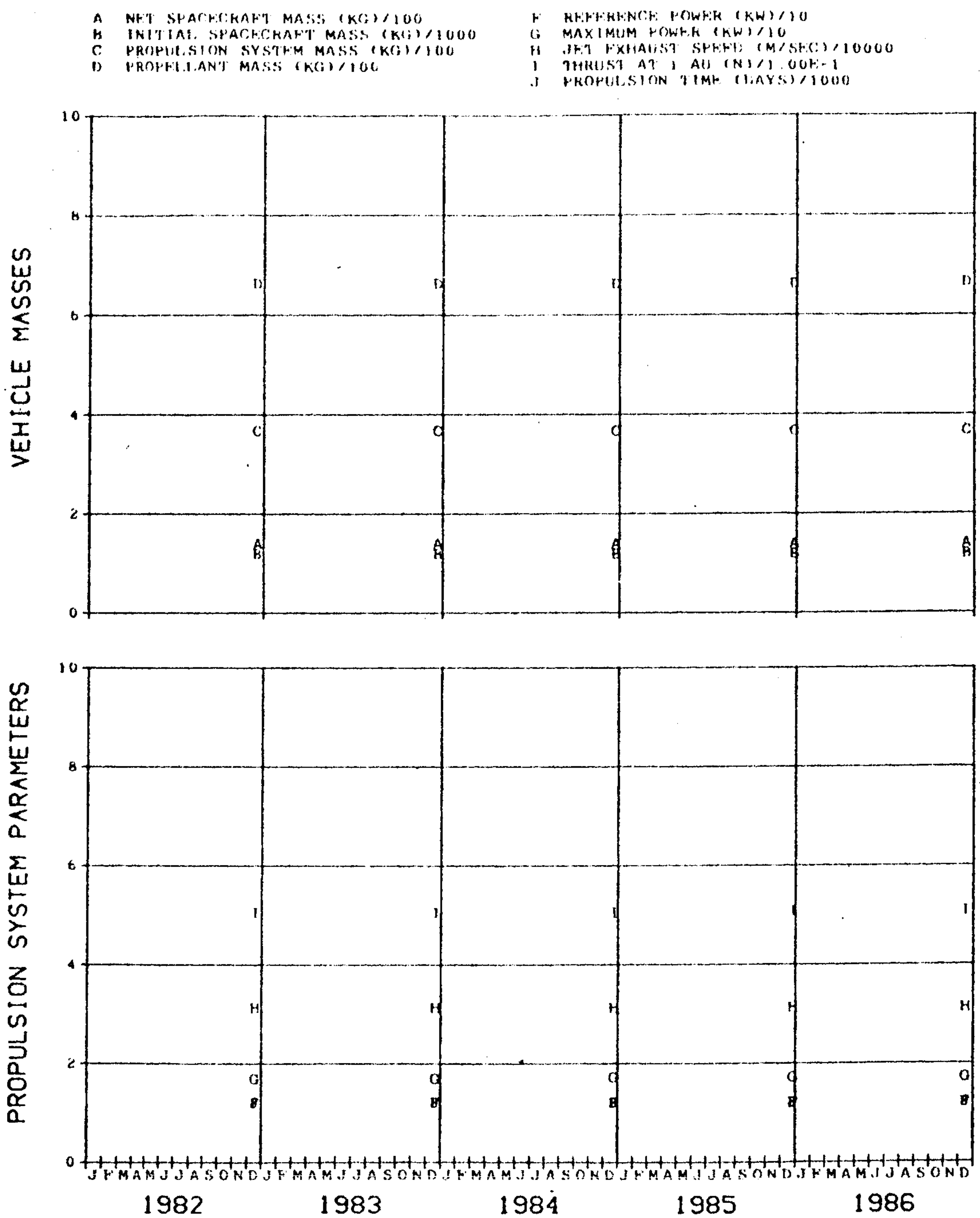

FIG. 43C. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2600 DAYS

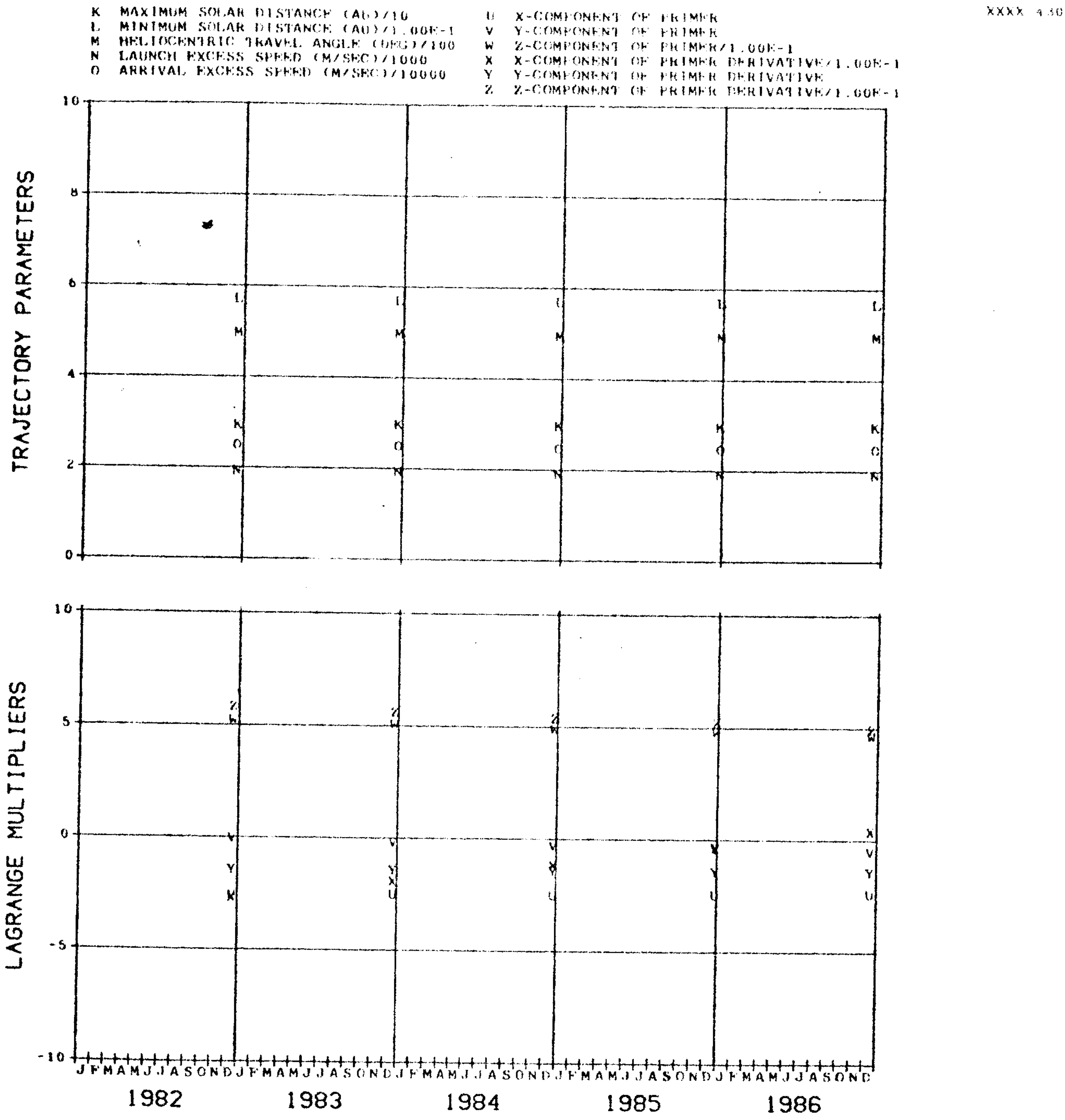

FIG. 43C. (CONCLUDED)

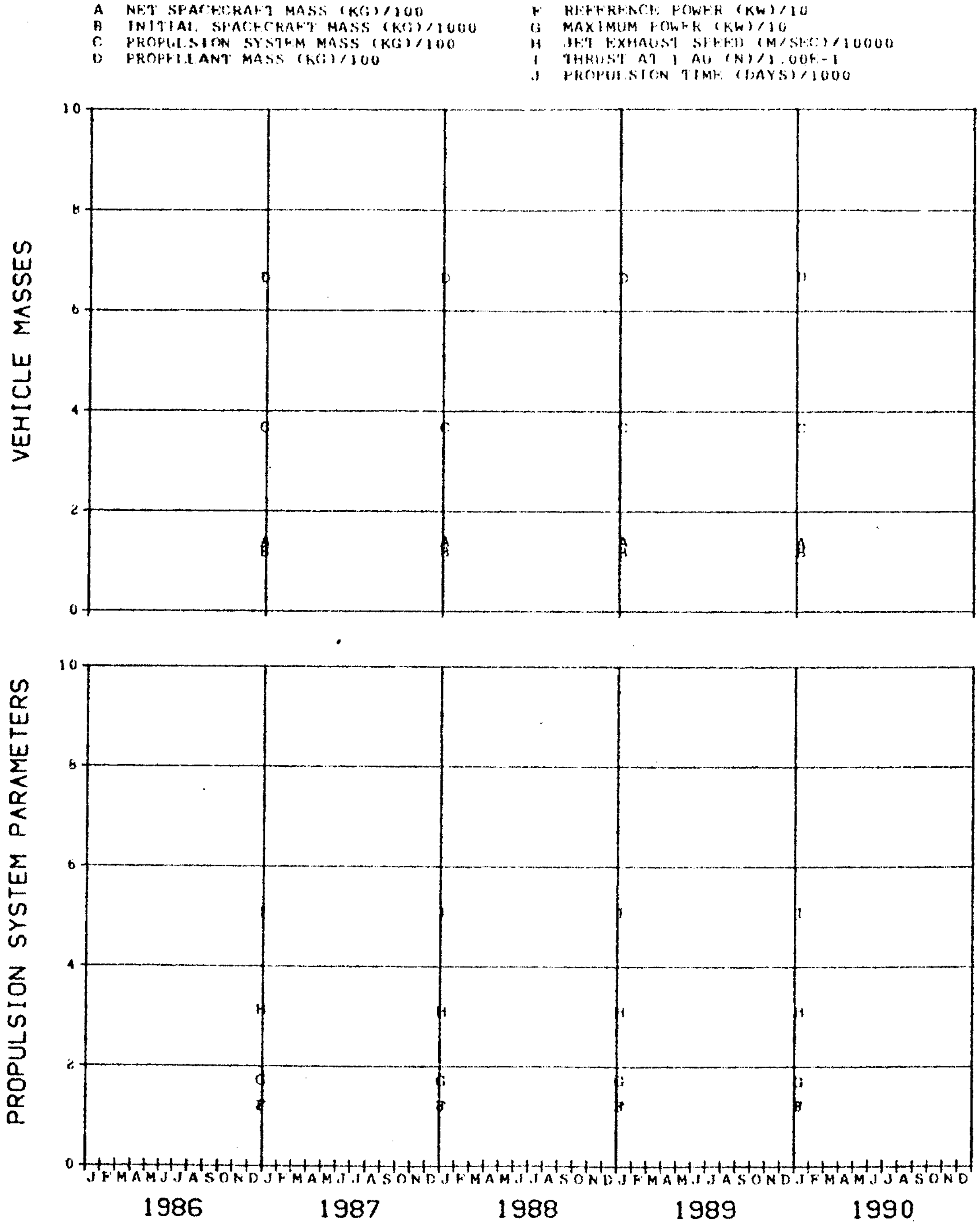

FIG. 43D. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 2600 DAYS

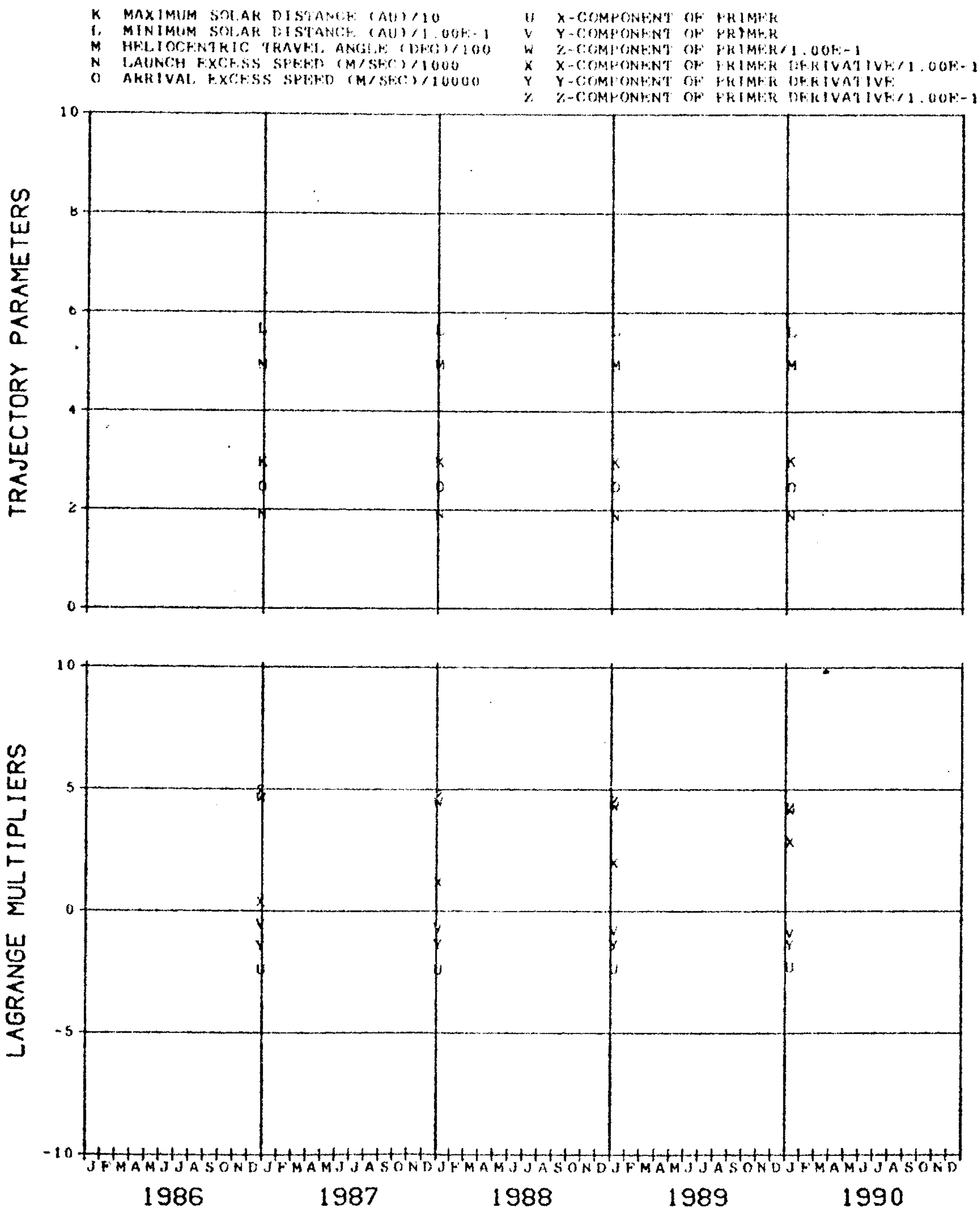

FIG. 43D. (CONCLUDED)

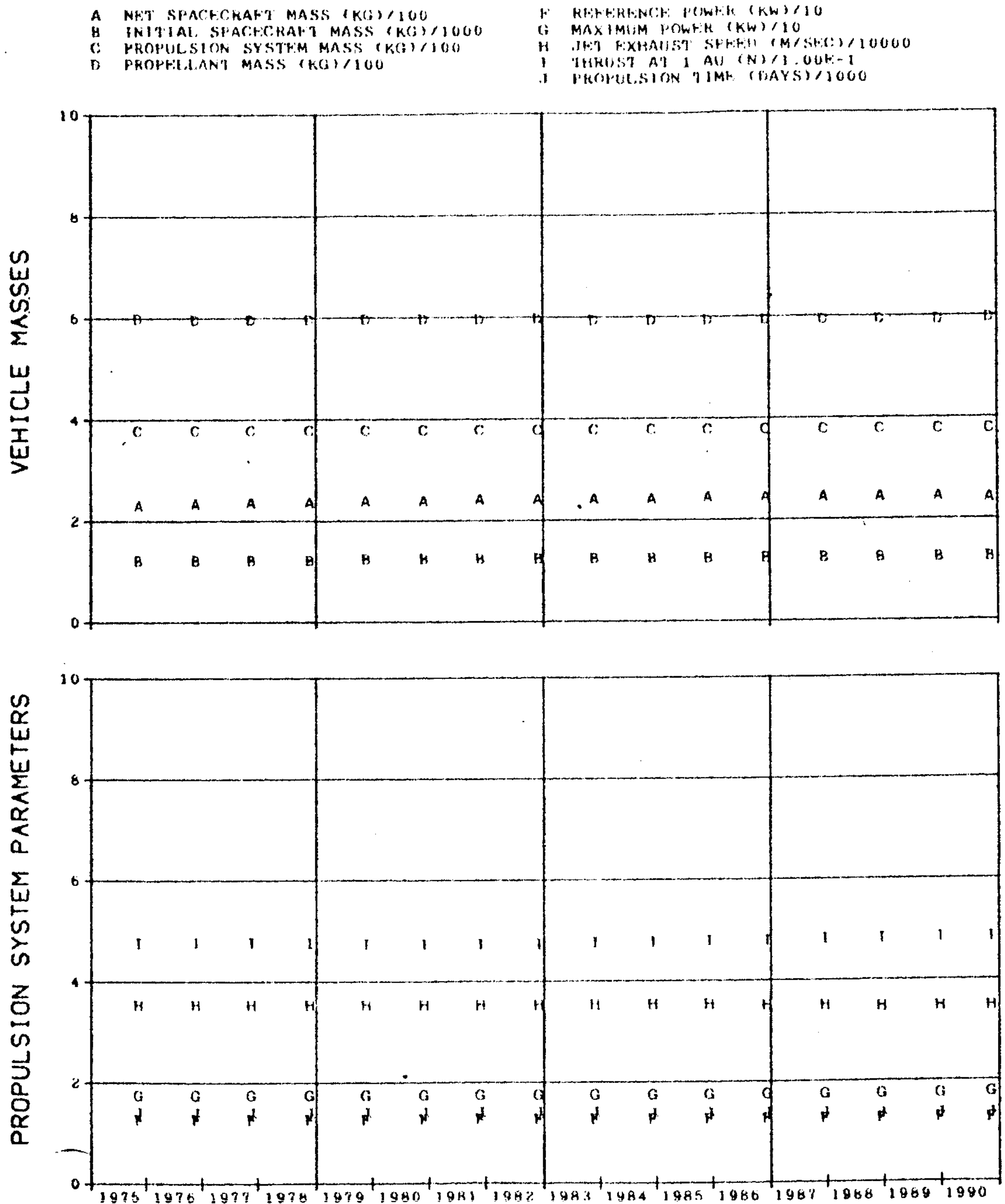

FIG. 44. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

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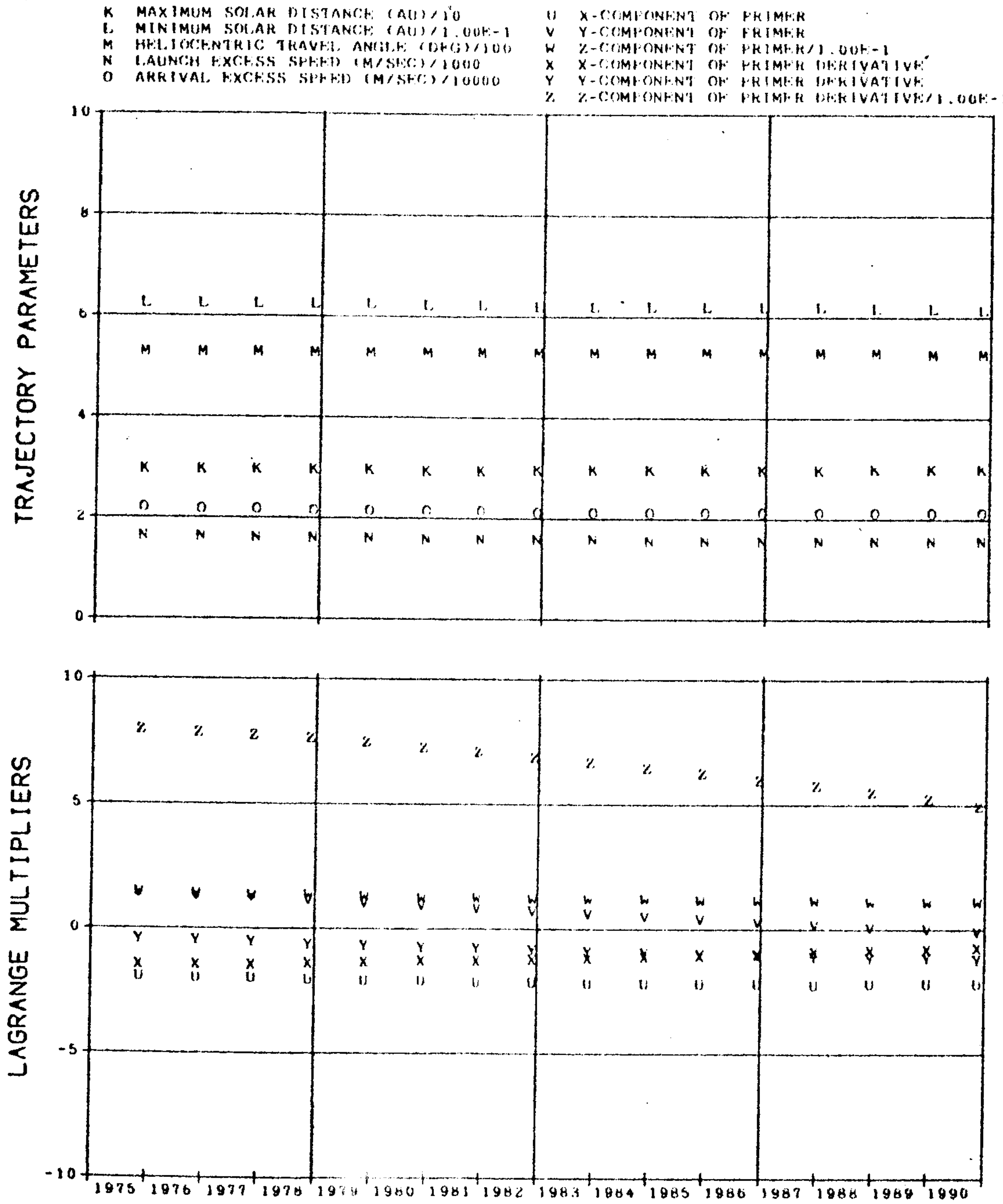

FIG. 44. (CONCLUDED)

