VII.1

OPPORTUNITIES FOR EUROPEAN PAYLOADS ON THE SATURN VEHICLE

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The two stage version of the Saturn I vehicle has flown four times and placed a total of approximately 100,000 pounds into earth orbit. These initial flights have been designed to test the vehicle performance and, except for the last flight, have not been for the purpose of placing scientific payloads into the space environment. The tremendous weight-carrying capability of this vehicle and the vehicles to follow has led us to consider the concept of auxiliary or piggyback accommodations on Saturn. In this sense, the auxiliary payload would be furnished by an independent experimenter, mounted on the vehicle or payload itself with minimum interference, and flown as a passenger to the intended orbit. Because the vehicle will be flown for another primary purpose, the cost of these accommodations will be low. The high weight-carrying capability, low cost, and high volume availabilities may make this type of space carrier attractive to European experimenters.

It is our understanding that in the majority of cases, the European payload agencies may face some unique problems. In most European countries, payloads are designed by the universities. The universities, in turn, contract with European industry to fabricate the payload as a whole, or to furnish component parts of the payload. These payloads are largely government-sponsored, with funding and priority being determined by the central national agency. The following questions must occur to a European experimenter who has a particular payload in mind: (1) Does my payload satisfy a national or European goal and thereby provide an incentive for authorization?, (2) Is funding available?, and (3) Is there a vehicle which can carry my experiment?

In this paper, we will not deal with the first two questions, which must be of interest to every potential experimenter, but only with the last question of vehicle availability.

Several vehicle opportunities are open to European experimenters. For payloads in the sounding rocket class, there are many solid propellant, multistage probes. For medium range ballistic experiments, vehicles such as the Blue Streak or Diamant exist. For orbital experiments, the ELDO launcher vehicle has a significant payload capacity. At a 300 nautical mile orbit, ELDO A can place a payload of approximately 2800 pounds; the projected ELDO B, 5500 pounds. For deep space probes, ELDO A can escape a payload of about 100 pounds; ELDO B, 1000 pounds. However, it would seem that because of the limited number of vehicles to be launched, the restricted volume and weight, many potential experiments could not find accommodation on this vehicle for many years.

As you may know, our Government has requested potential experimenters to submit their suggestions for payloads to be carried aboard vehicles furnished and launched by the United States. Specifically included in this invitation are experiments for OGO, OAO, Nimbus, AOSO, Explorer satellites, geodetic satellites, sounding rockets and balloons, X-15 aircraft, and in the Apollo earth orbital and lunar landing programs. The NASA document summarizing the opportunities for flights as passengers in these payloads is, *Opportunities for Participation in Space Flight Investigations*, published by Homer E. Newell, Associate Administrator for Space Science and Applications, dated January, 1965. Previous examples of international cooperation wherein the United States has launched foreign payloads include the Canadian Alouette I, launched by a

Thor/Agena from the Western Test Range in September, 1962; the United Kingdom Ariel, launched by a Delta from the Eastern Test Range in April, 1962; and the United Kingdom payload UK-2, launched by a Scout from Wallops Island in March, 1964. Projected experiments include the Canadian Alouette B to be launched on a Thor/Agena B, the Canadian International Satellite for Ionospheric Studies scheduled for a Thrust Augmented Delta, experiments on the Orbiting Geophysical Observatory scheduled for a Thor/Agena, and the United Kingdom experiments on the OSO and OAO.

With this type of previous cooperation as a model, let us consider for a moment the potential application of European payloads to the Saturn program. In the Government publication NPC 500-9, titled, *Apollo In-Flight Experiment Guide*, dated September 15, 1964, NASA summarizes the space available in the Apollo spacecraft command module, Apollo service module, and lunar excursion module (LEM) shown in Figure 1. The orientation of these units during trans-lunar flight is shown in Figure 2. General ground rules set forth by NASA in this document include:

1. The inflight experiments shall be conducted on a non-interference basis to the primary and alternate missions.
2. All flight equipment must meet Apollo flight qualification requirements.
3. Launchings will not be delayed because of nonavailability of an experiment.

The Saturn vehicle can also provide accommodations for payloads that do not require manned attention. These types of experiments can be placed in the LEM adapter or in the S-IVB stage itself.

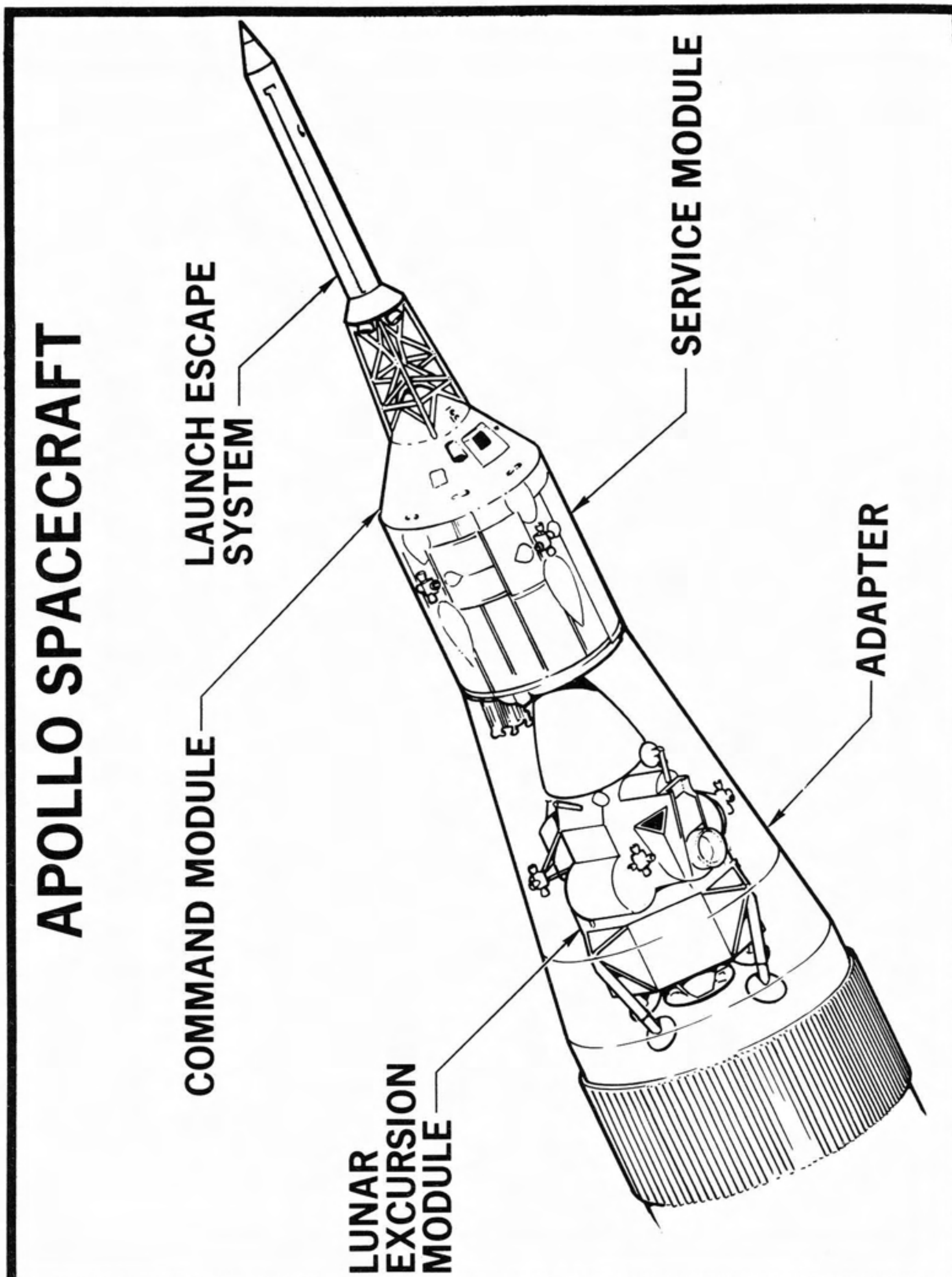

APOLLO SPACECRAFT
LAUNCH ESCAPE SYSTEM
SERVICE MODULE
COMMAND MODULE
ADAPTER
LUNAR EXCURSION MODULE

FIGURE 1

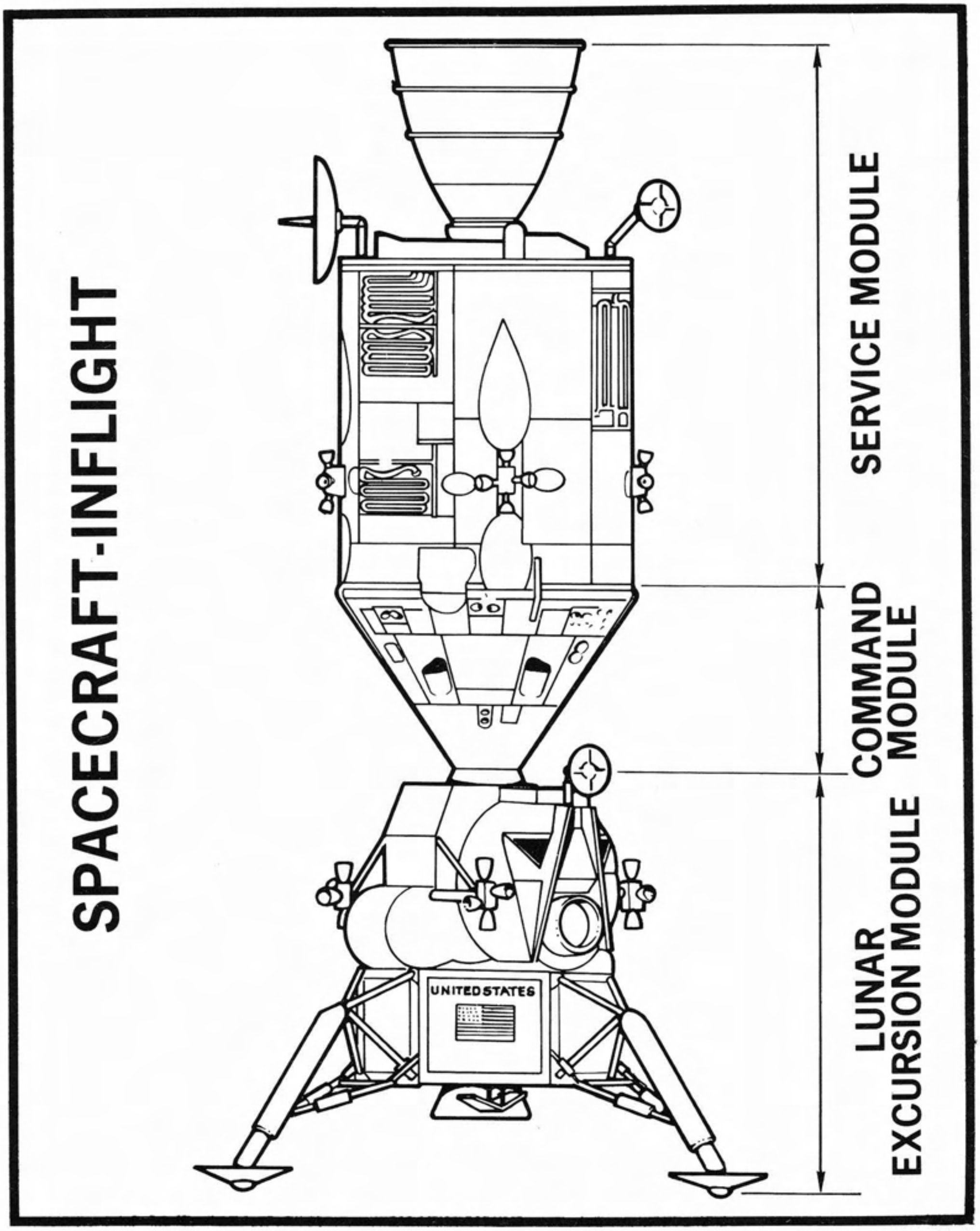

SPACECRAFT-INFLIGHT
SERVICE MODULE
COMMAND MODULE
LUNAR EXCURSION MODULE
UNITED STATES

FIGURE 2

The Saturn IB vehicle (shown in Figure 3) has been designed to place the Apollo command module, service module (partially loaded) and lunar excursion module in earth orbit for practice rendezvous, re-entry tests, and command and control system operations. The vehicle has the capability of placing 35,000 pounds into a 100 nautical mile orbit. The S-IVB stage itself can provide attitude control for 4-1/2 hours after injection. If a Centaur third stage is added to this two stage configuration, the Saturn IB vehicle has an escape capability of approximately 12,000 pounds. Figure 3 also shows the three stage vehicle. Performance of the Saturn IB is shown in Figures 4 and 5, both for the two stage and three stage versions.

Within the S-IVB stage itself there are several areas where auxiliary payloads can be accommodated. These are shown schematically in Figure 6. Payload volume 1 indicates a pod mounted externally to the S-IVB; payload volumes 2, 3, and 4a represent space available on the forward equipment racks of the stage; volume 4b represents space available forward of the hydrogen tank dome; volume 5 is on the aft skirt; volume 6 is on the thrust structure; and volume 7 is space within the hydrogen tank itself. Typical configurations of the external volume 1 available are shown in Figure 7.

In summary, then, the Saturn vehicle offers an opportunity to experimenters to fly their payloads in volumes that permit man's attention, or that can be mounted and operated remotely. Payloads can be accommodated in the command module, service module, or on the LEM if they require manned attention; in the LEM adapter, the instrument unit, or the S-IVB stage if they can be remotely operated. A summary of these accommodations is shown in Figure 8. Of course,