XXXX 4.35

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/1000

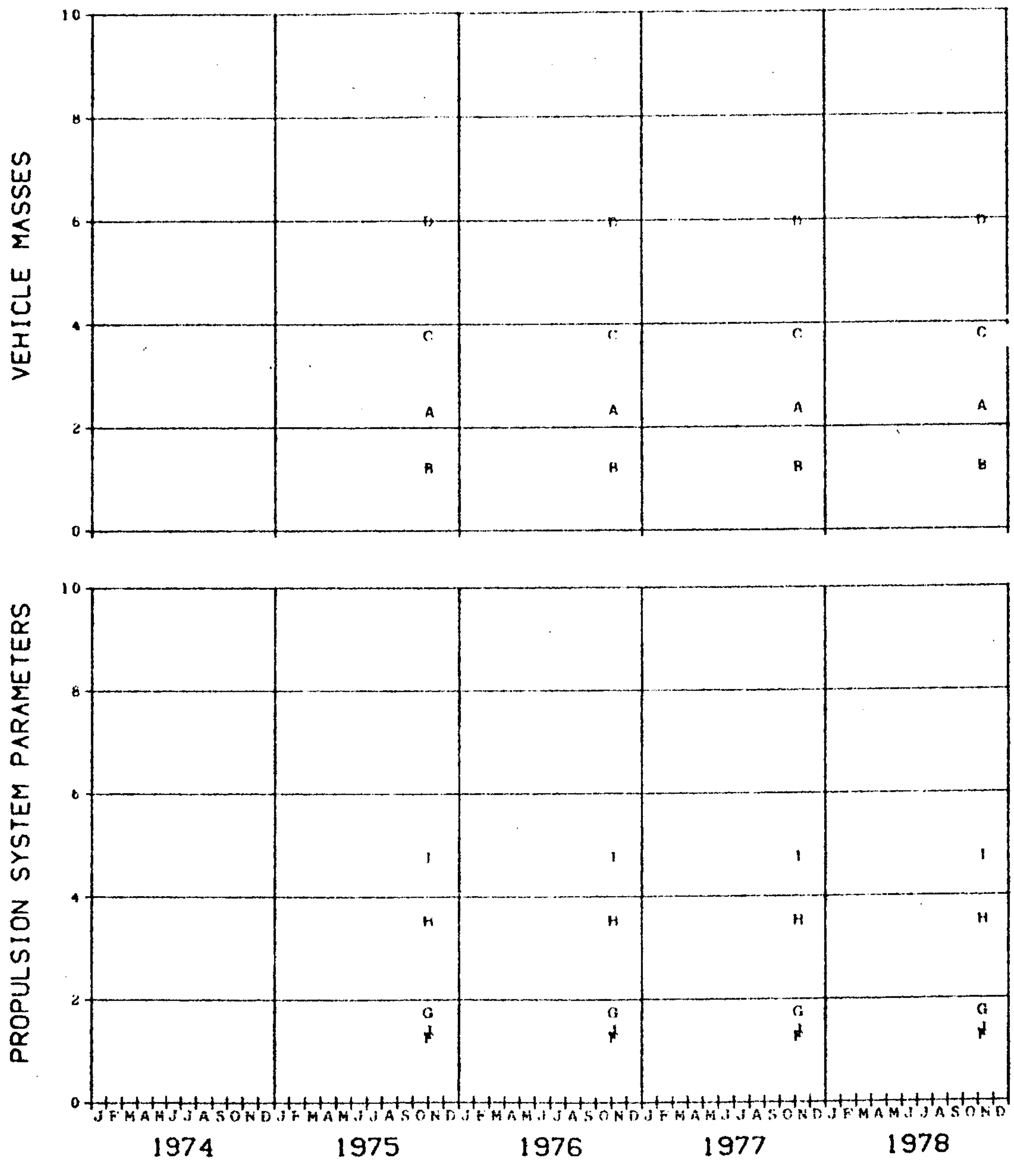

FIG. 44A. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

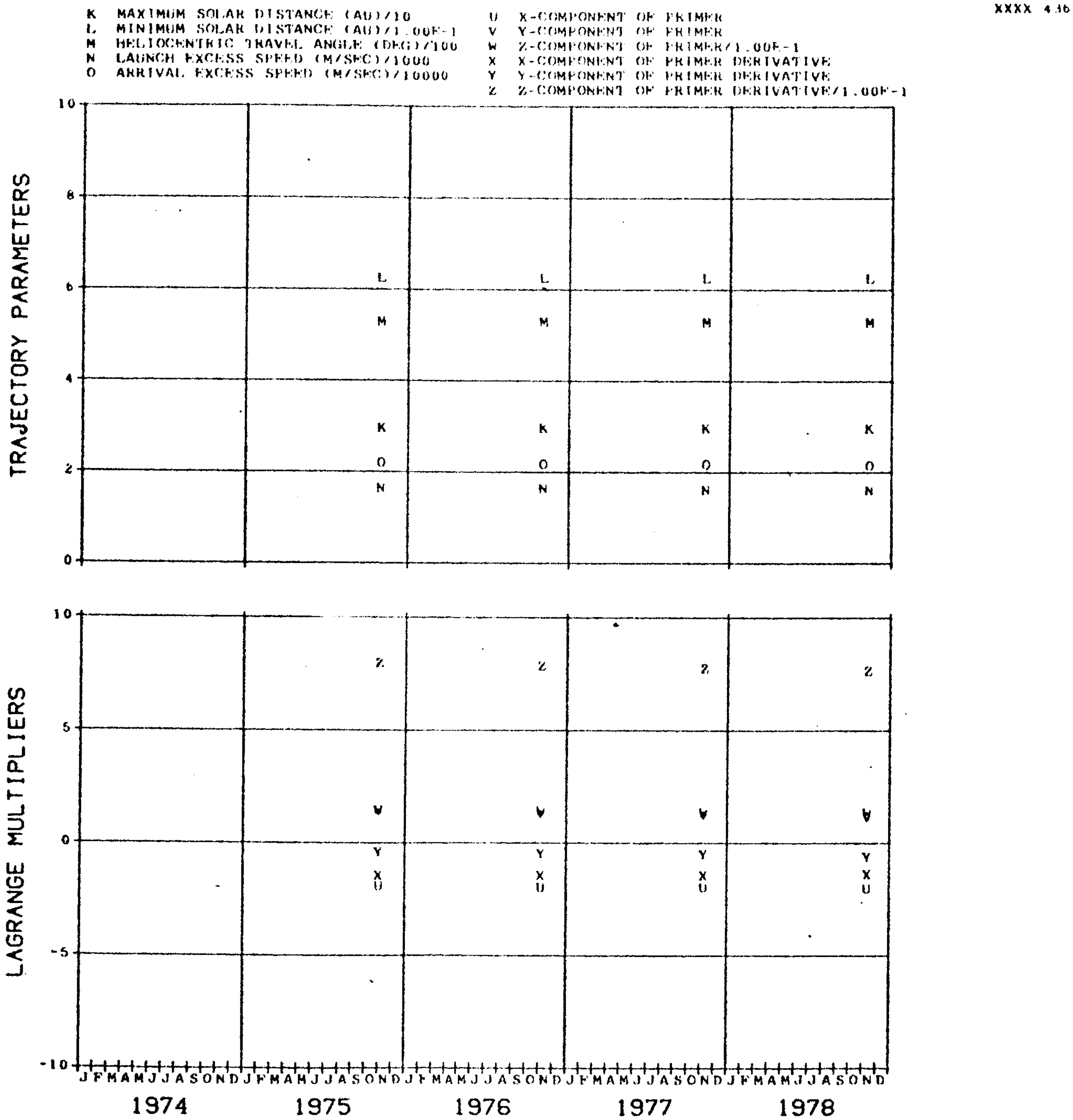

FIG. 44A. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/100
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/1000

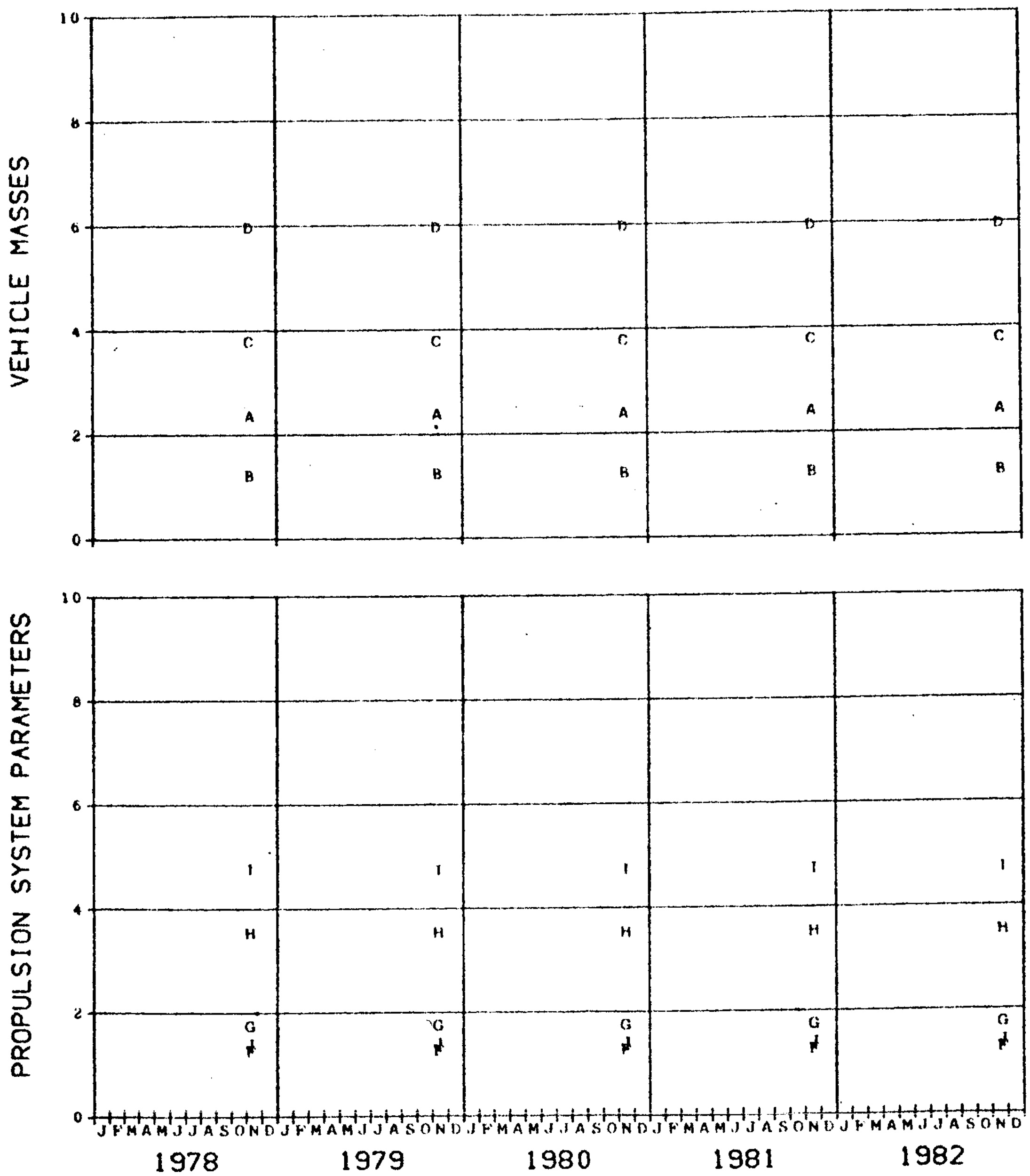

FIG. 44B. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

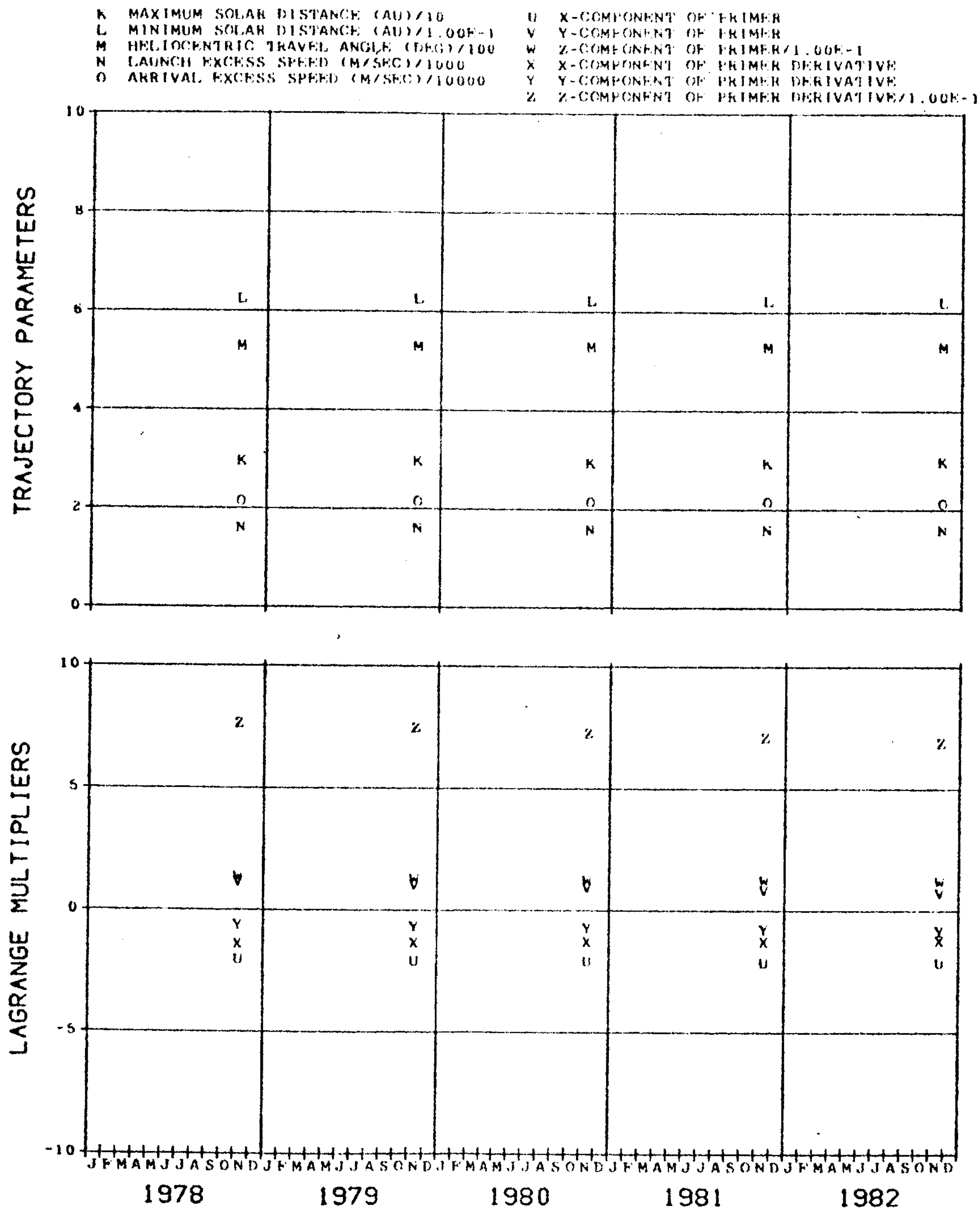

FIG. 44B. (CONCLUDED)

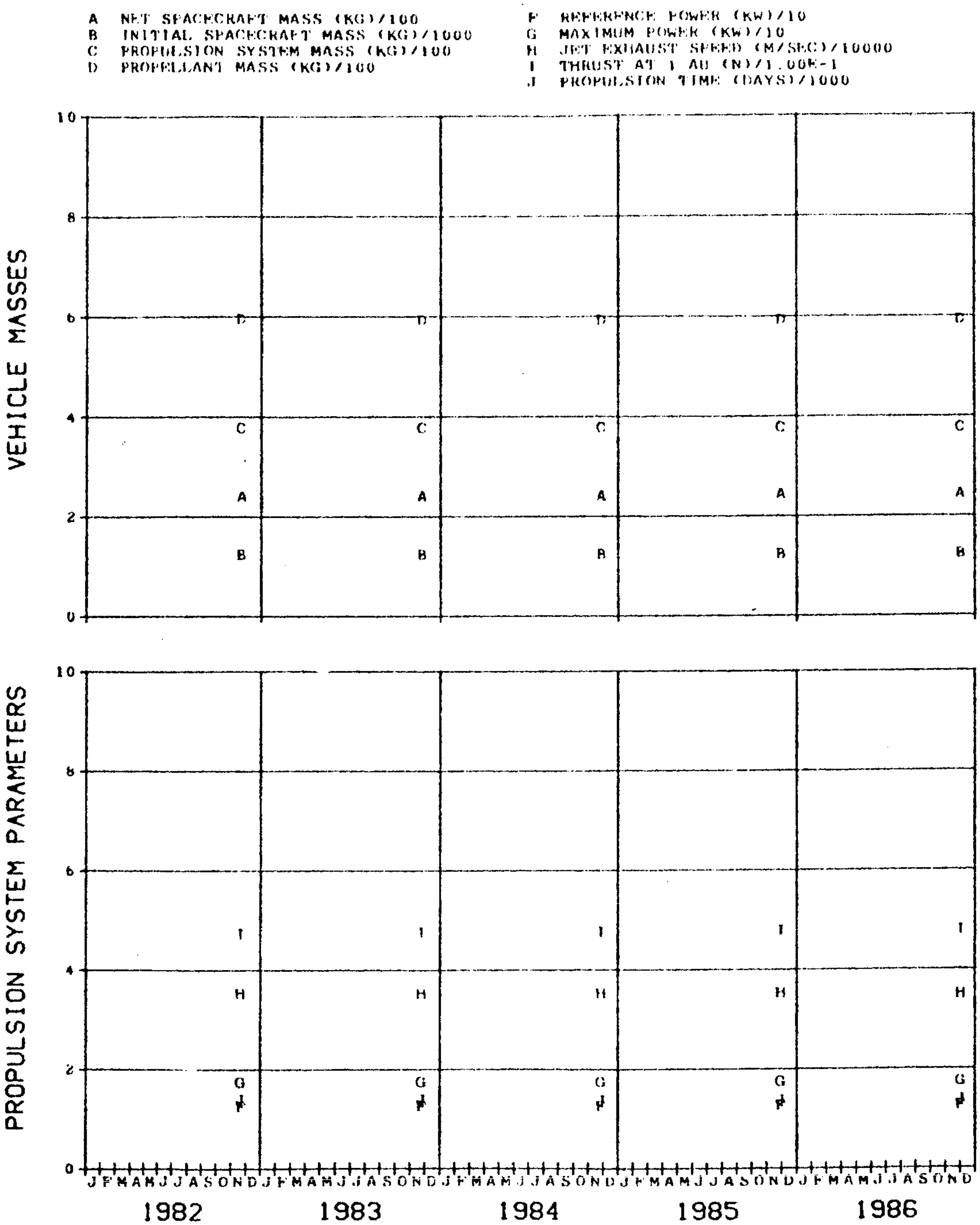

FIG. 44C. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

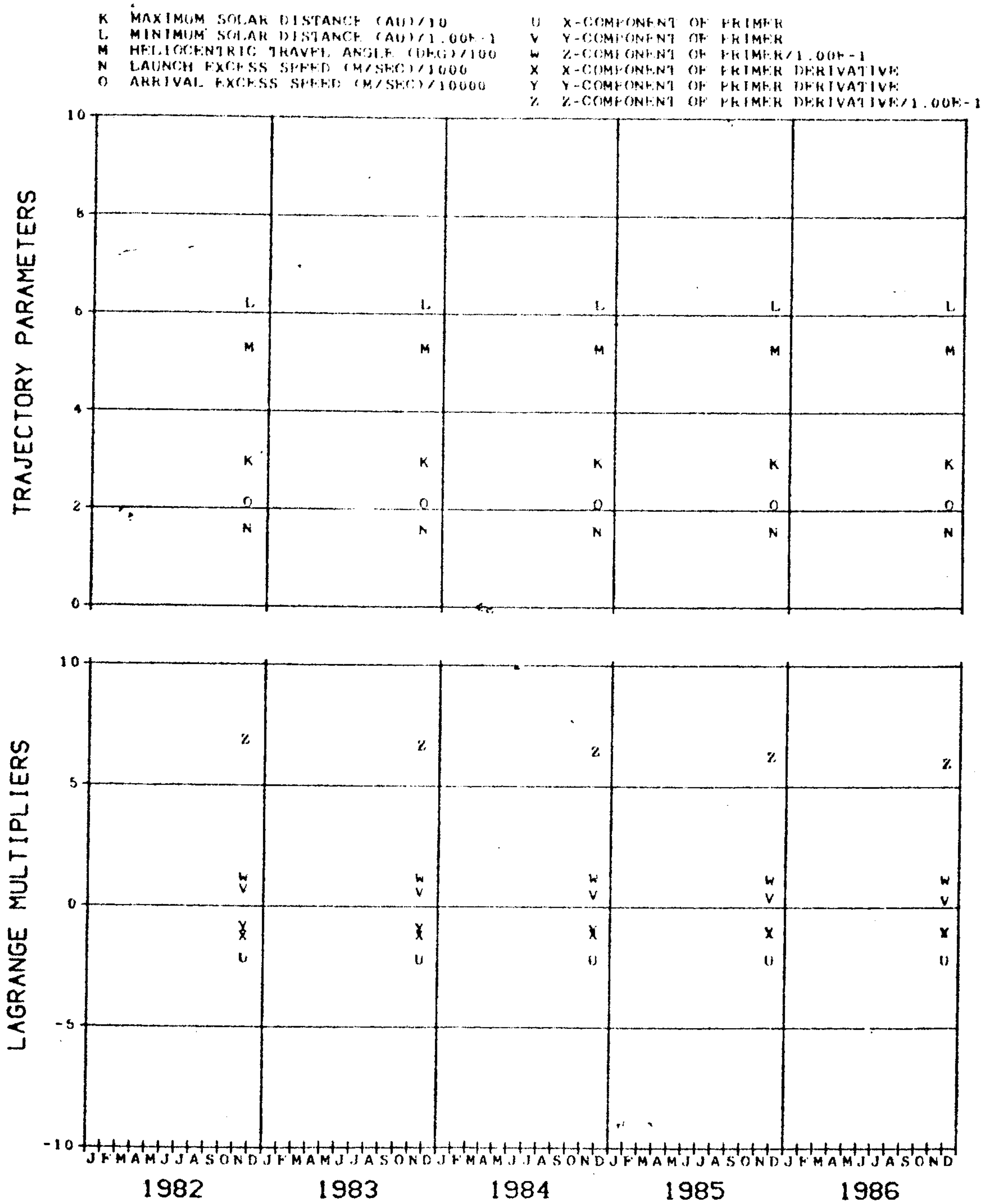

FIG. 44C. (CONCLUDED)

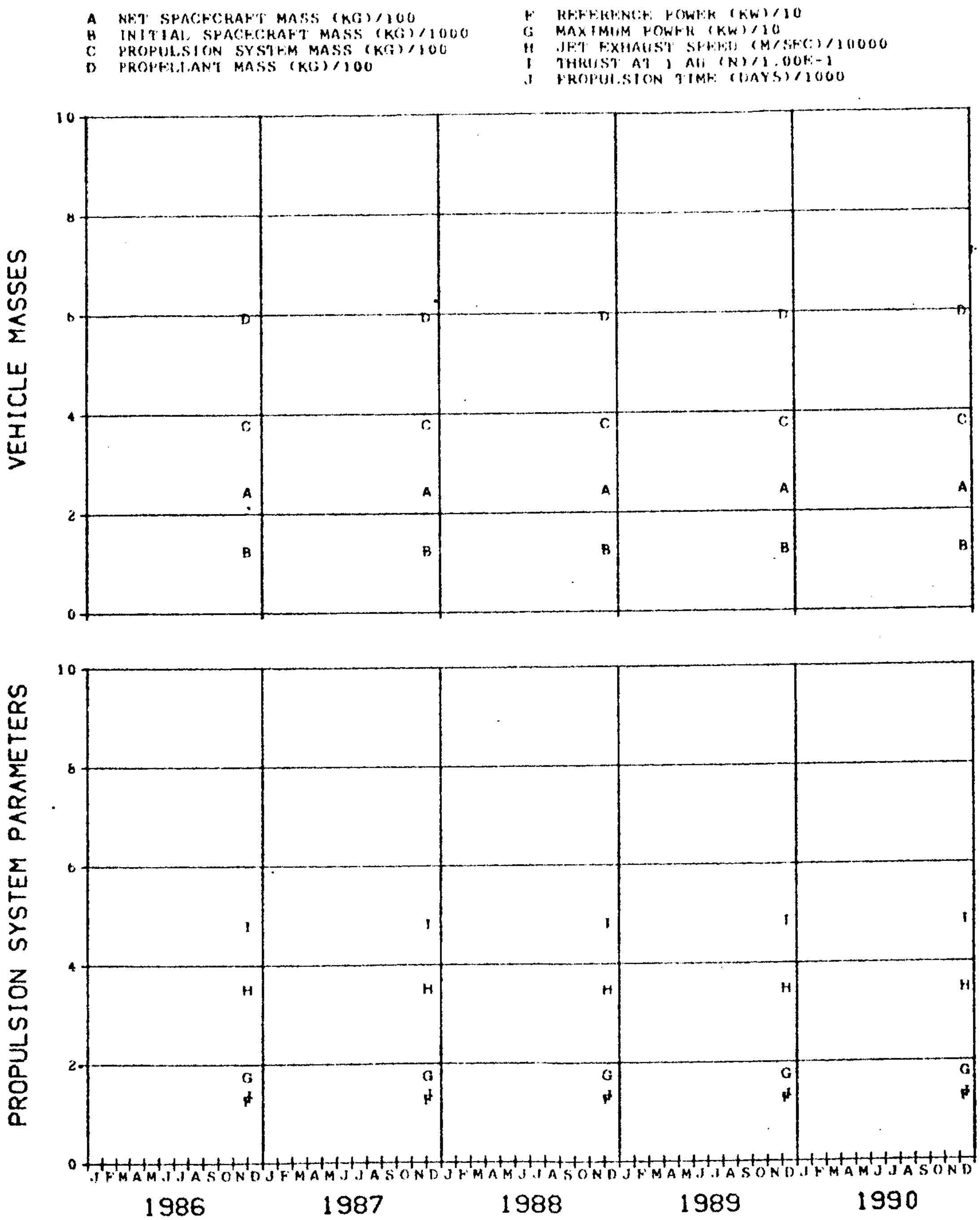

FIG. 44D. PLUTO MODE B FLYBY OPPORTUNITIES
FLIGHT TIME 3000 DAYS

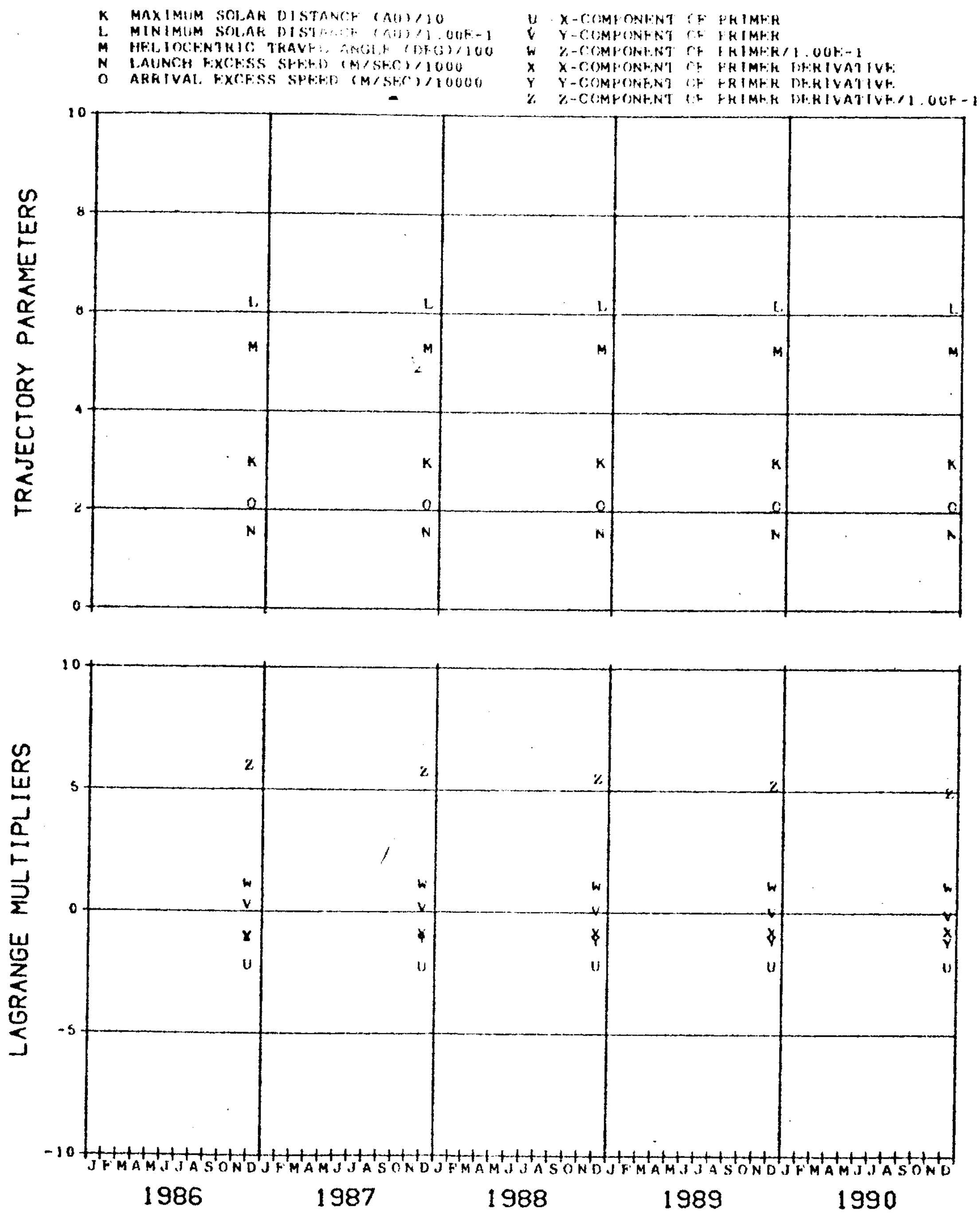

FIG. 44D. (CONCLUDED)