SATURN IB CONFIGURATIONS

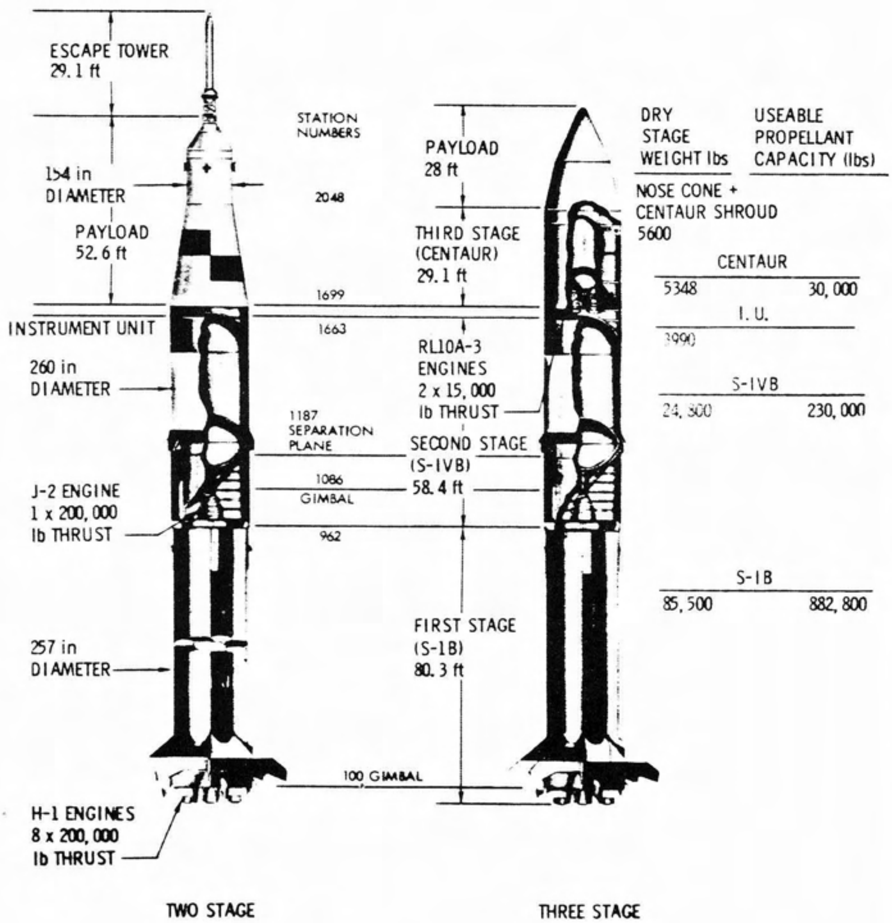


FIGURE 3

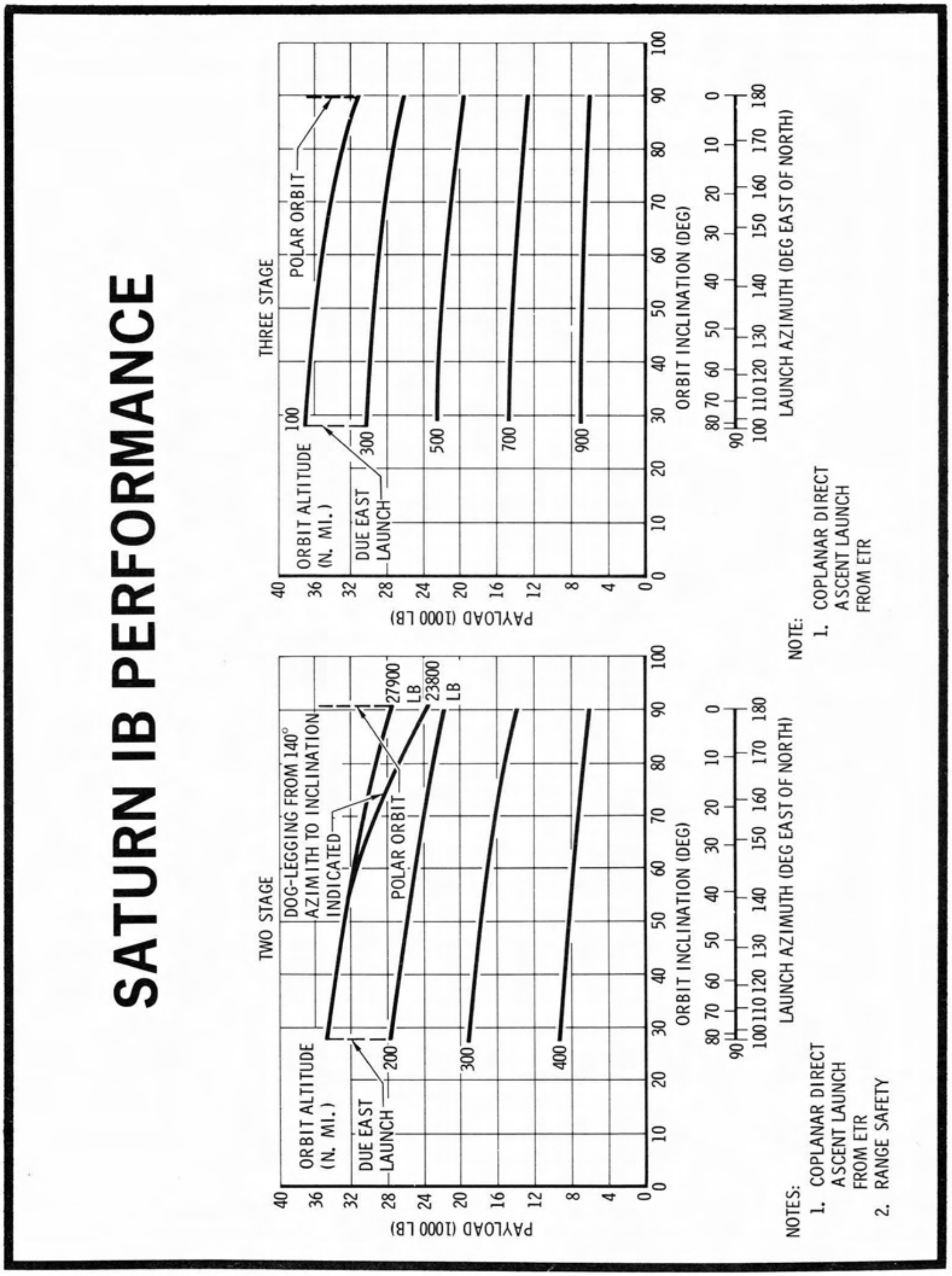

SATURN IB PERFORMANCE
TWO STAGE
PAYLOAD (1000 LB)
ORBIT ALTITUDE (N. MI.)
DUE EAST LAUNCH
200
300
400
DOG-LEGGING FROM 140° AZIMUTH TO INCLINATION INDICATED
POLAR ORBIT
27900 LB
23800 LB
ORBIT INCLINATION (DEG)
LAUNCH AZIMUTH (DEG EAST OF NORTH)
NOTES:
1. COPLANAR DIRECT ASCENT LAUNCH FROM ETR
2. RANGE SAFETY
THREE STAGE
PAYLOAD (1000 LB)
ORBIT ALTITUDE (N. MI.)
DUE EAST LAUNCH
100
300
500
700
900
POLAR ORBIT
ORBIT INCLINATION (DEG)
LAUNCH AZIMUTH (DEG EAST OF NORTH)
NOTE:
1. COPLANAR DIRECT ASCENT LAUNCH FROM ETR