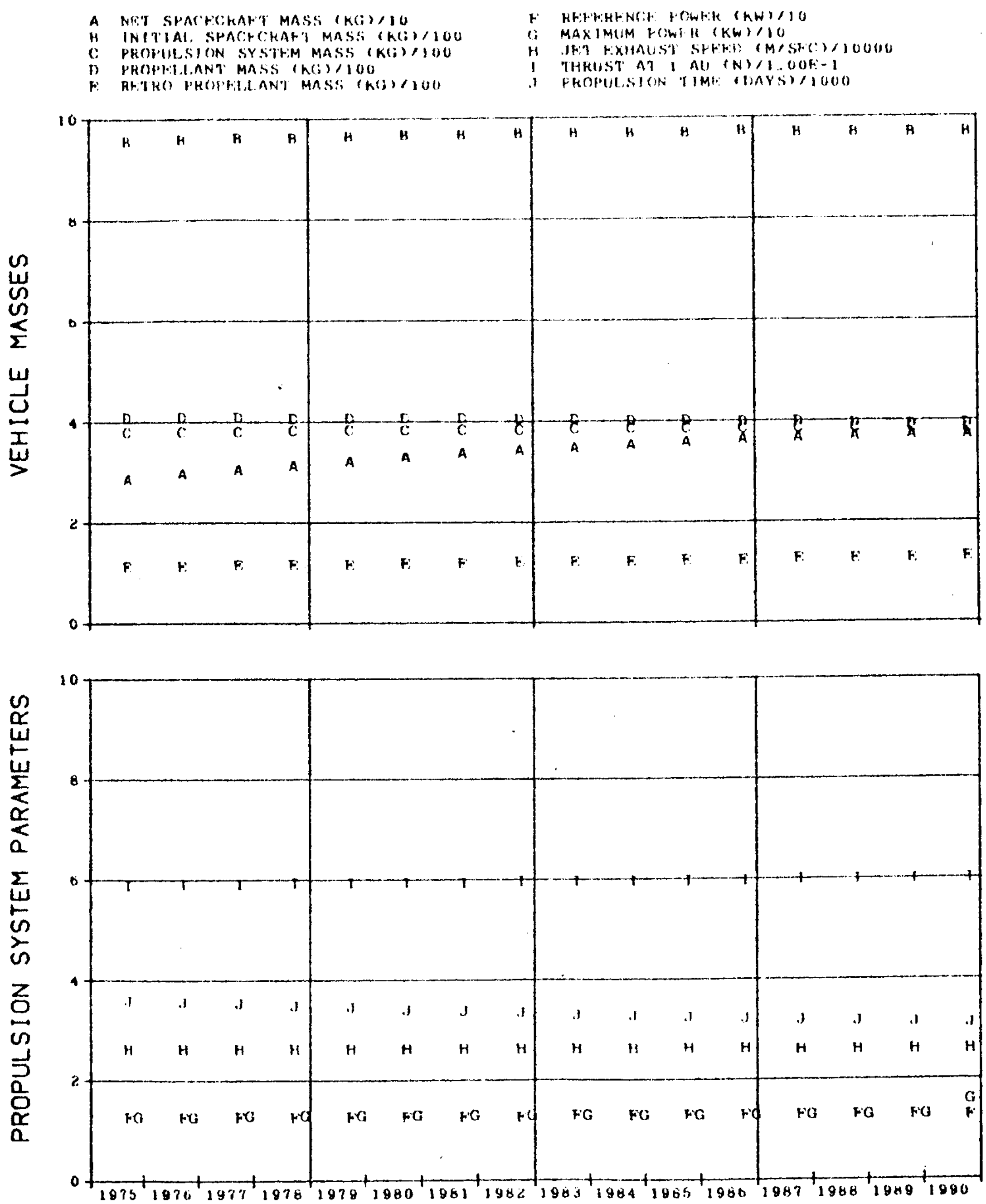

FIG. 45. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

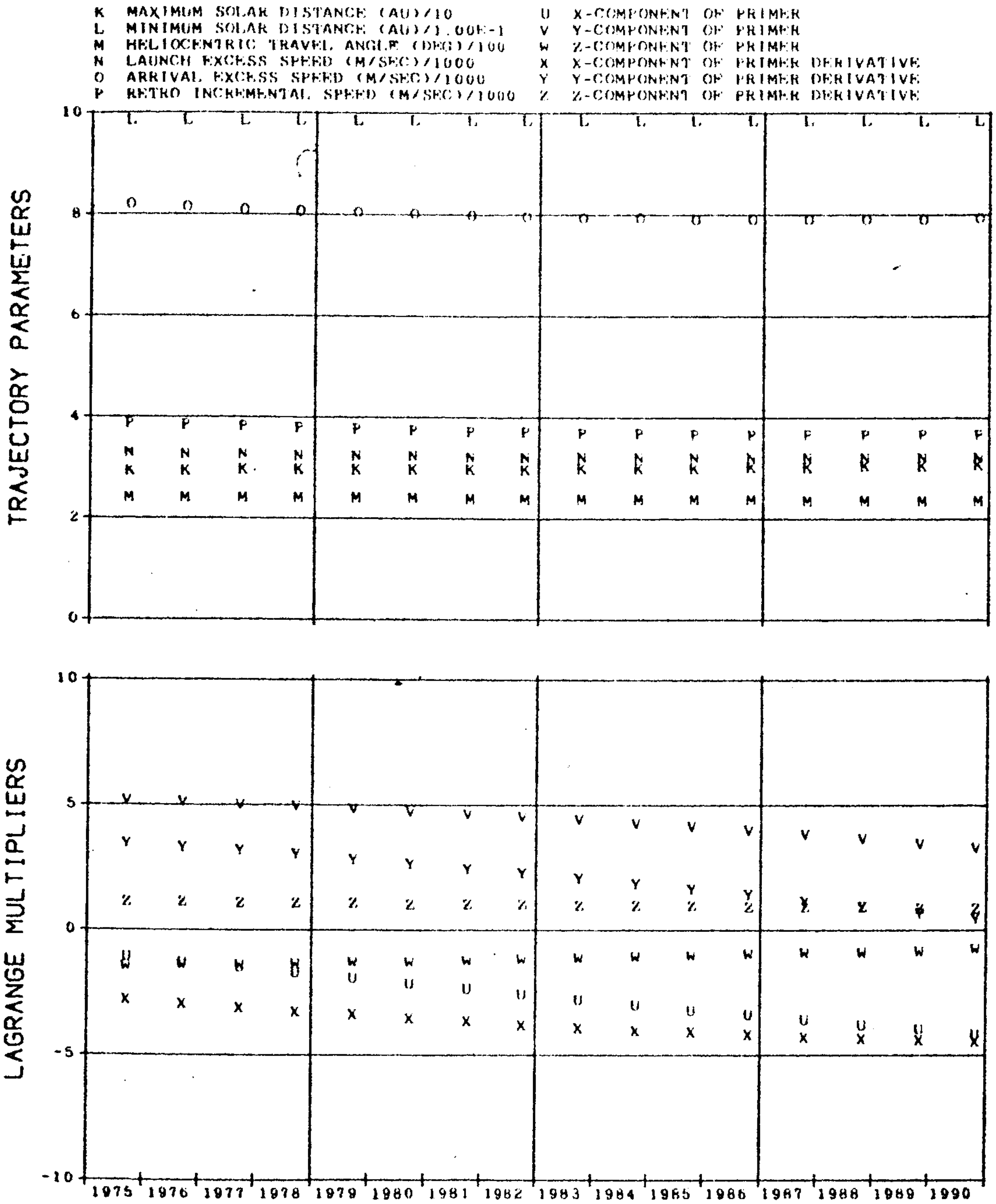

FIG. 45. (CONCLUDED)

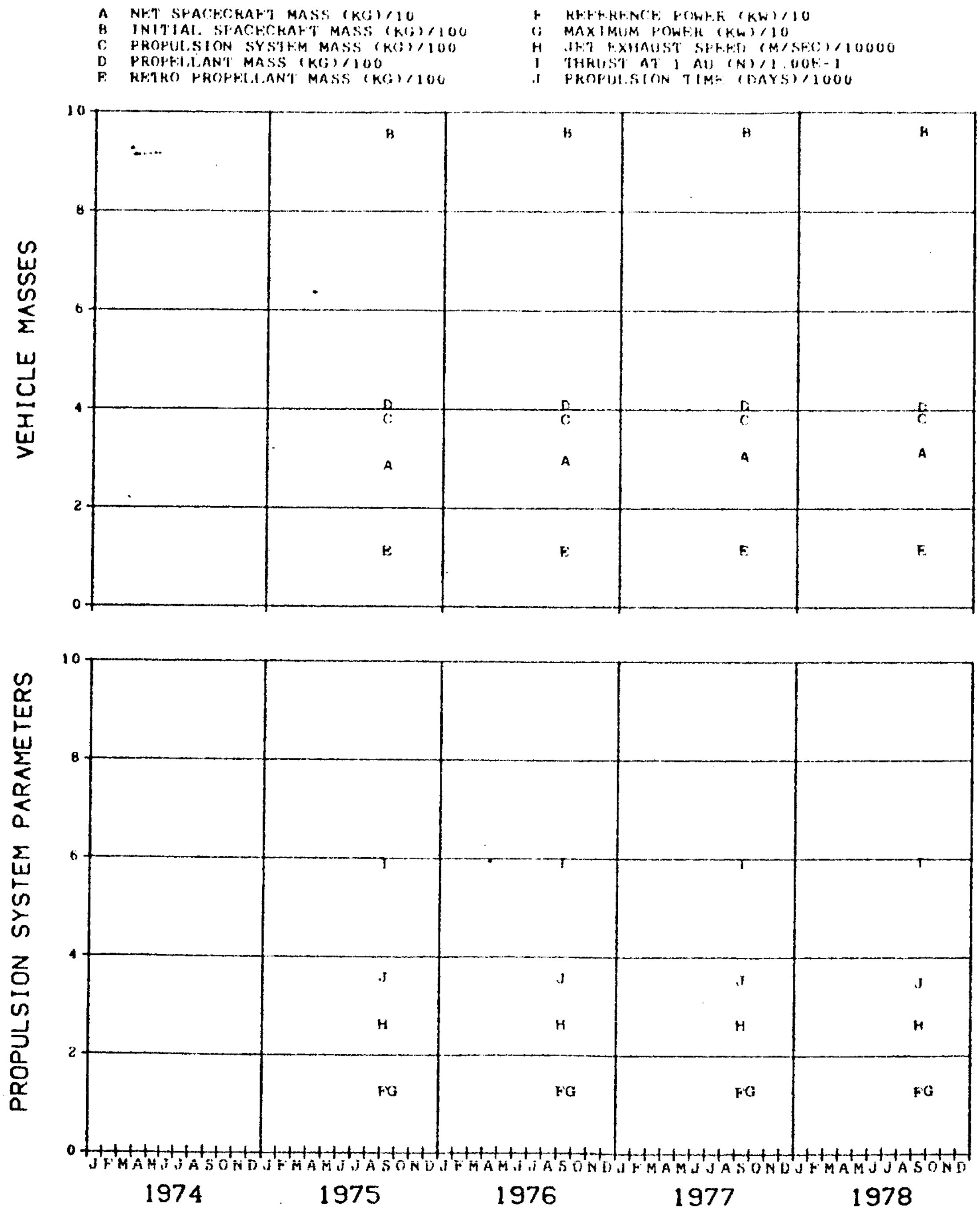

FIG. 45A. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

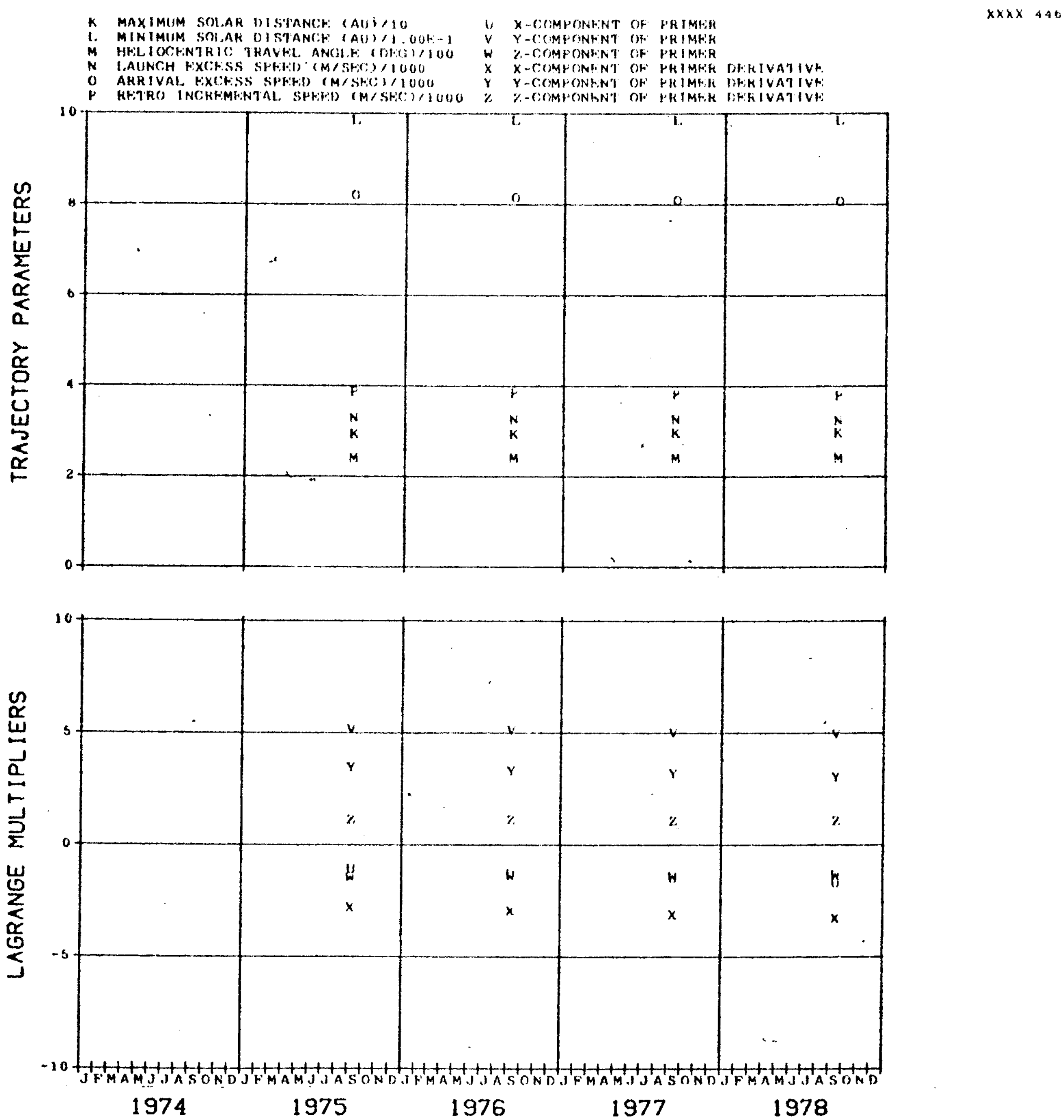

FIG. 45A. (CONCLUDED)

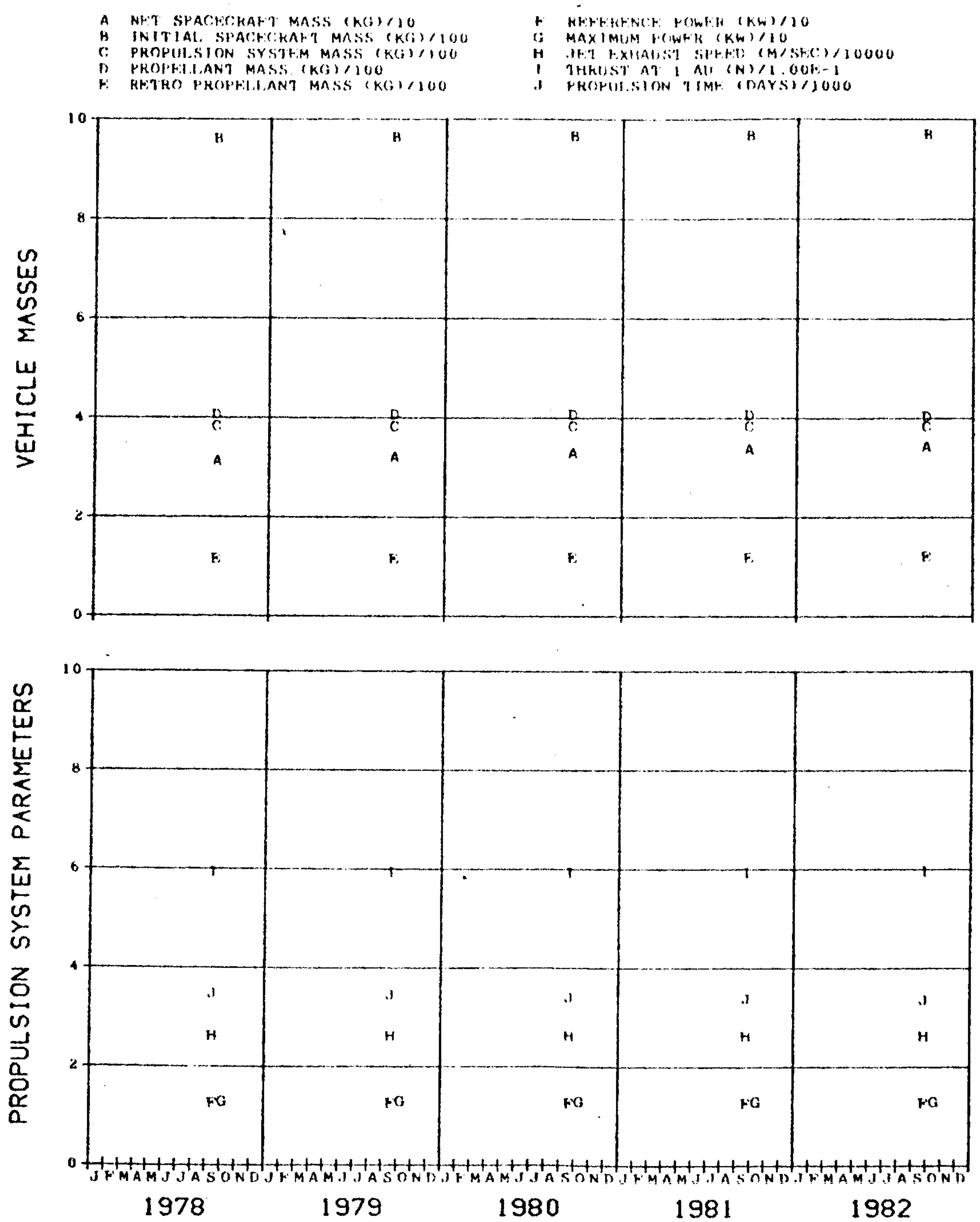

FIG. 45B. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

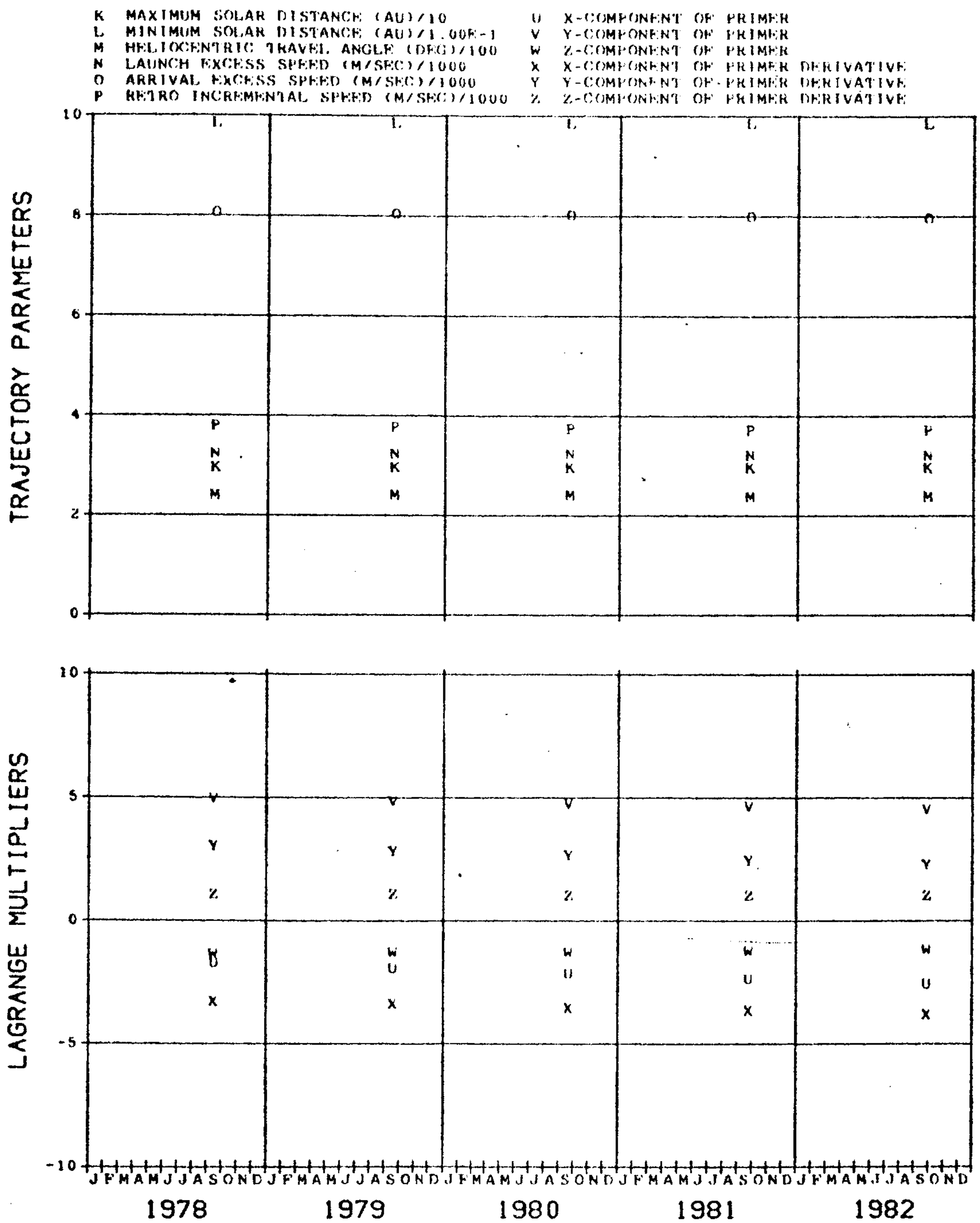

FIG. 45B. (CONCLUDED)

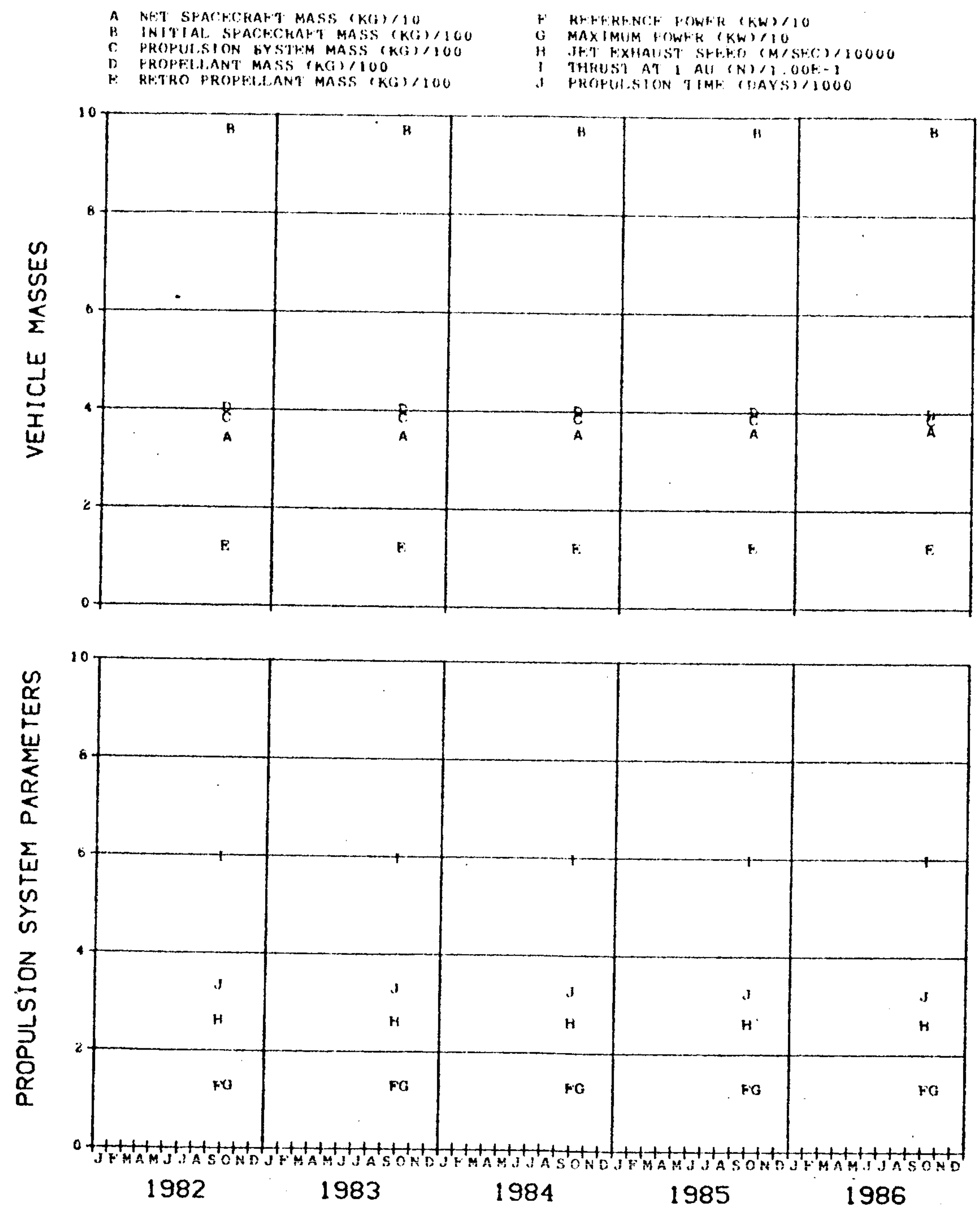

FIG. 45C. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

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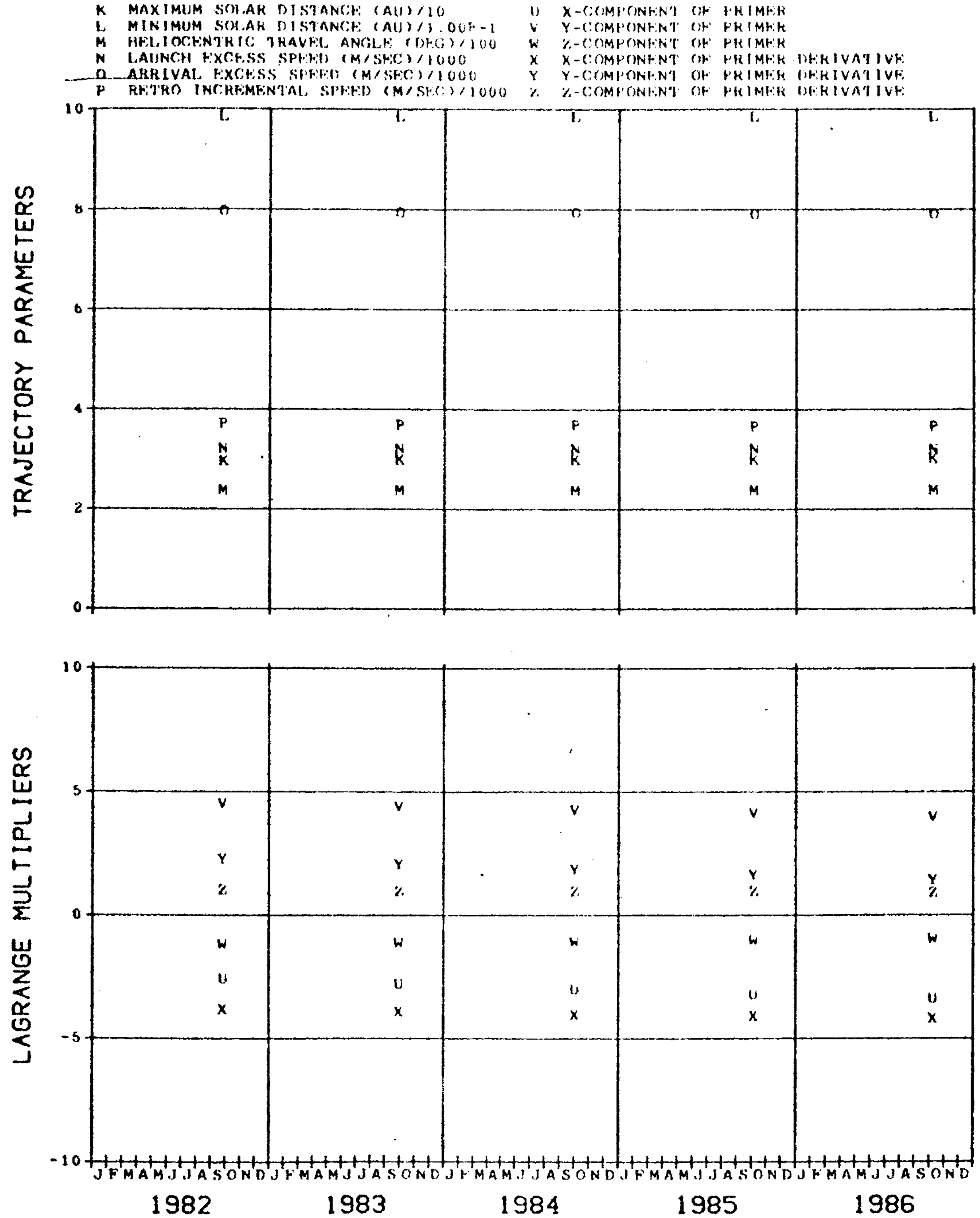

FIG. 45C. (CONCLUDED)

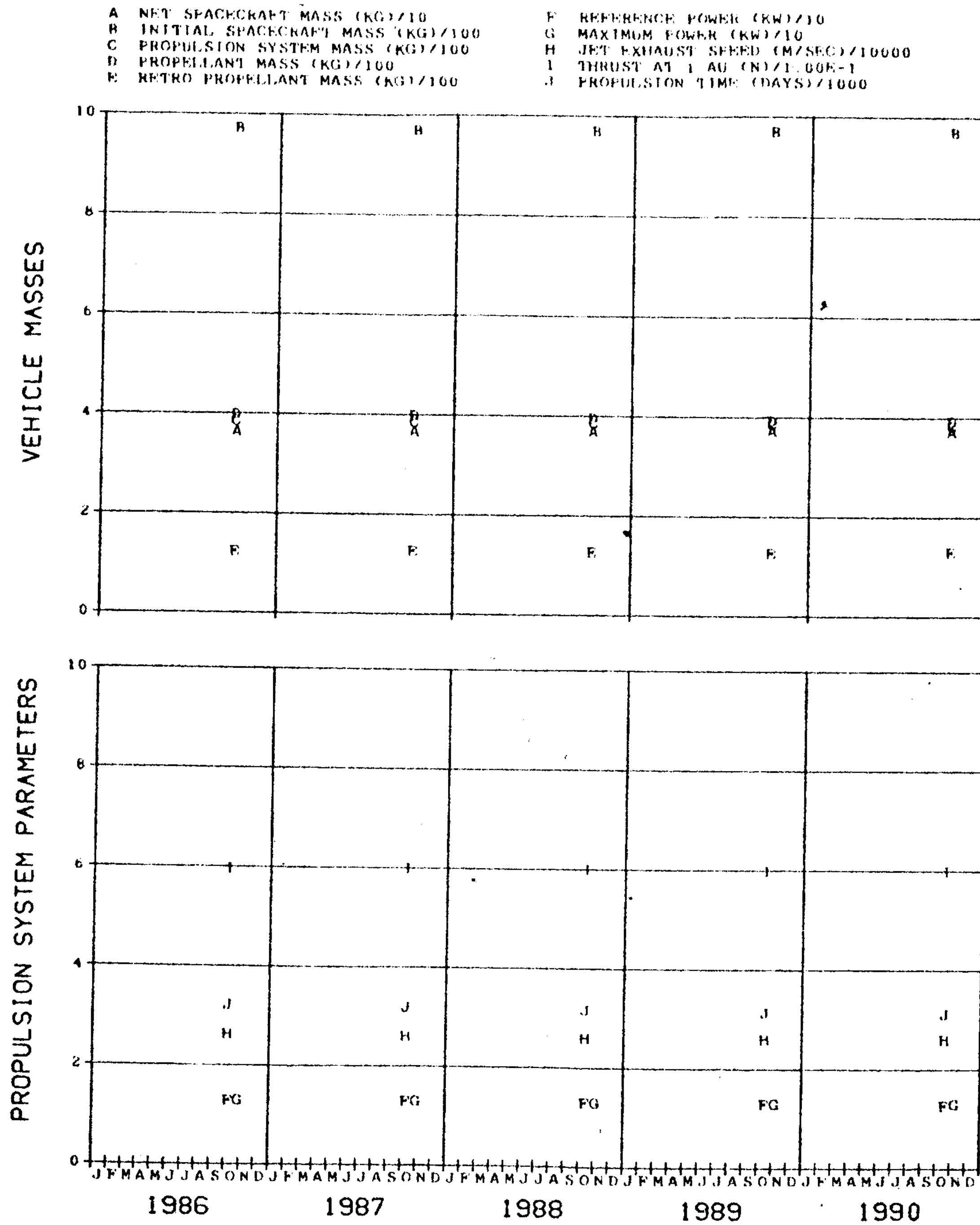

FIG. 45D. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 5000 DAYS

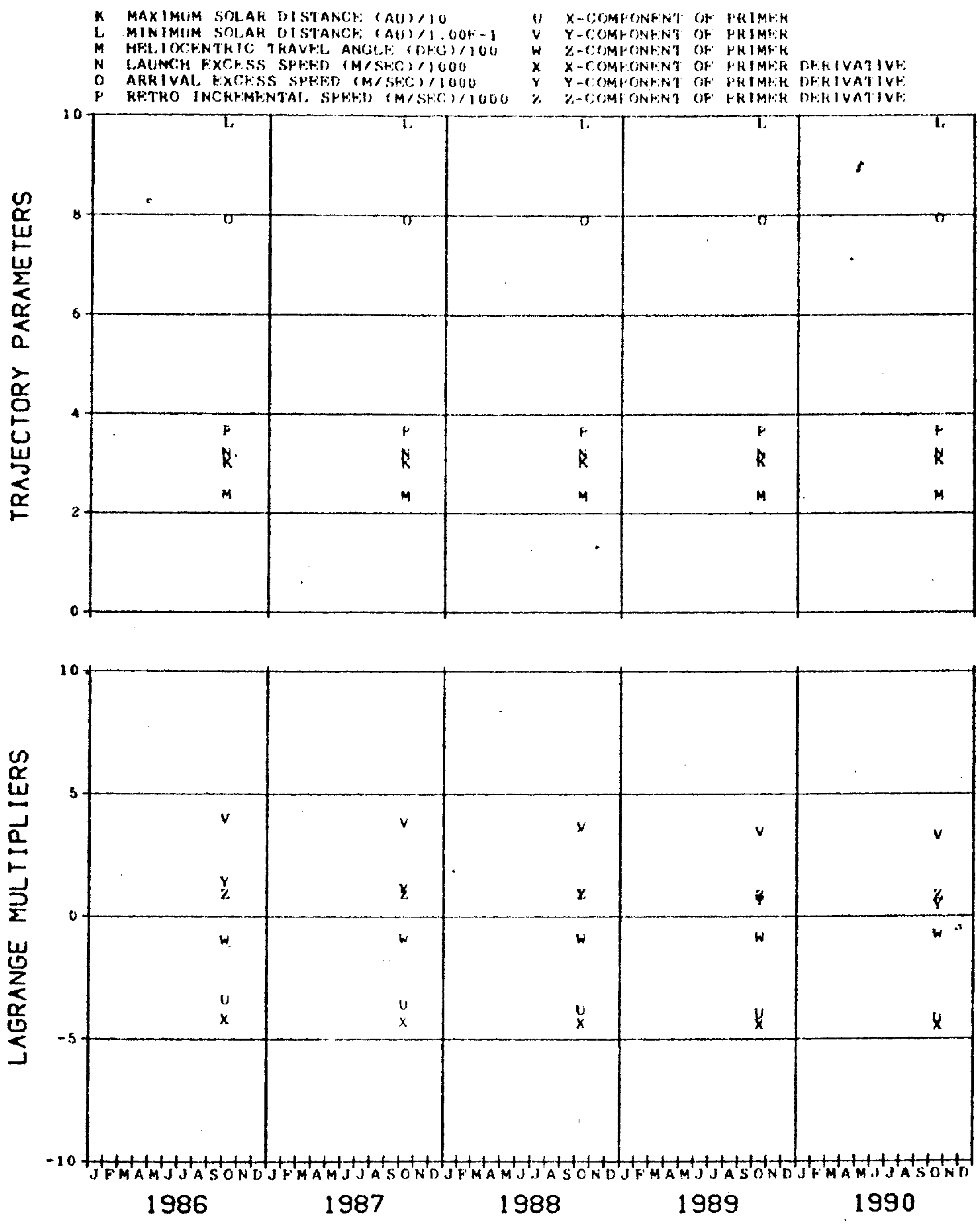

FIG. 45D. (CONCLUDED)

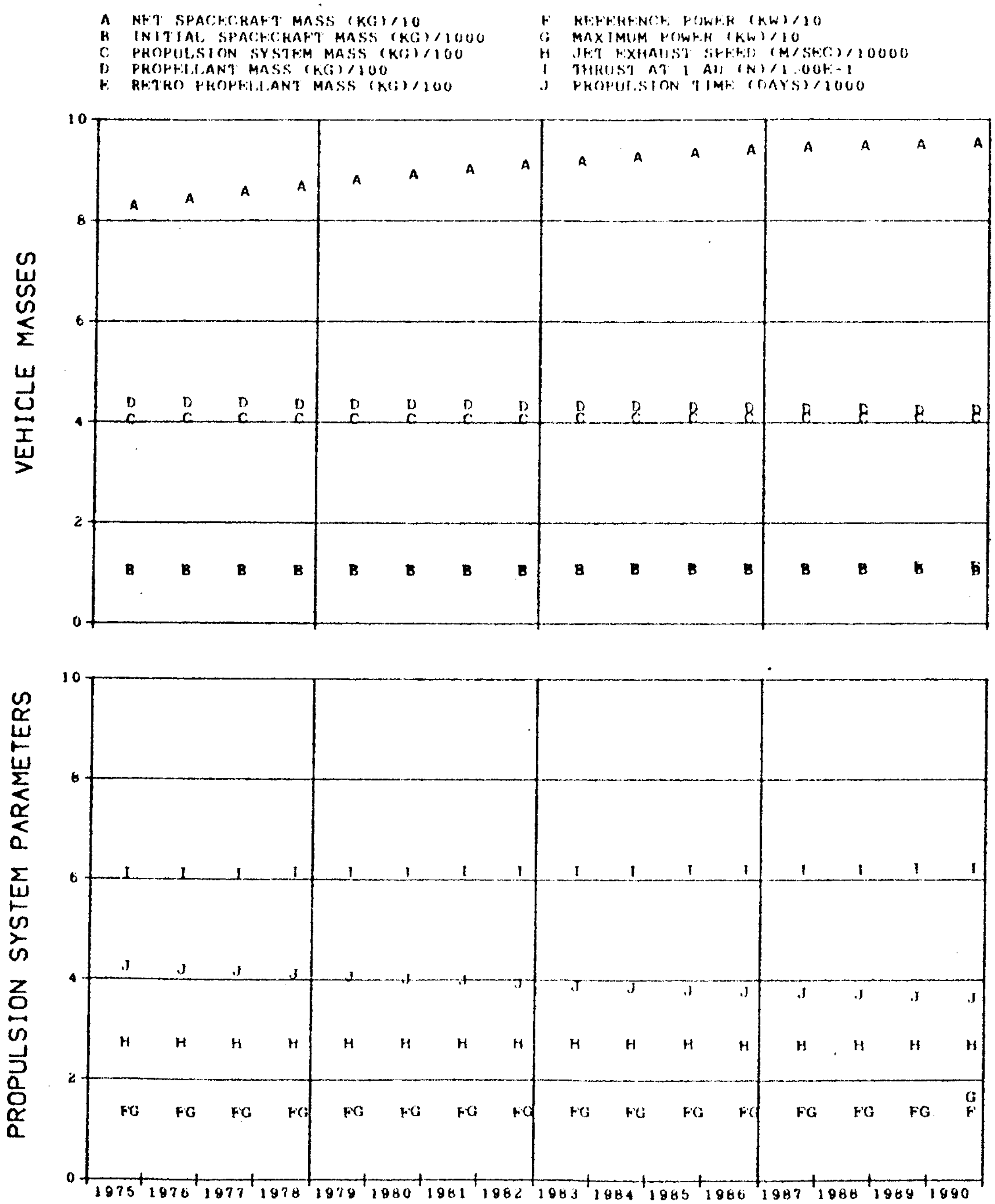

FIG. 46. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6500 DAYS

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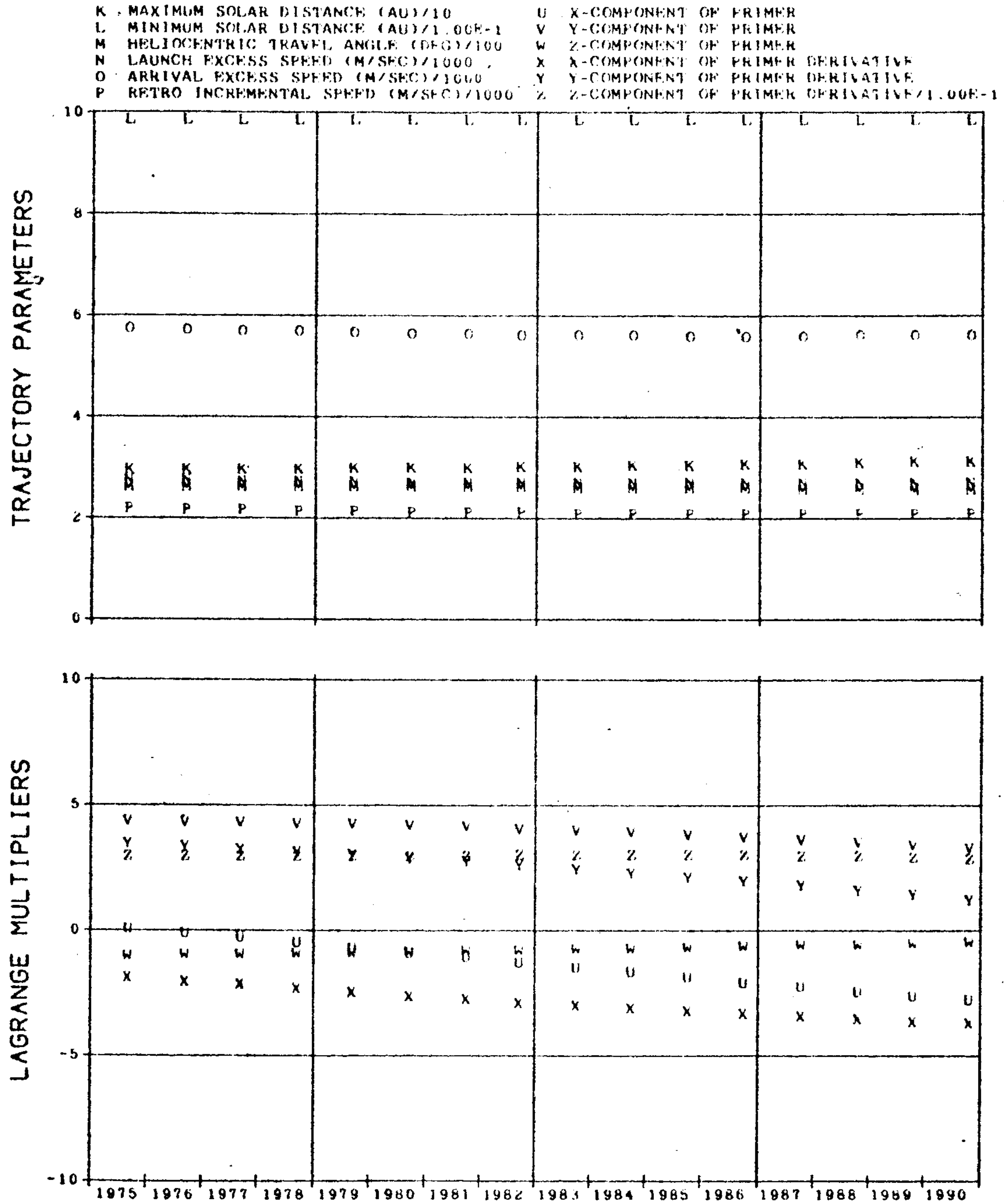

FIG. 46. (CONCLUDED)

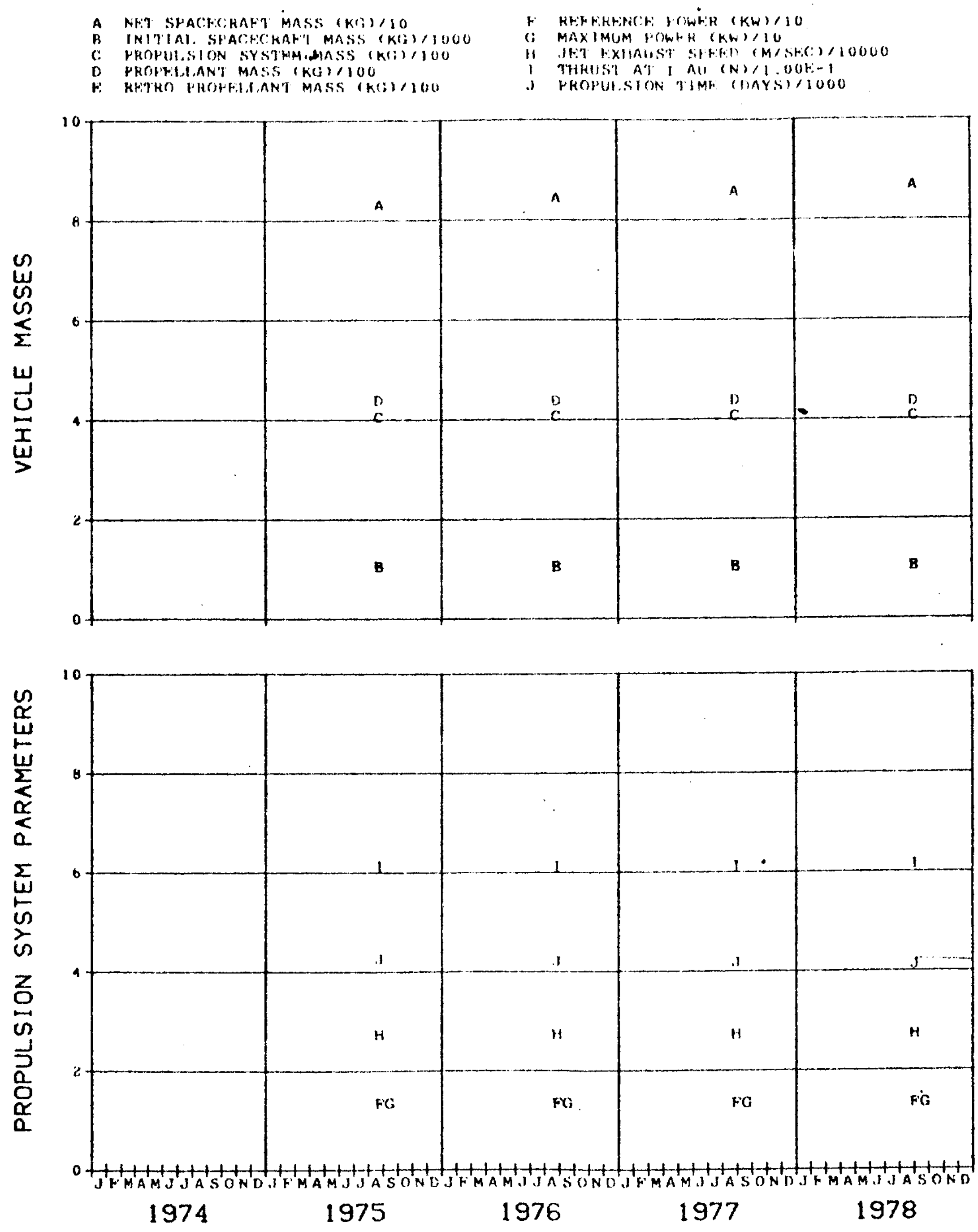

FIG. 46A. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6500 DAYS

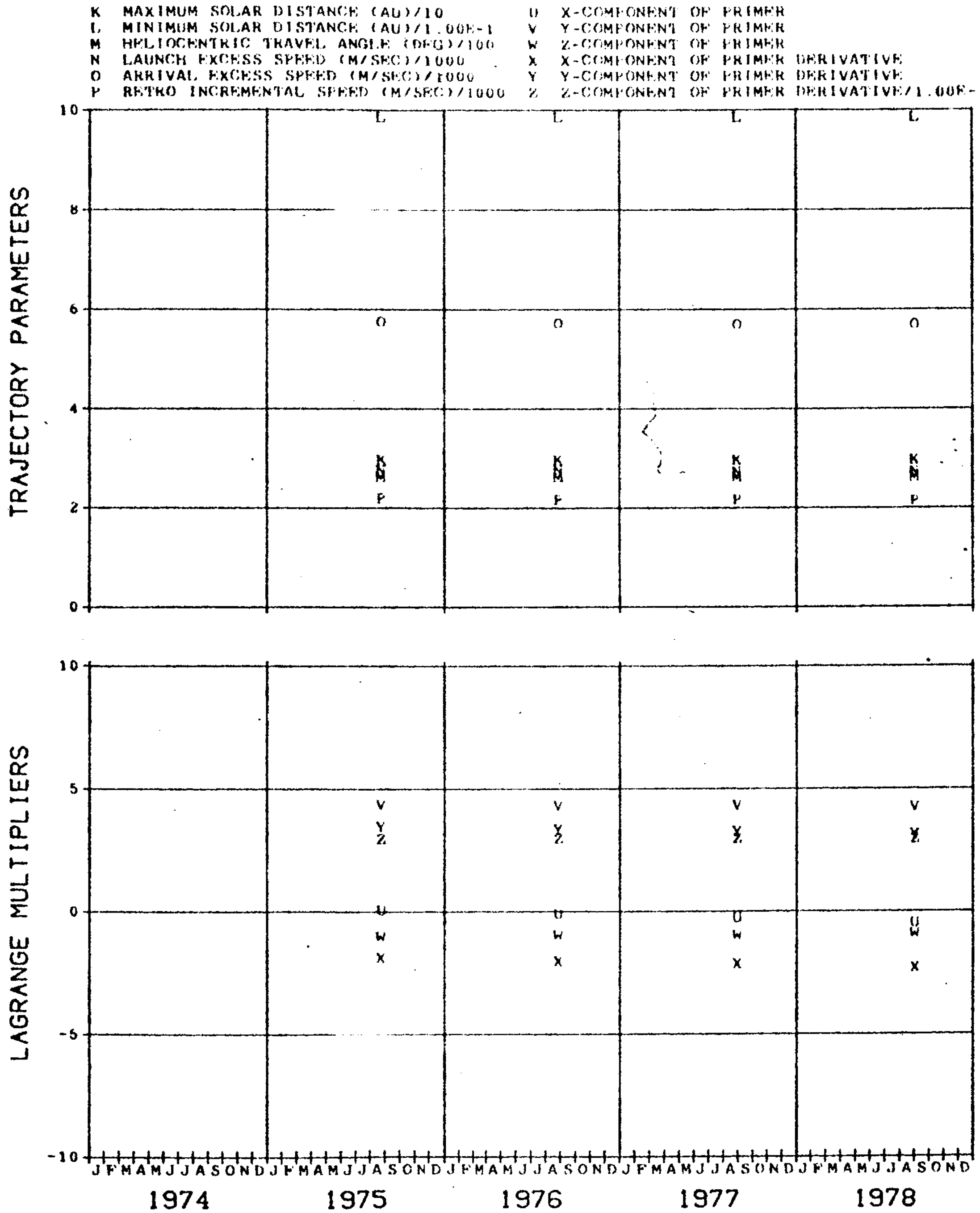

FIG. 46A. (CONCLUDED)

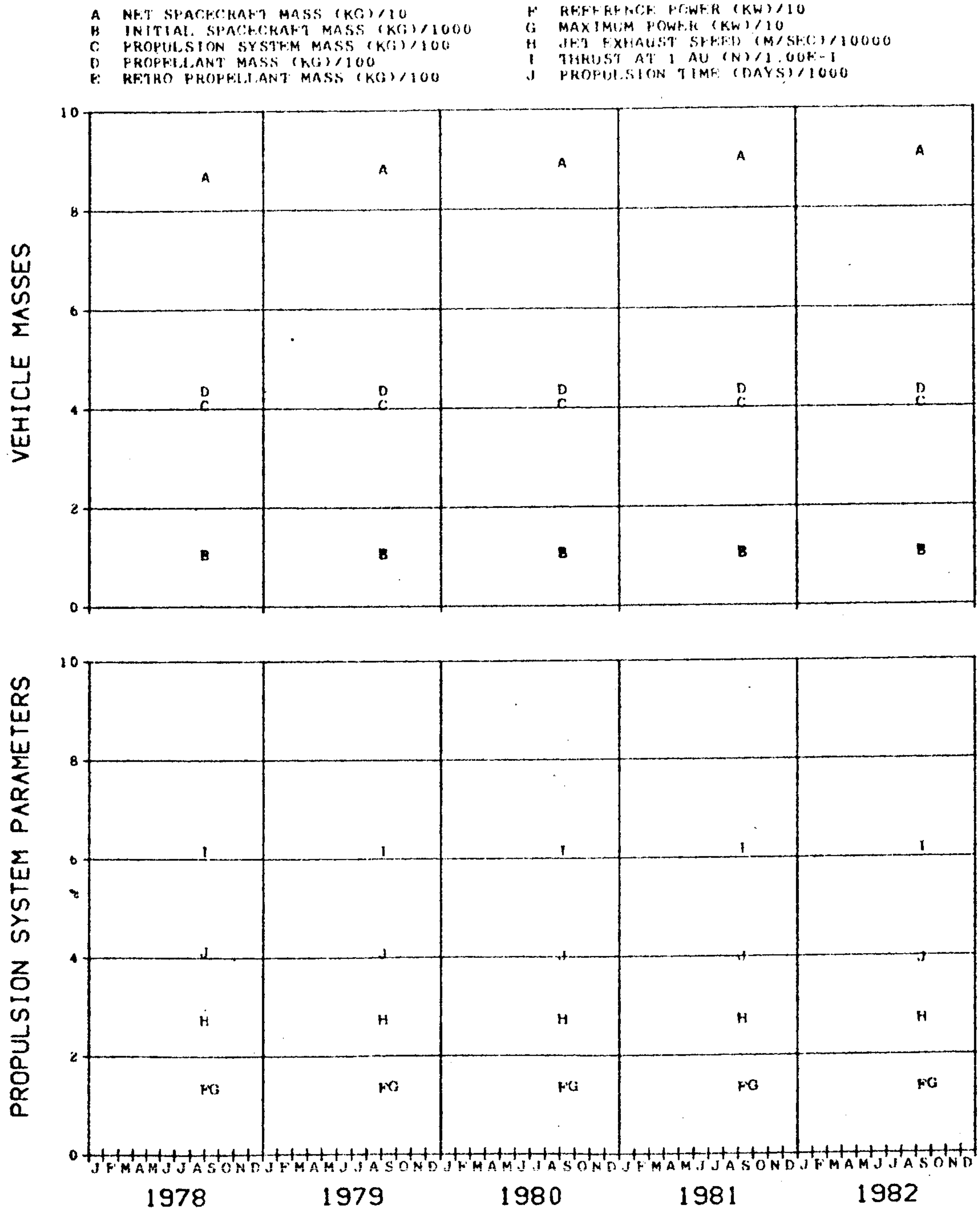

FIG. 46B. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6500 DAYS

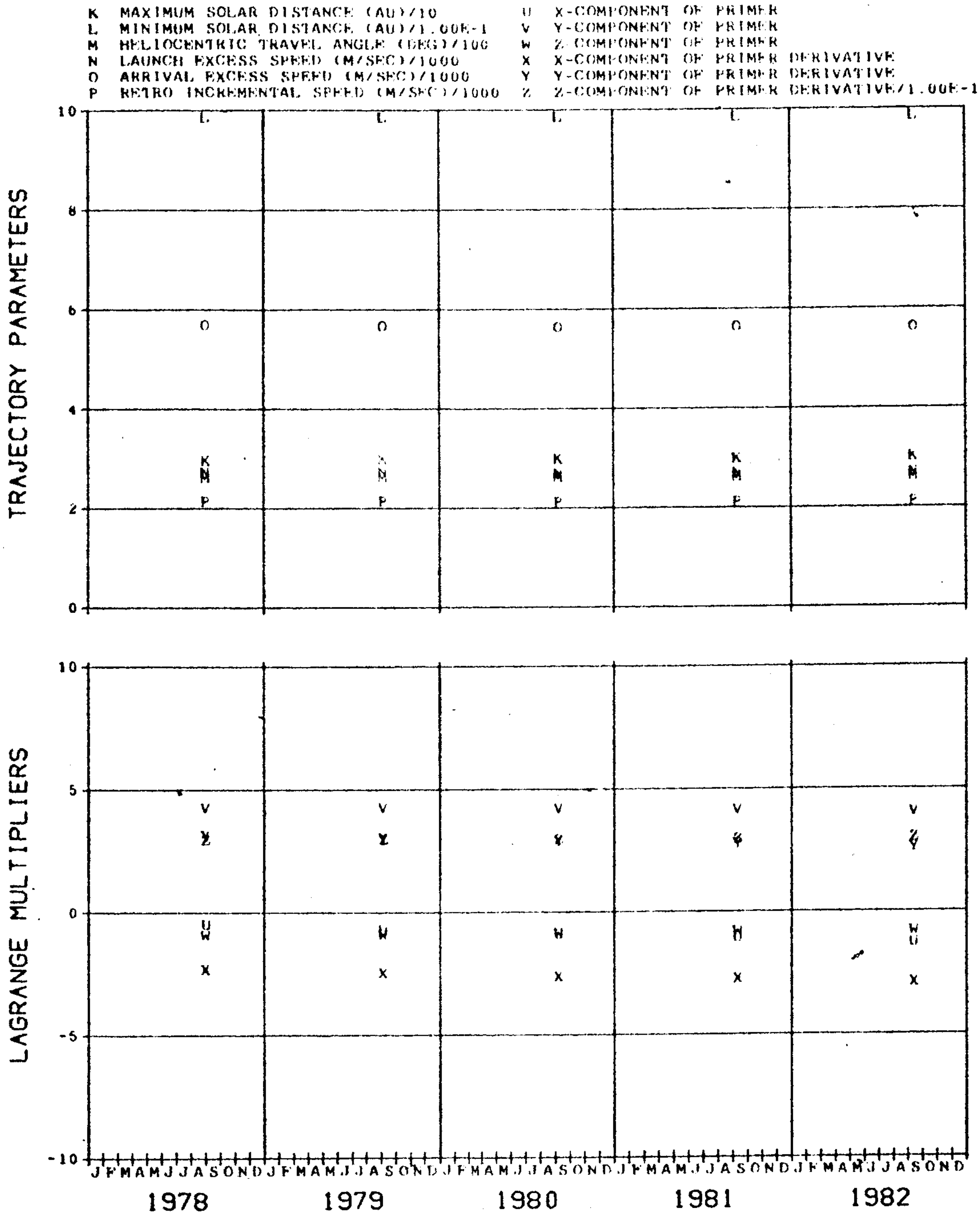

FIG. 46B. (CONCLUDED)

A NET SPACECRAFT MASS (KG)/10
B INITIAL SPACECRAFT MASS (KG)/1000
C PROPULSION SYSTEM MASS (KG)/100
D PROPELLANT MASS (KG)/100
E RETRO PROPELLANT MASS (KG)/100
F REFERENCE POWER (KW)/10
G MAXIMUM POWER (KW)/10
H JET EXHAUST SPEED (M/SEC)/10000
I THRUST AT 1 AU (N)/1.00E-1
J PROPULSION TIME (DAYS)/1000

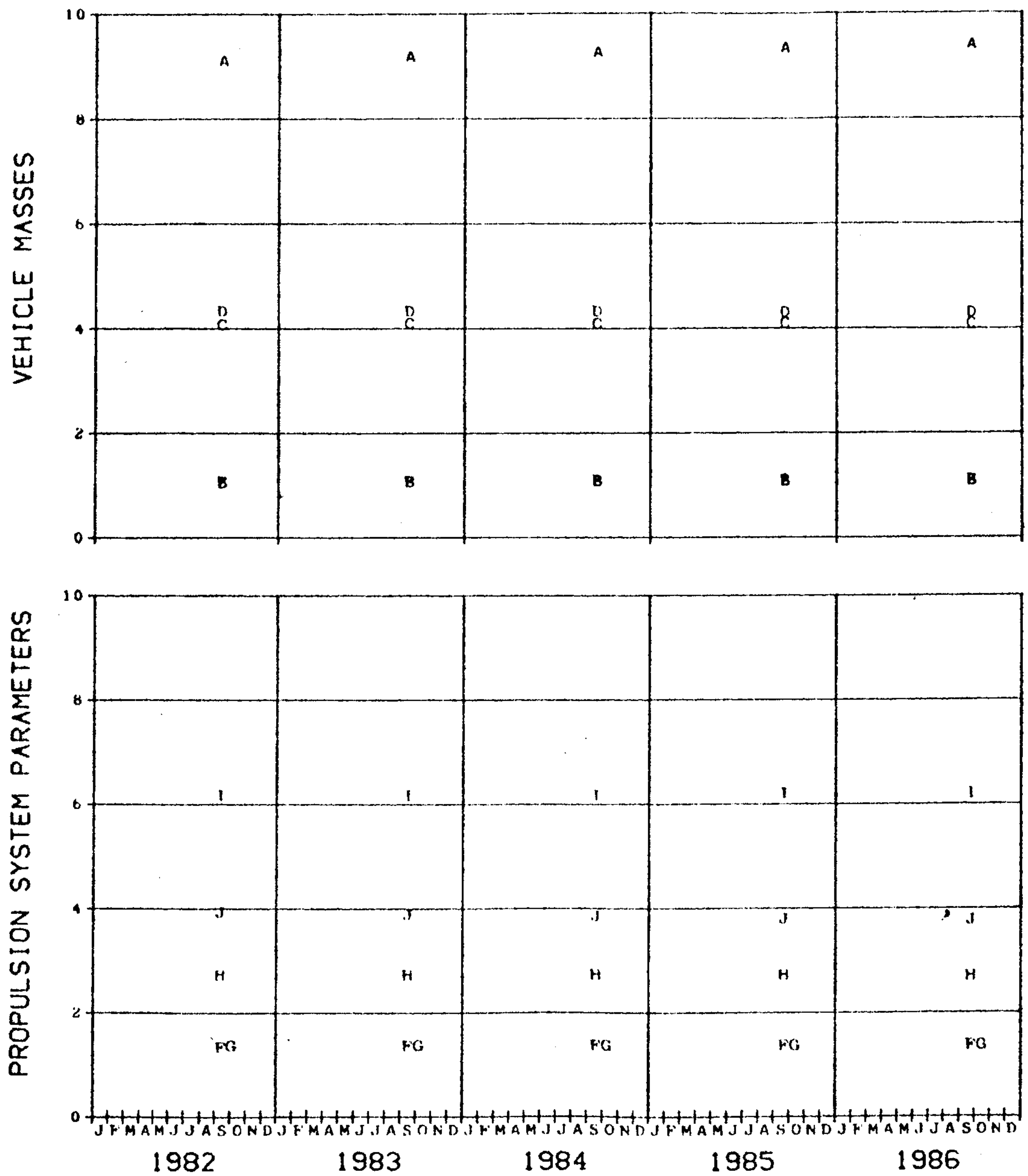

FIG. 46C. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6500 DAYS

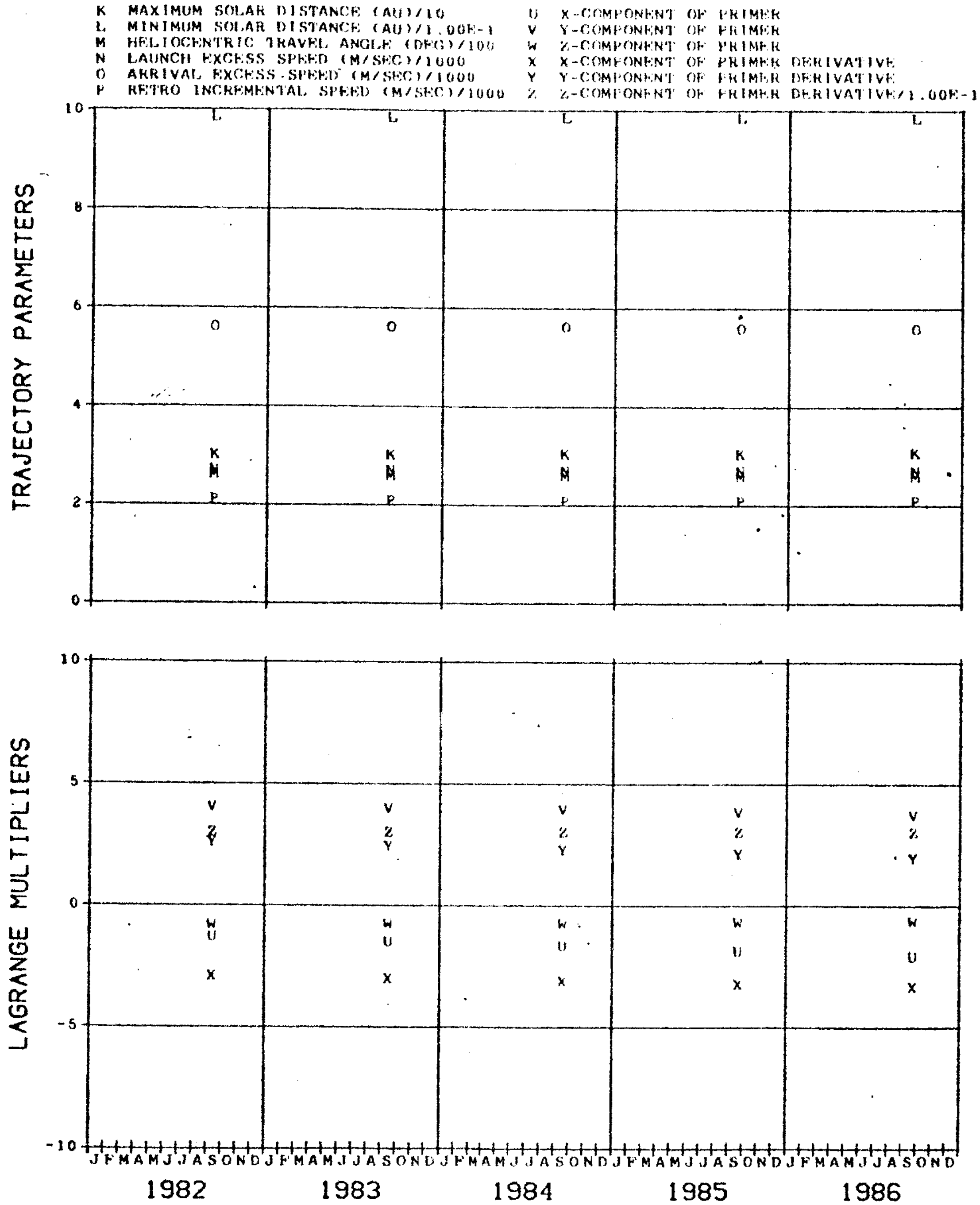

FIG. 46C. (CONCLUDED)

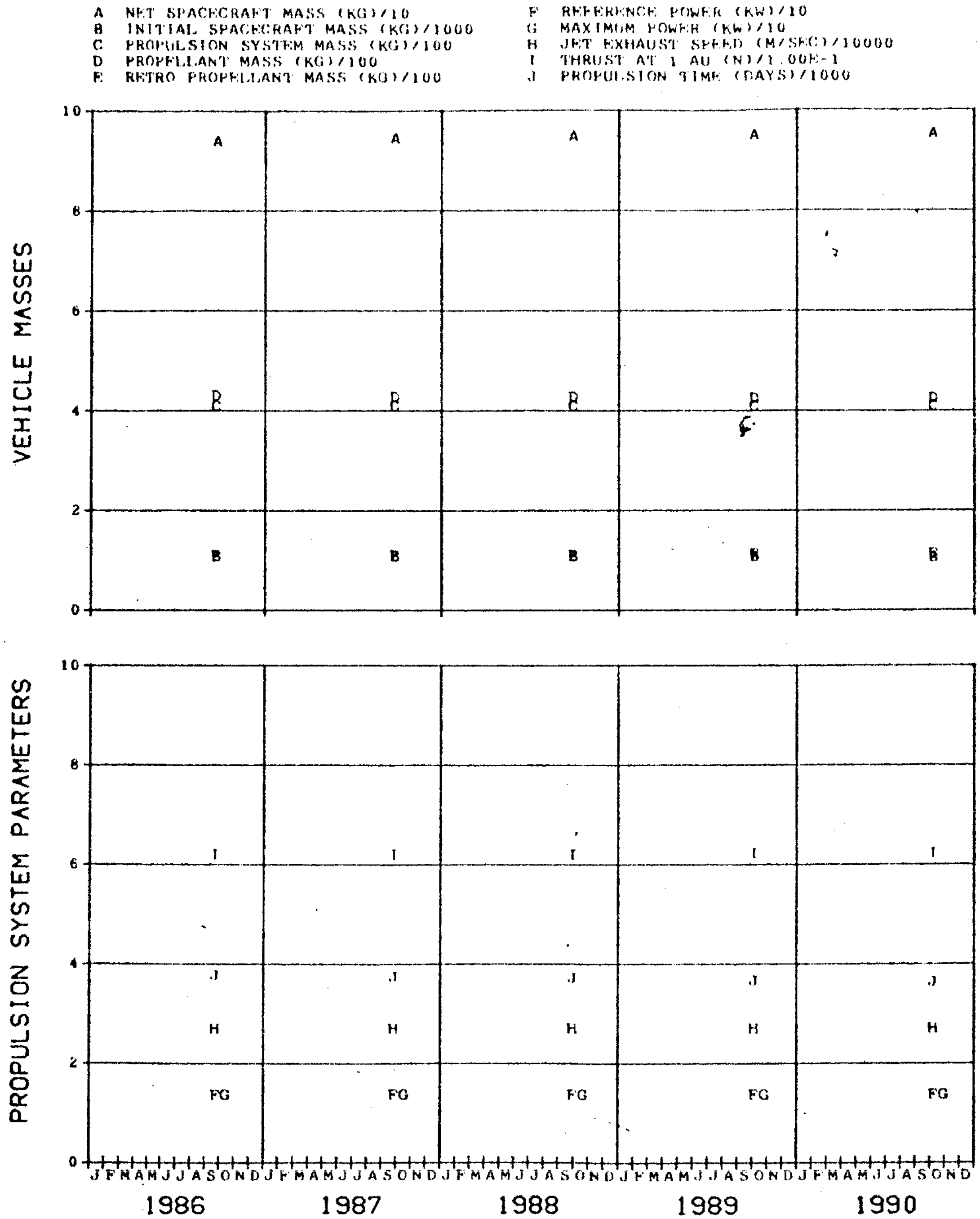

FIG. 46D. PLUTO MODE A ORBITER OPPORTUNITIES
FLIGHT TIME 6500 DAYS

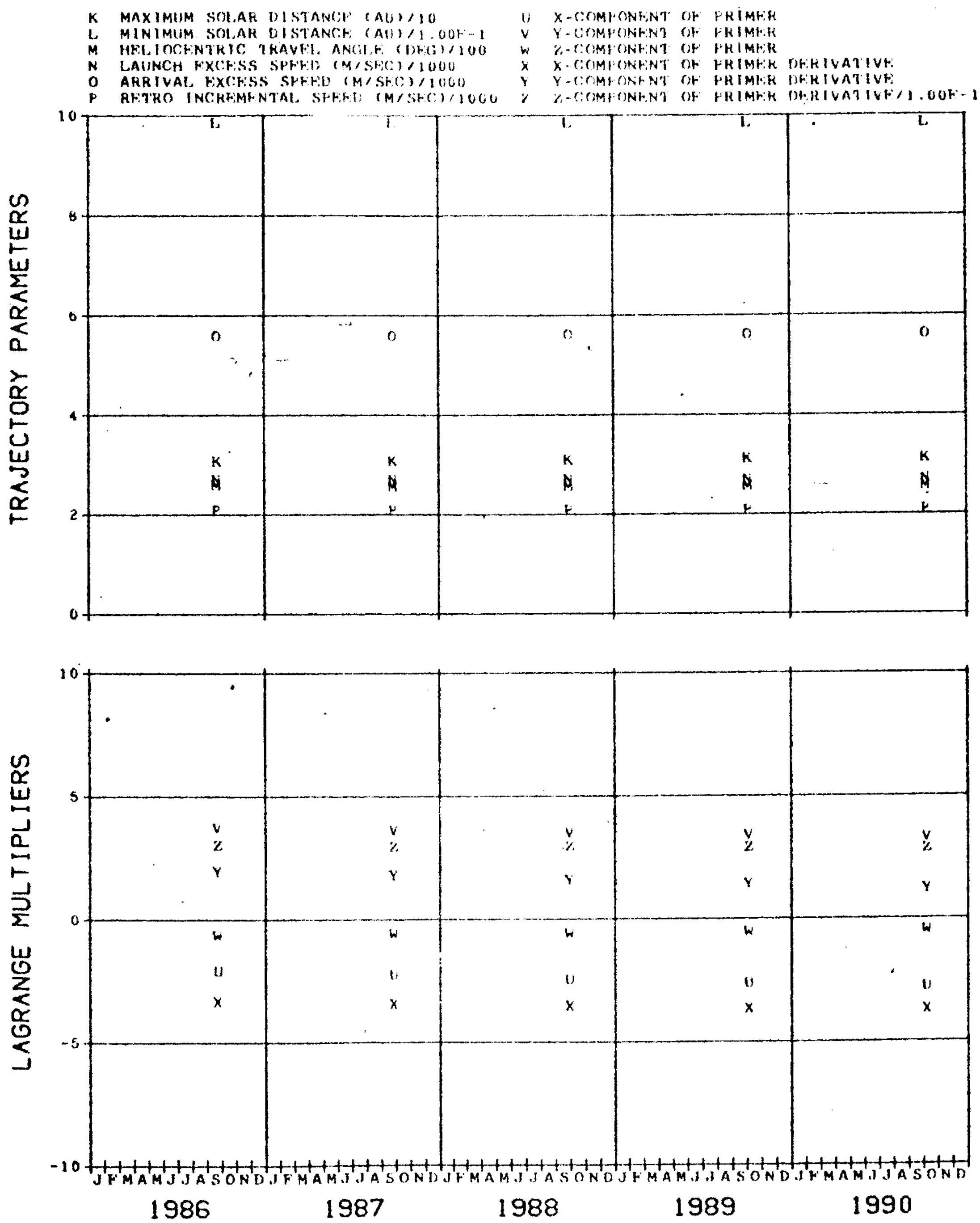

FIG. 46D. (CONCLUDED)

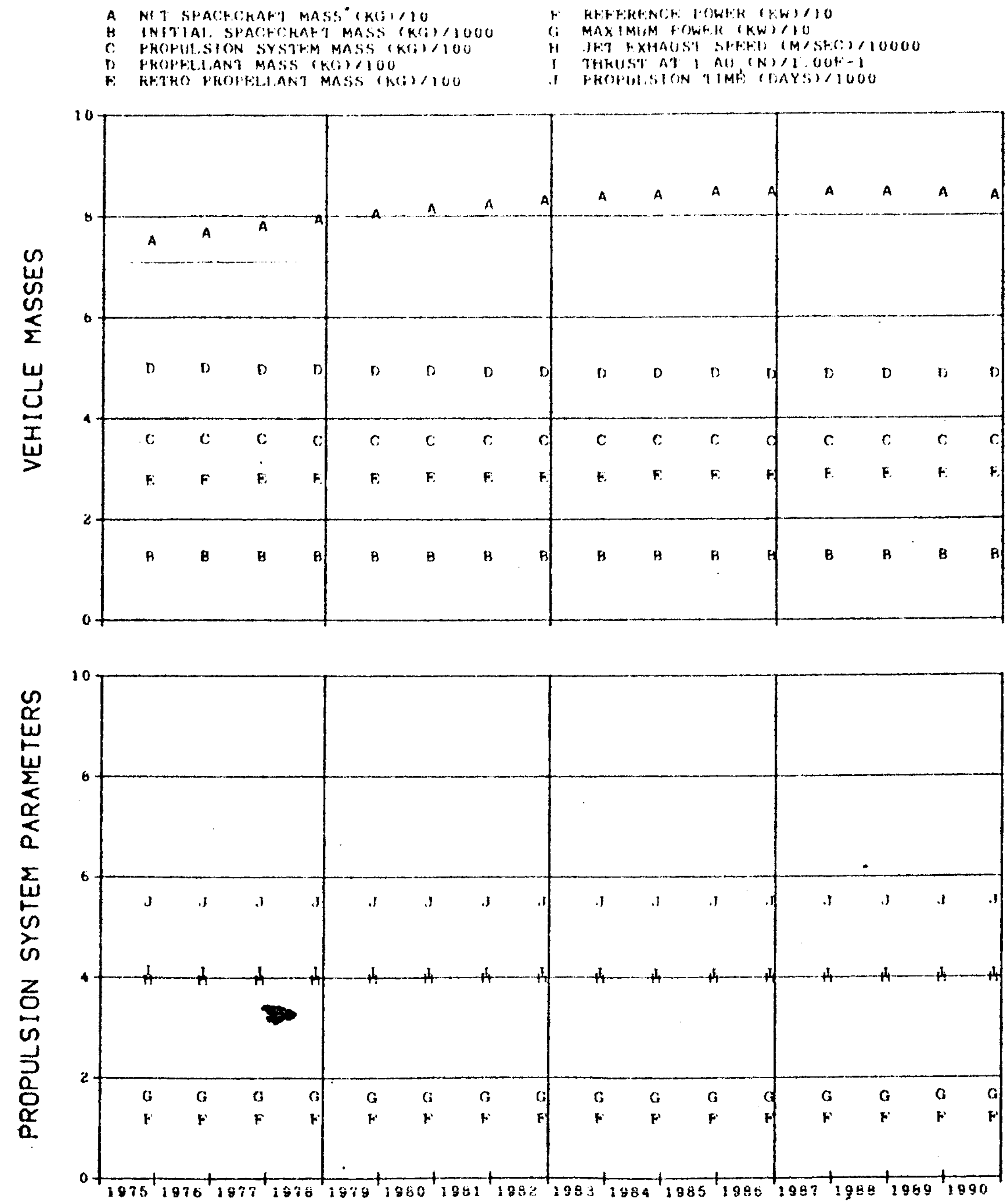

FIG. 47. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

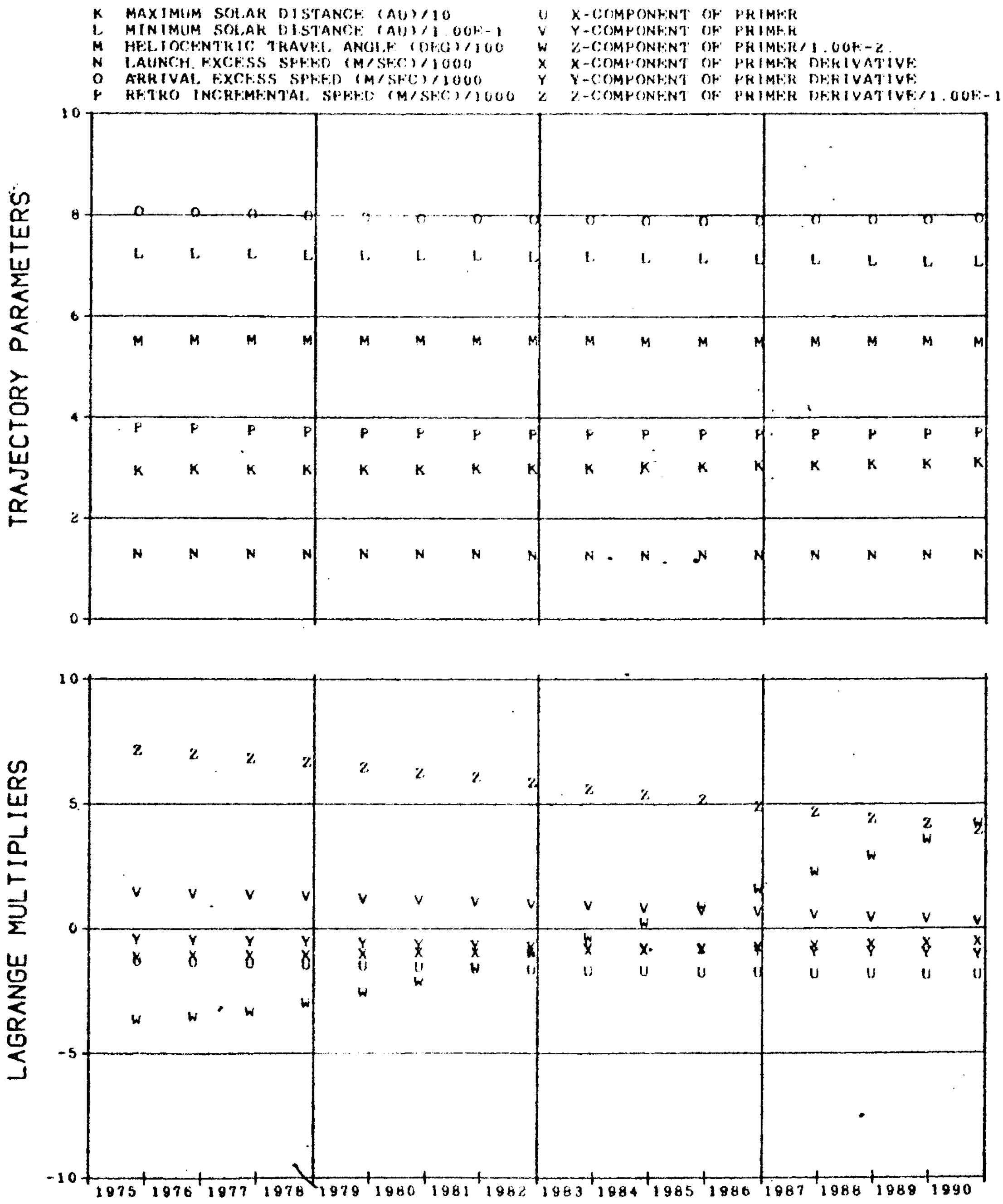

FIG. 47. (CONCLUDED)

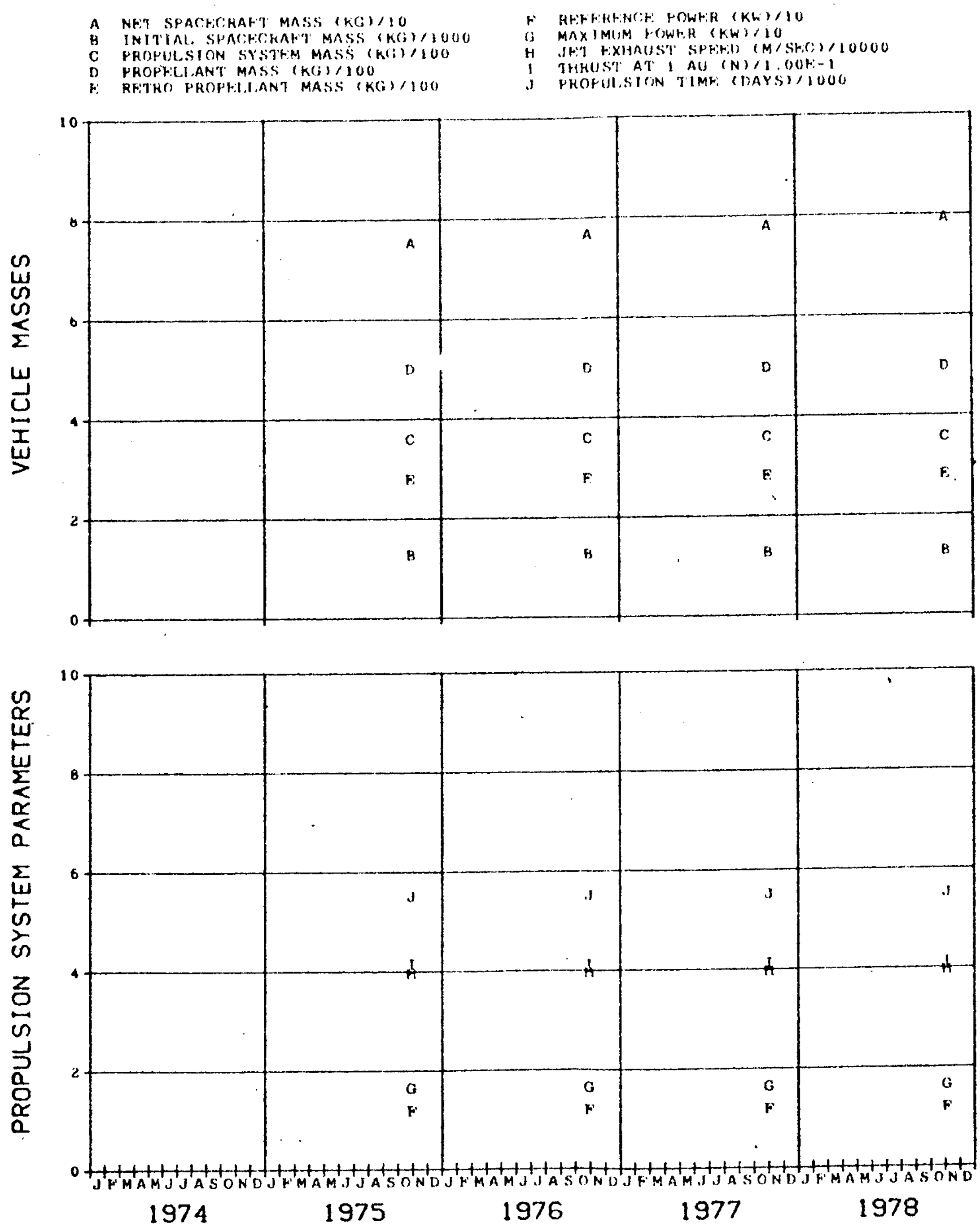

FIG. 47A. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

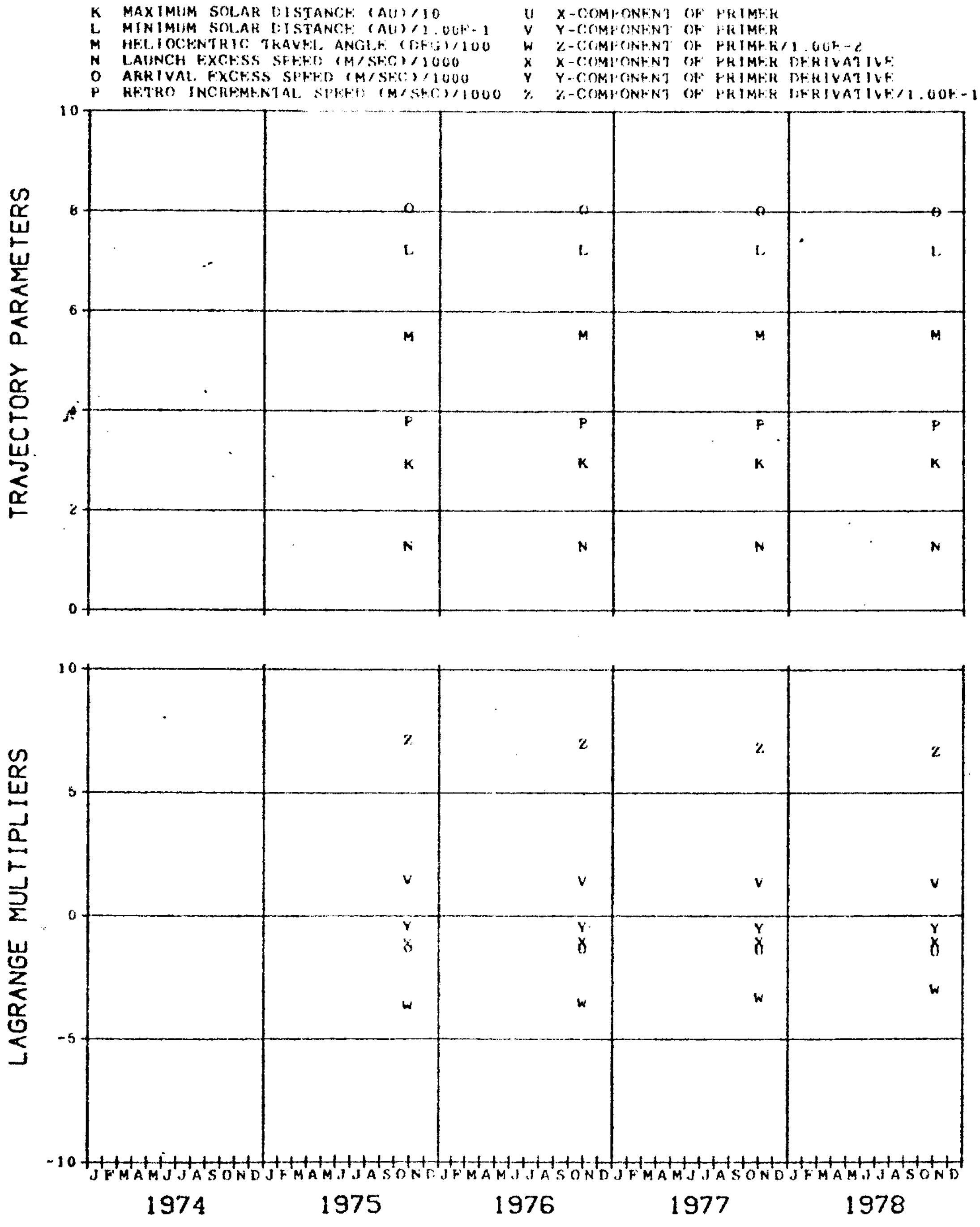

FIG. 47A. (CONCLUDED)

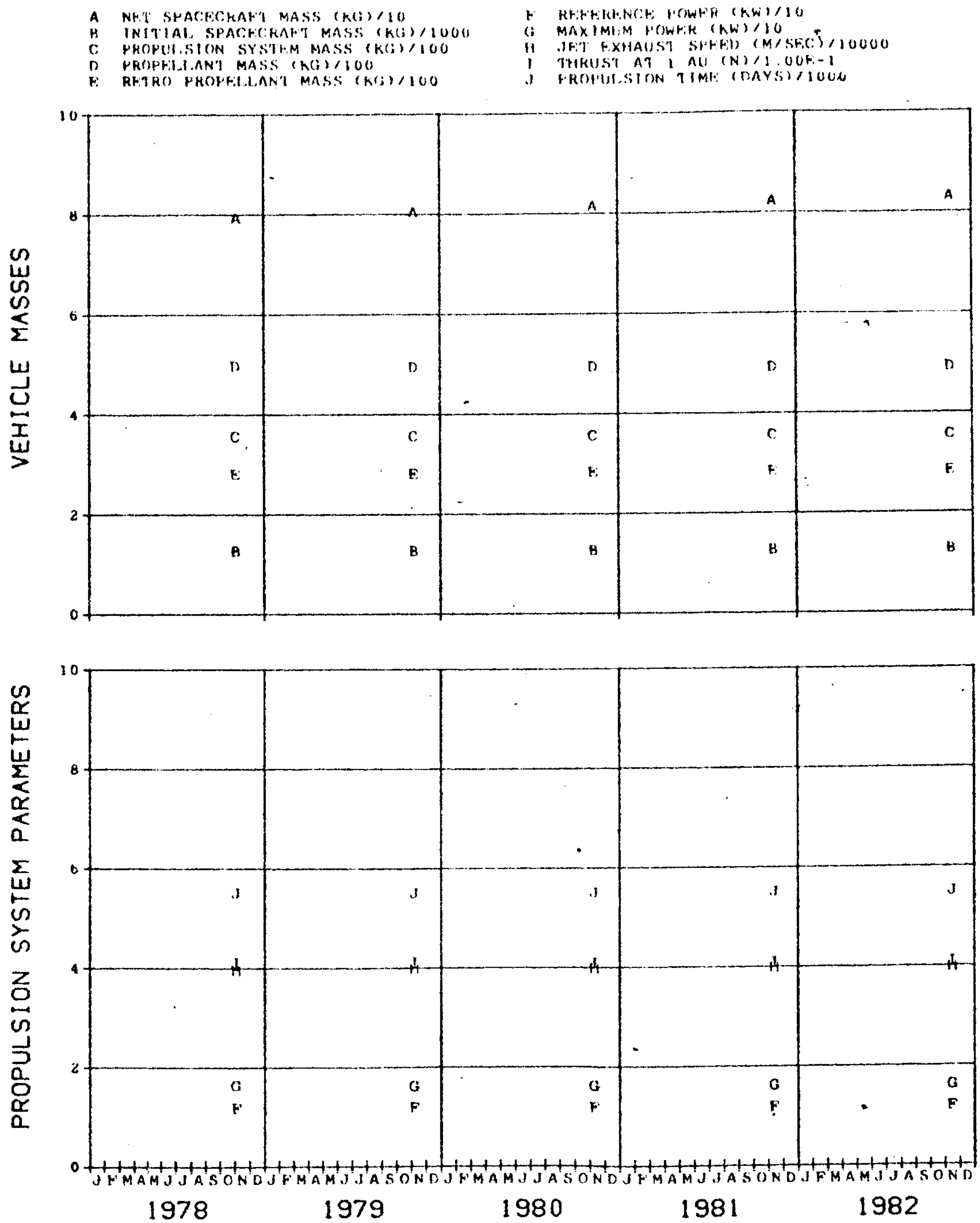

FIG. 47B. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

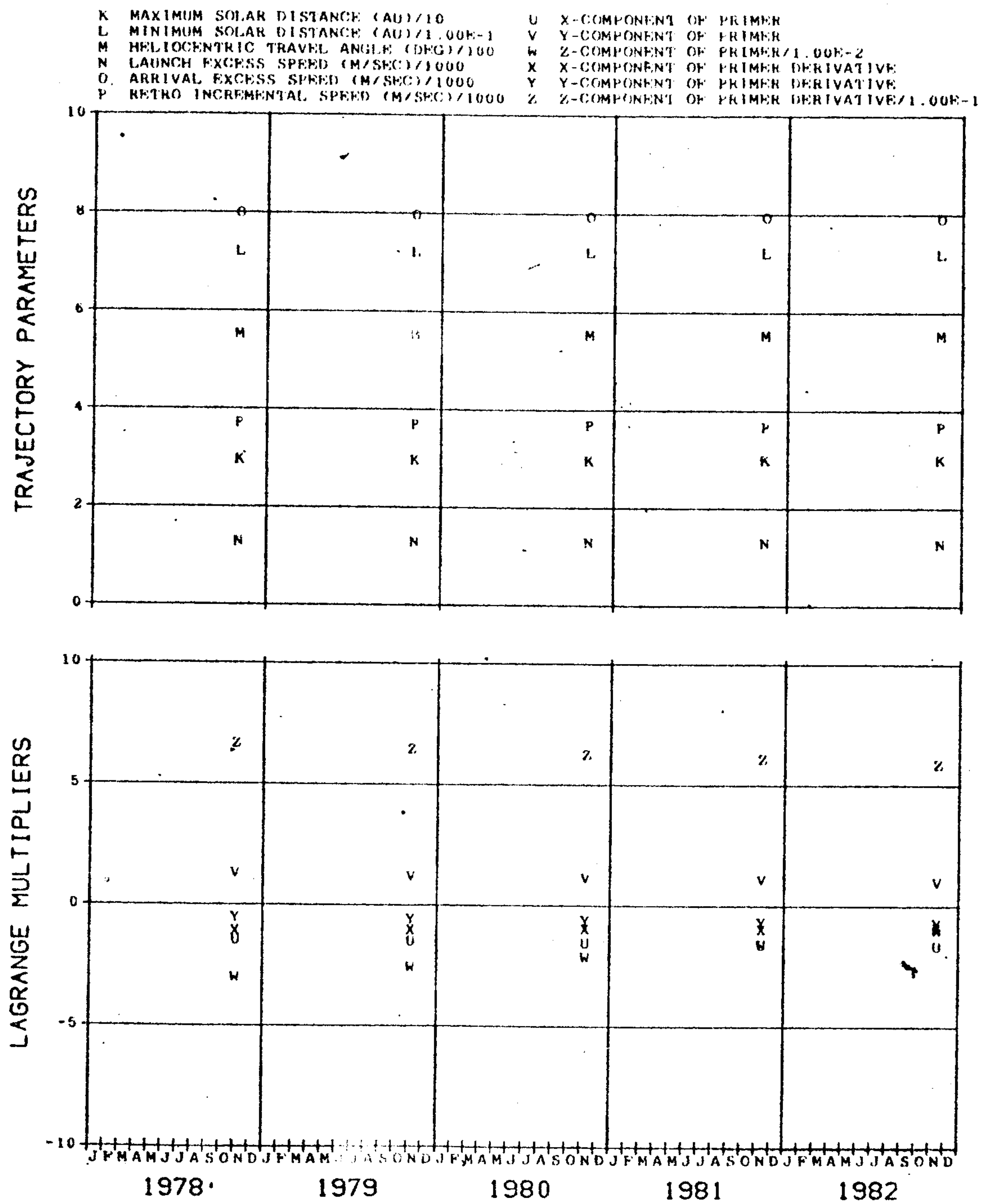

FIG. 47B. (CONCLUDED)

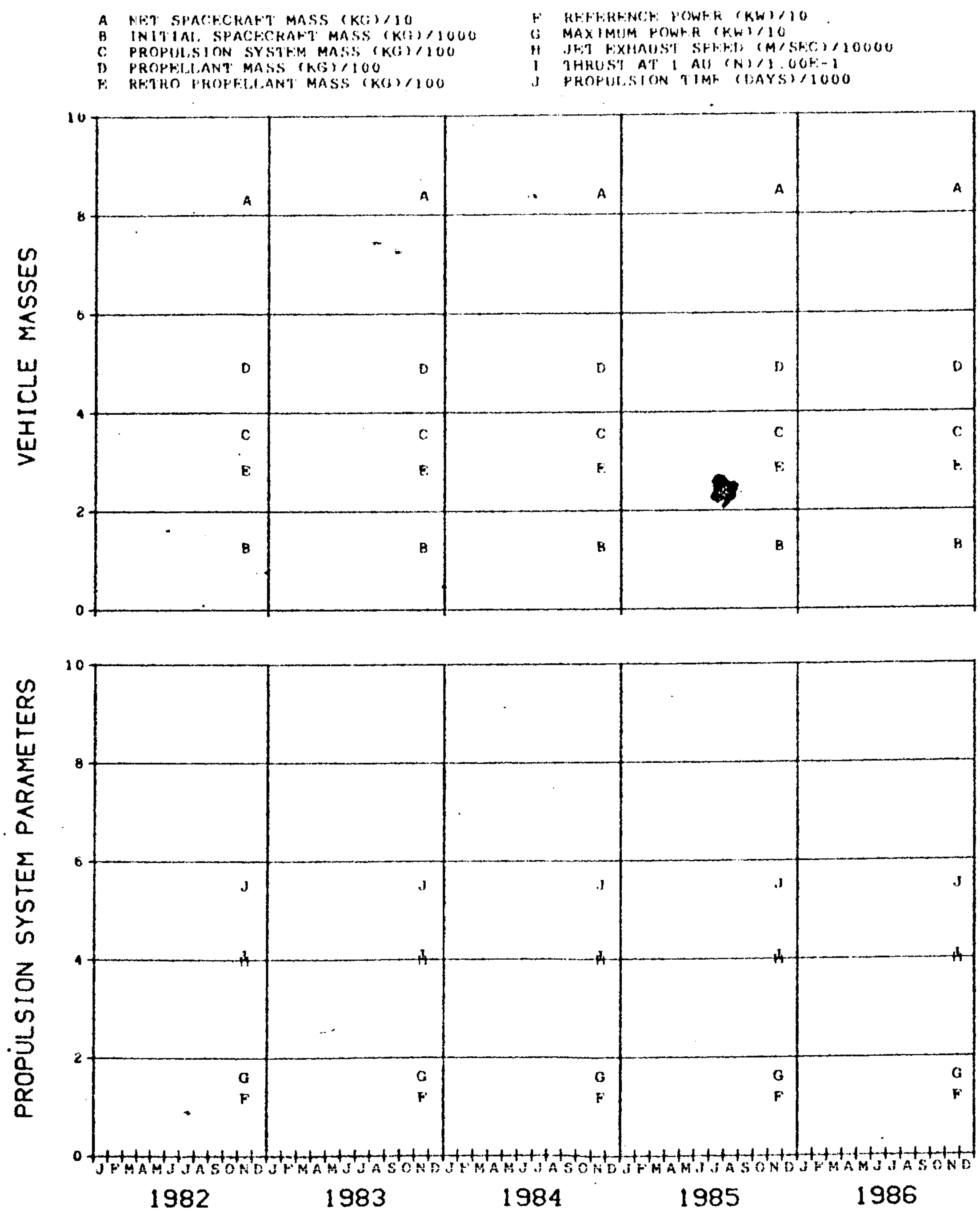

FIG. 47C. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

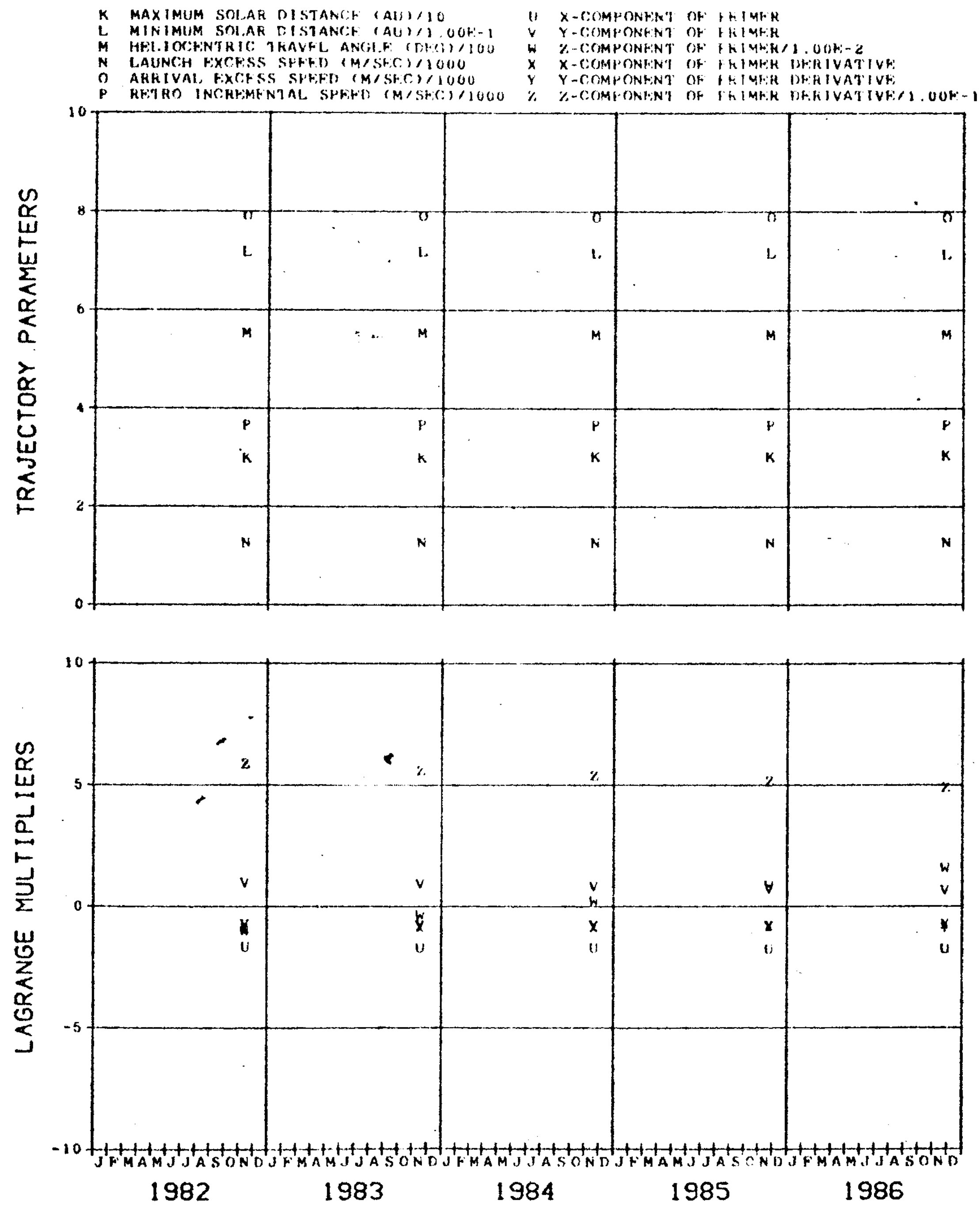

FIG. 47C. (CONCLUDED)

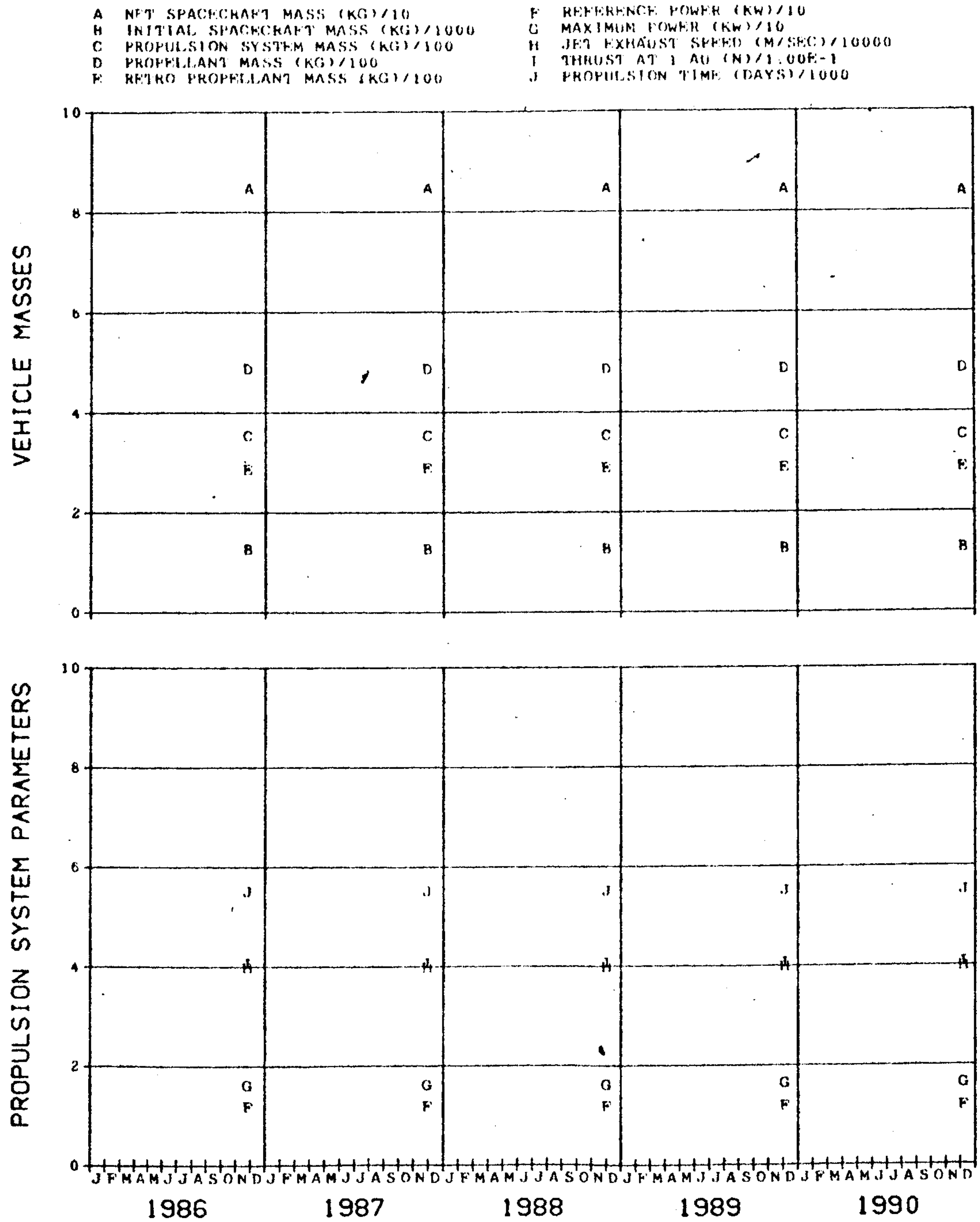

FIG. 47D. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5500 DAYS

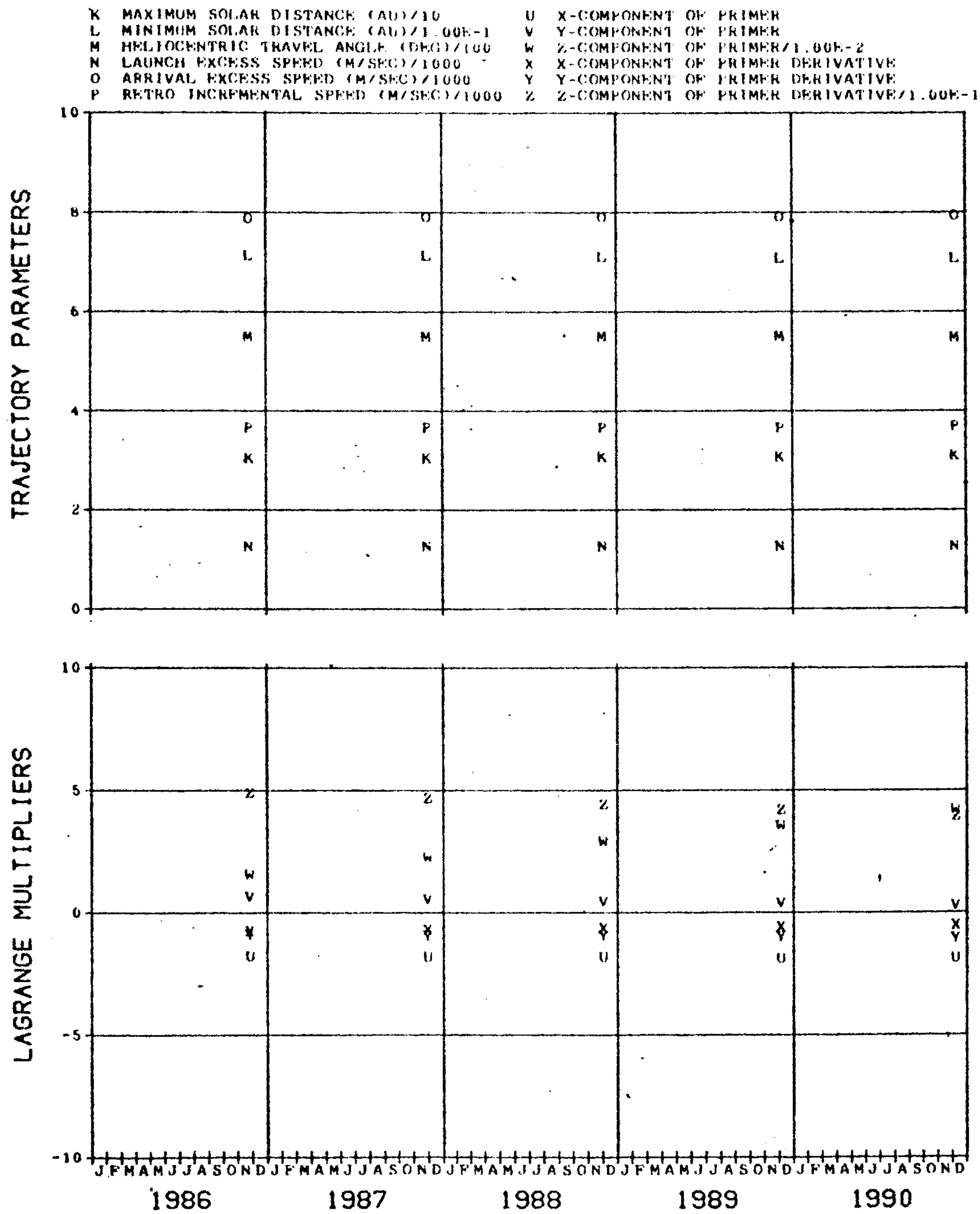

FIG. 47D. (CONCLUDED)

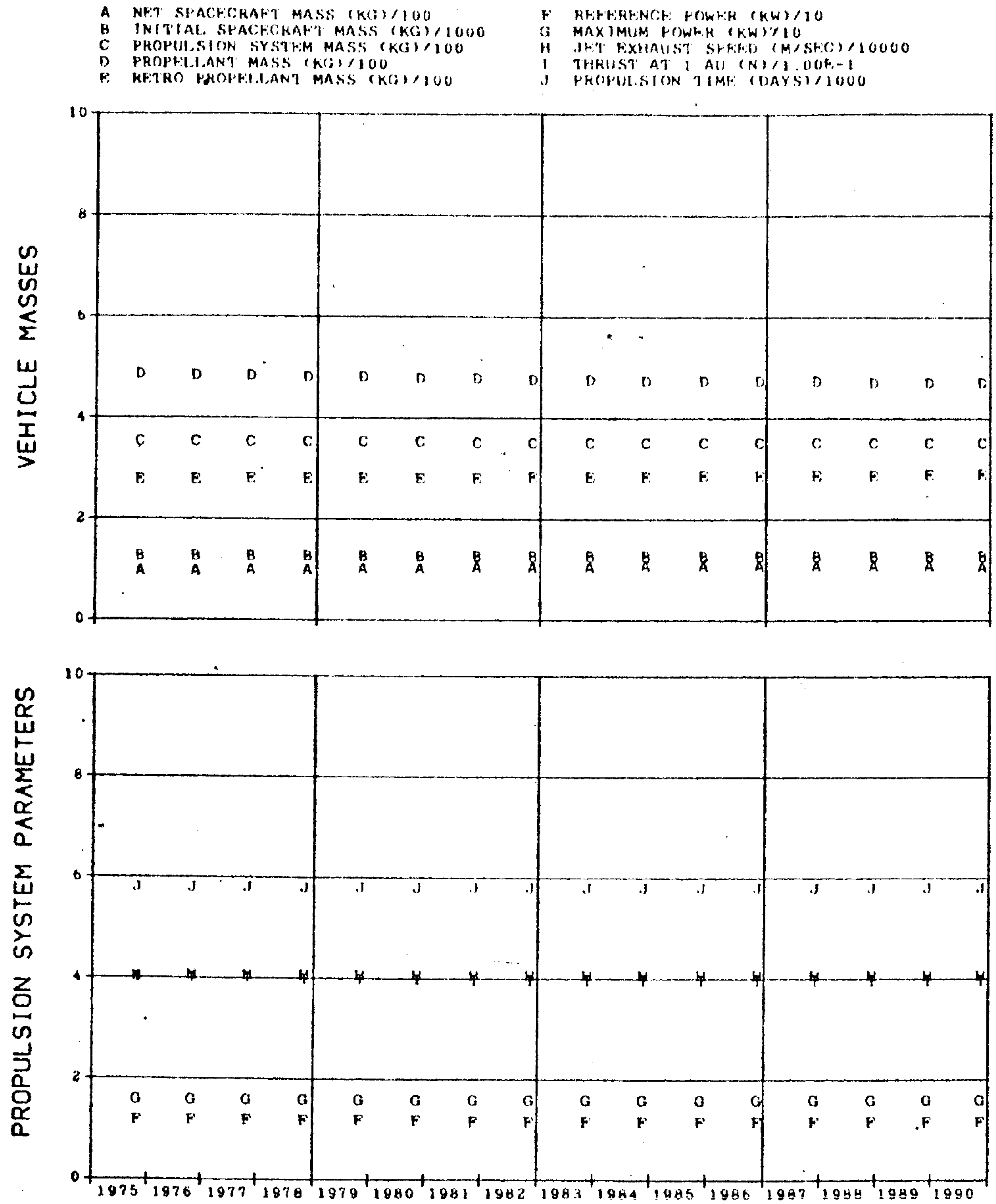

FIG. 48. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5800 DAYS

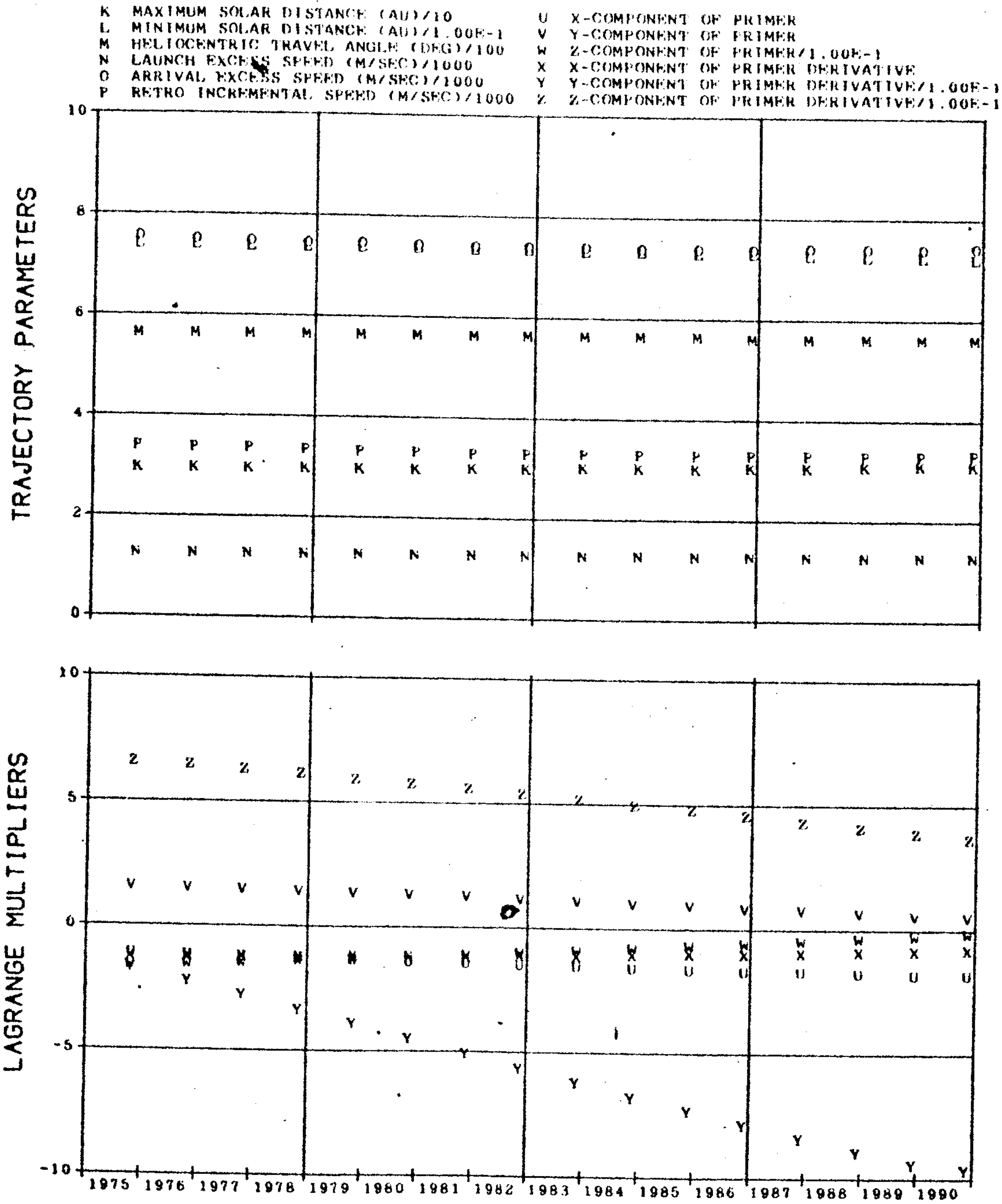

FIG. 48. (CONCLUDED)

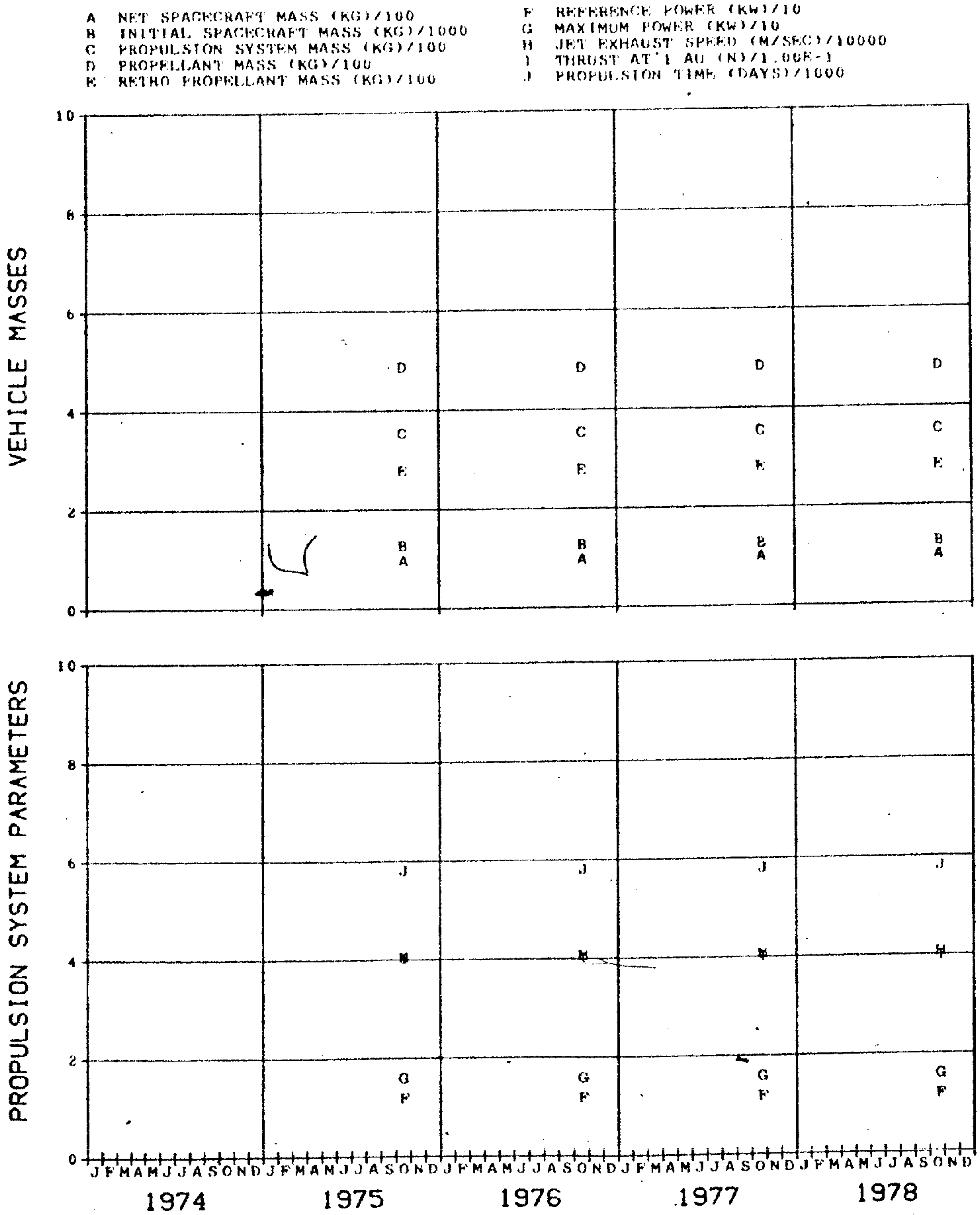

FIG. 48A. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5800 DAYS

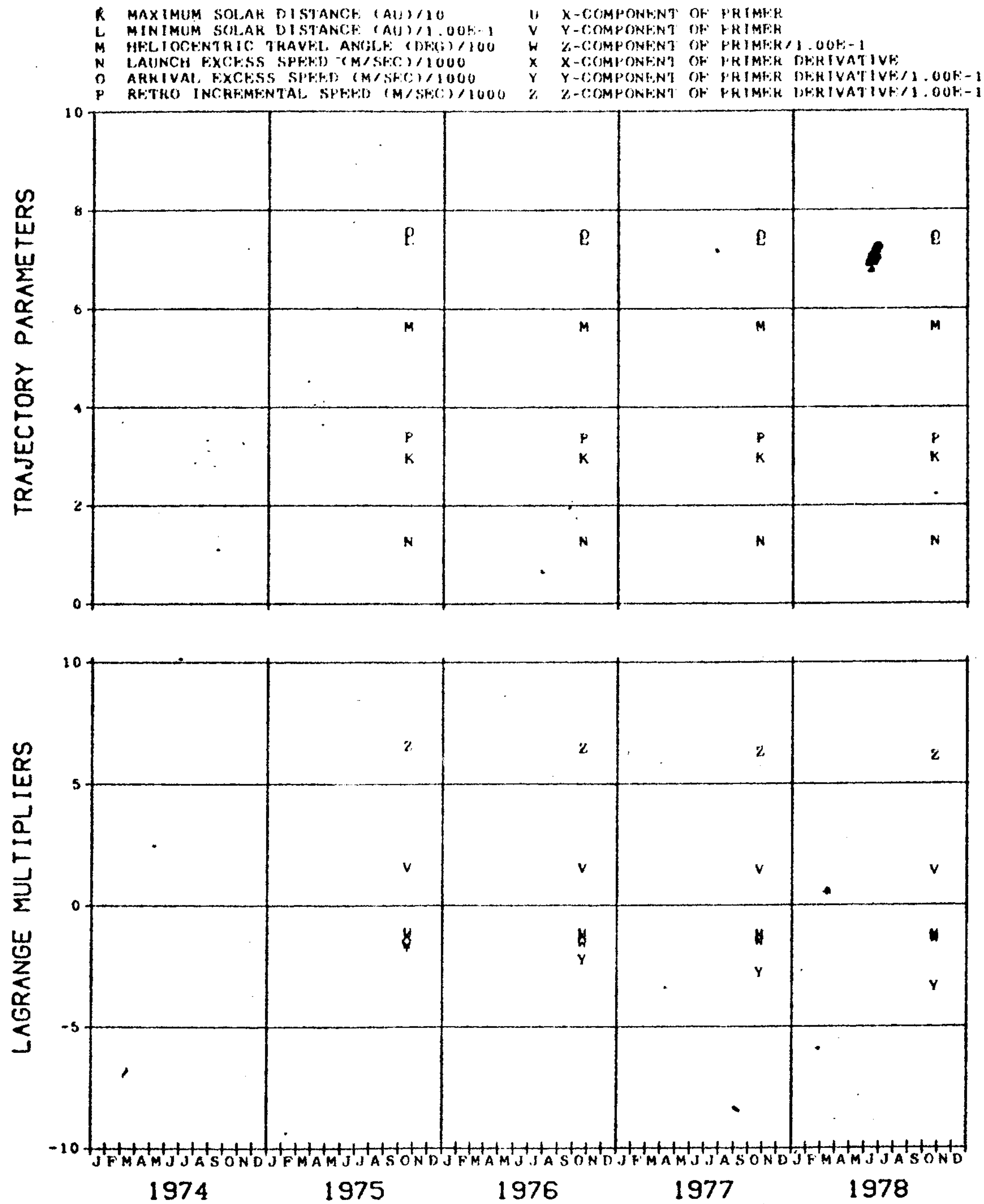

FIG. 48A. (CONCLUDED)

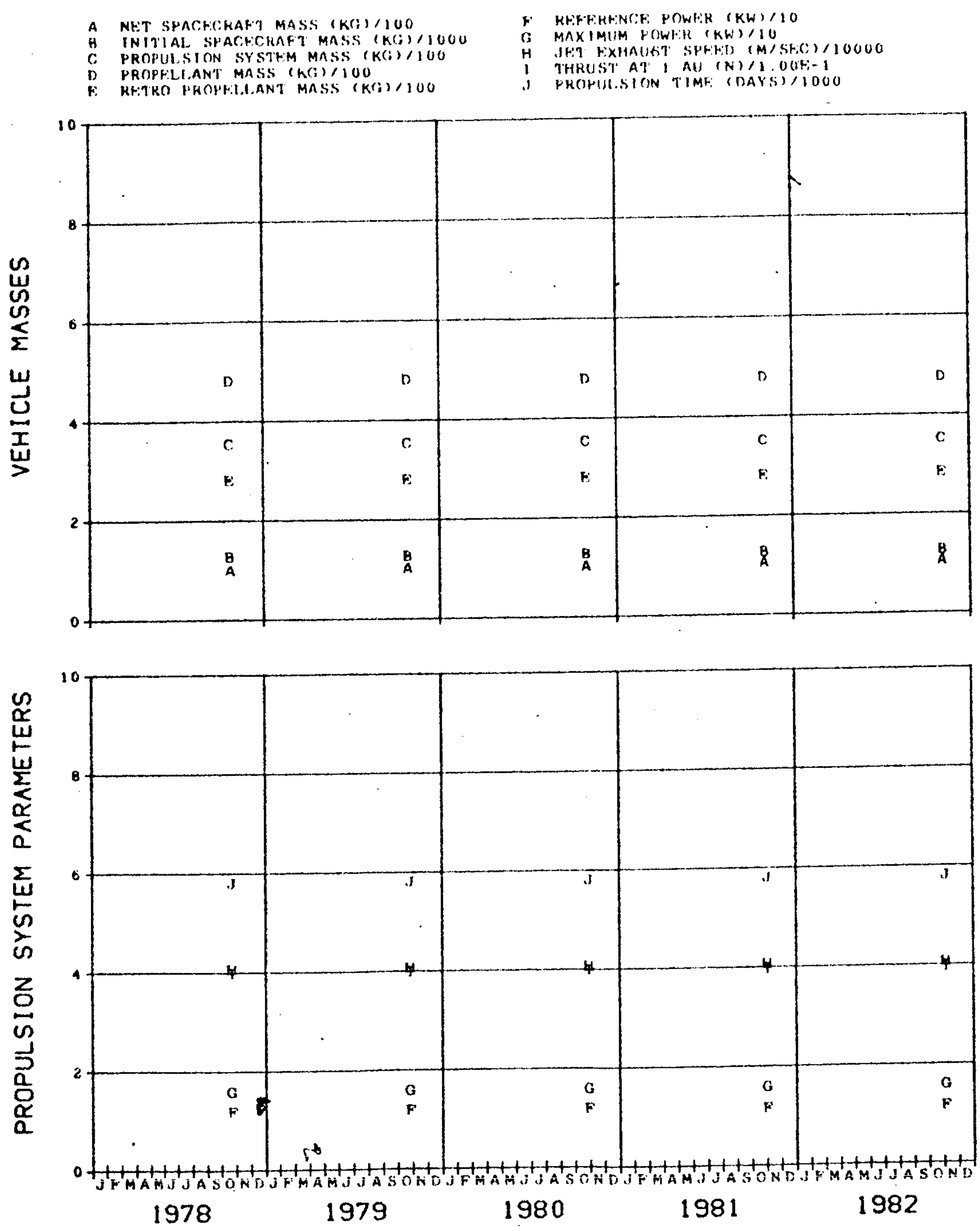

FIG. 48B. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5800 DAYS

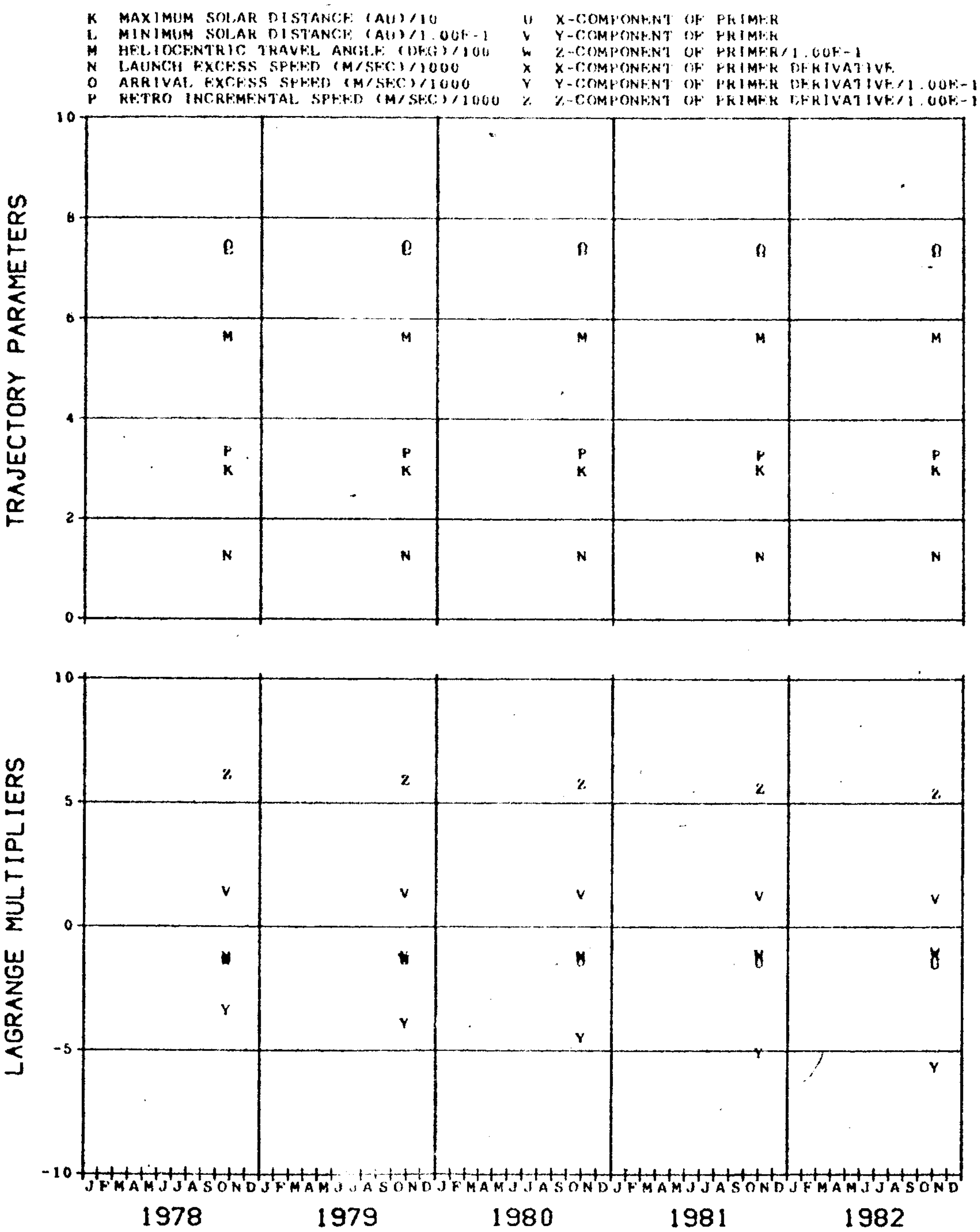

FIG. 48B. (CONCLUDED)

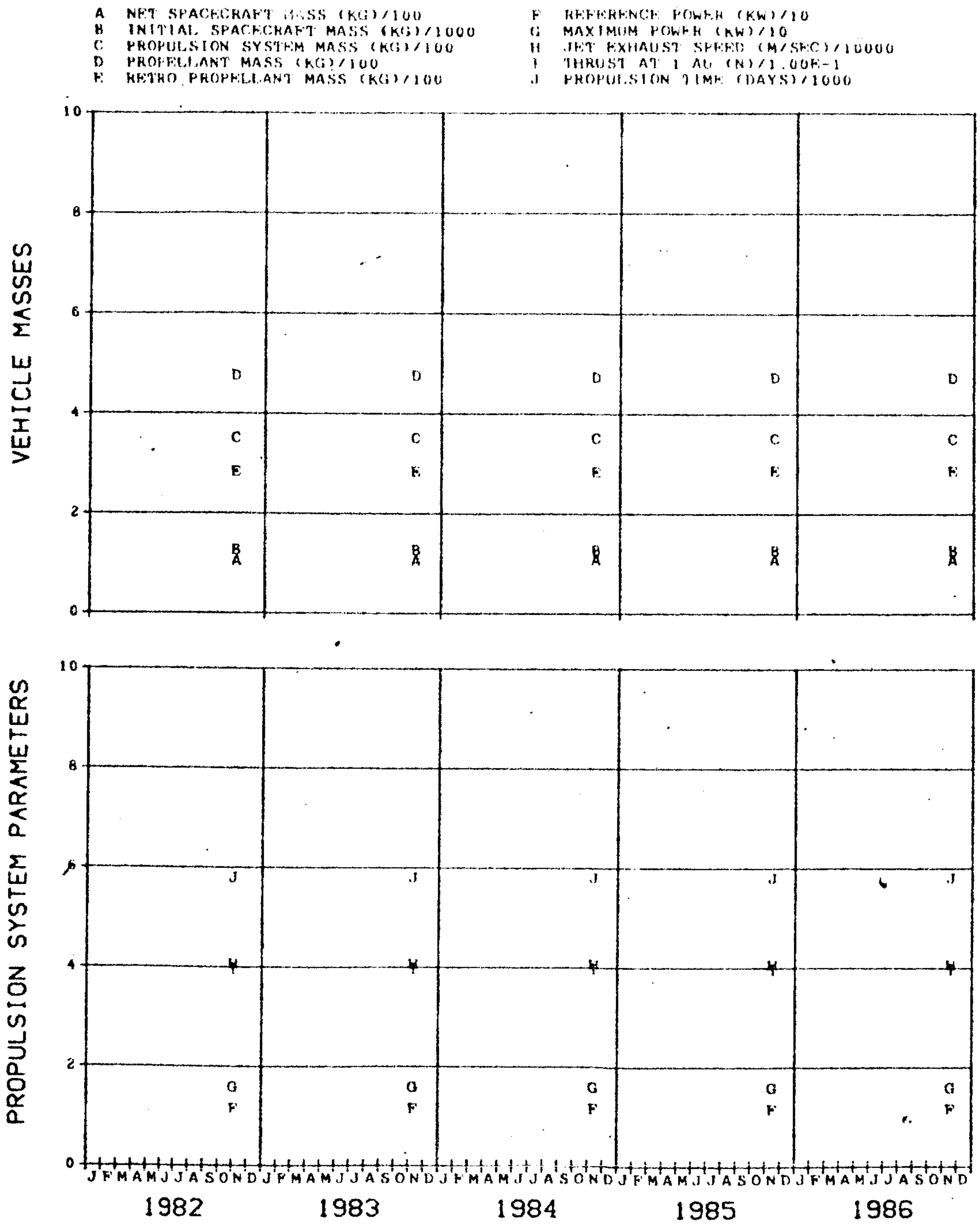

FIG. 48C. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5800 DAYS

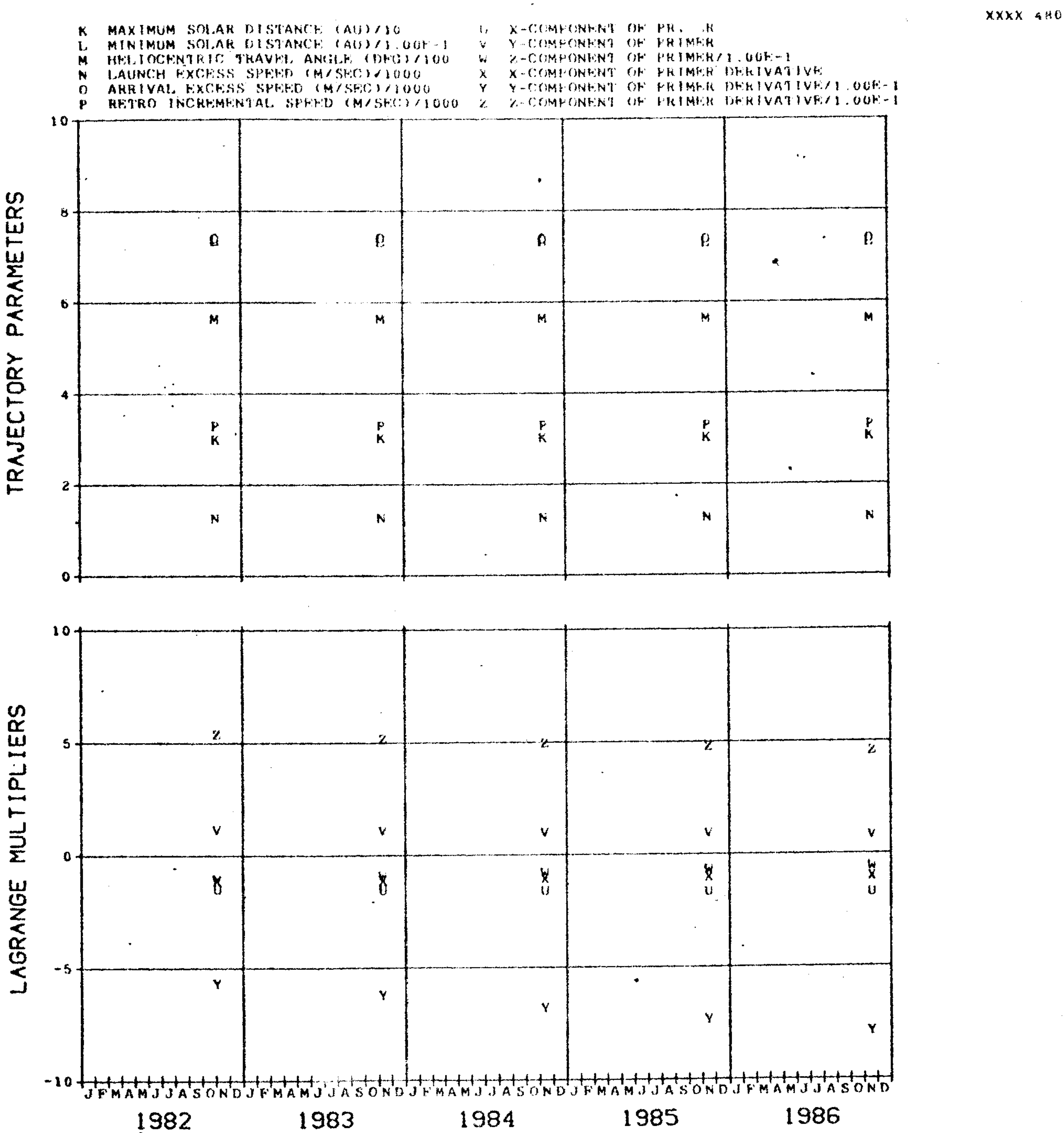

FIG. 48C. (CONCLUDED)

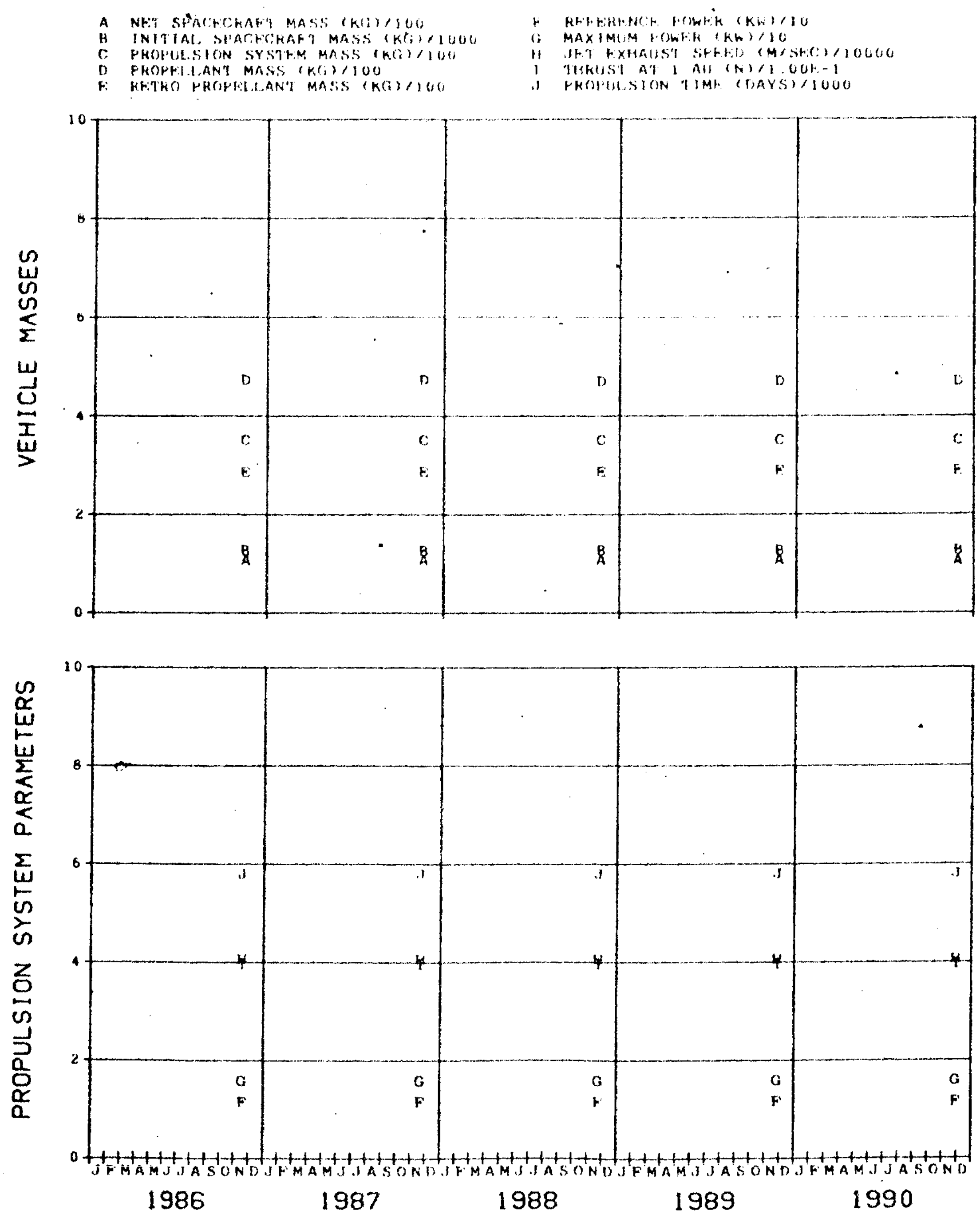

FIG. 48D. PLUTO MODE B ORBITER OPPORTUNITIES
FLIGHT TIME 5800 DAYS

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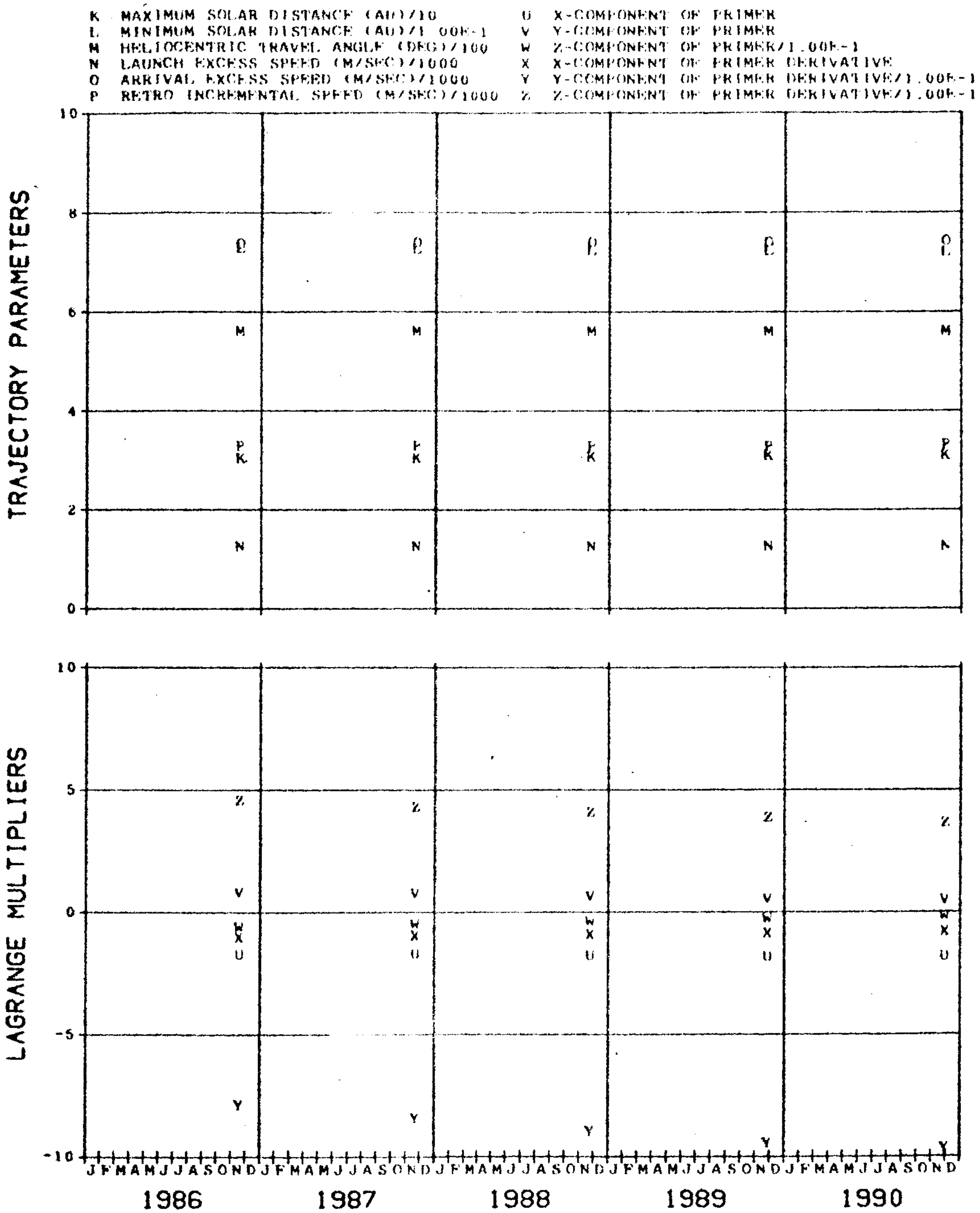

FIG. 48D. (CONCLUDED)