FIGURE 4

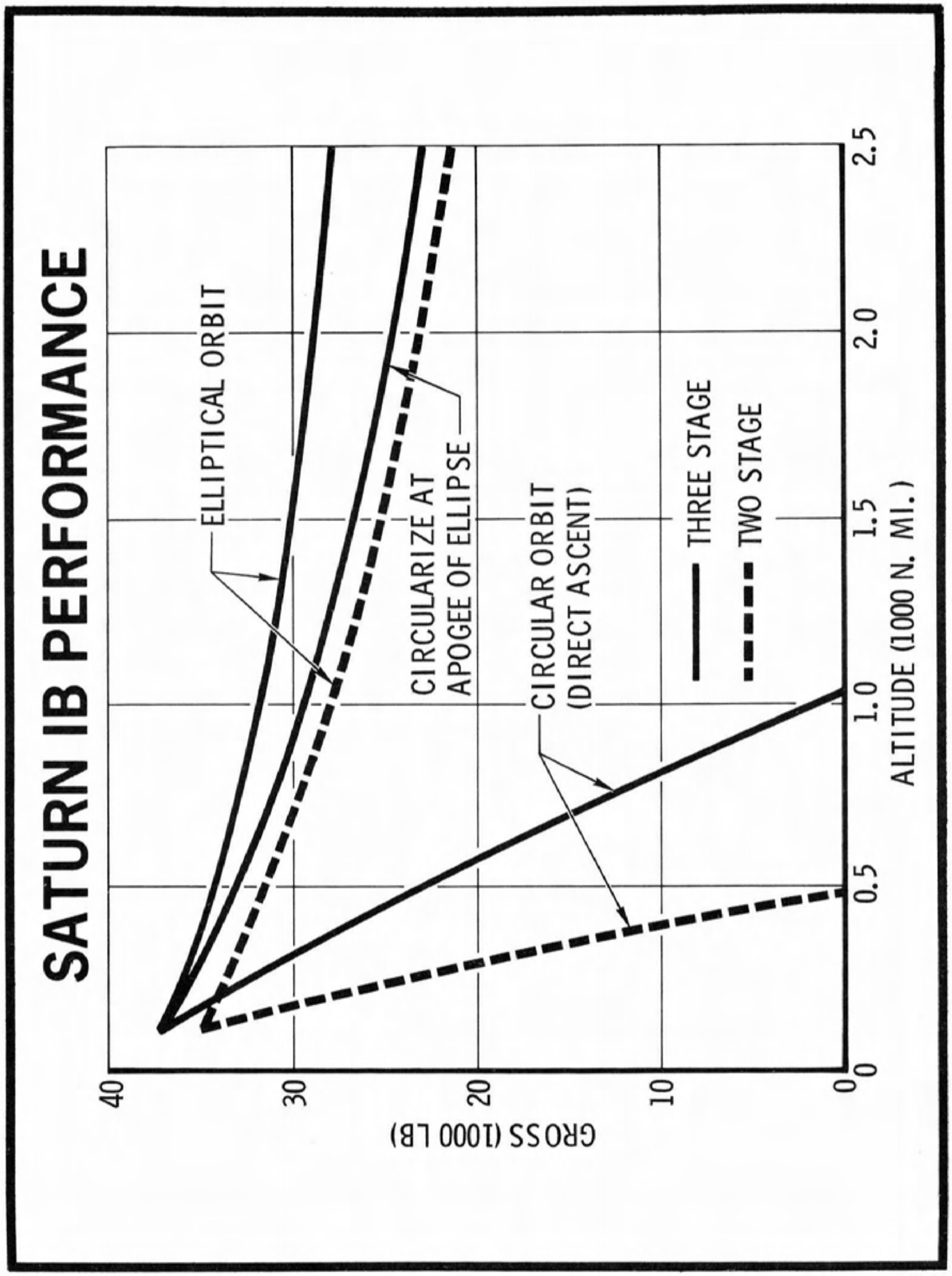
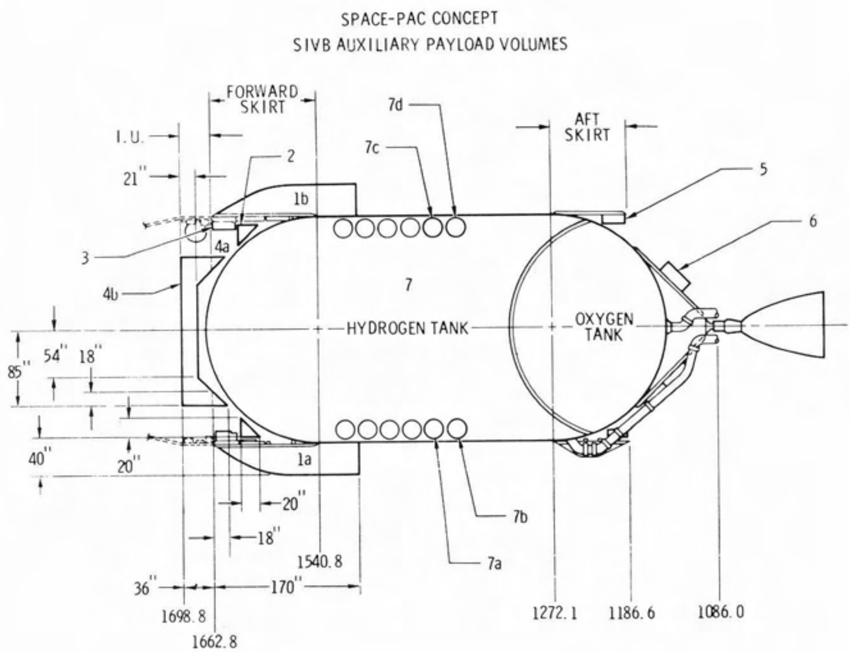

SATURN IB PERFORMANCE
ELLIPTICAL ORBIT
CIRCULARIZE AT
APOGEE OF ELLIPSE
CIRCULAR ORBIT
(DIRECT ASCENT)
THREE STAGE
TWO STAGE
GROSS (1000 LB)
ALTITUDE (1000 N. MI.)
0
10
20
30
40
0
0.5
1.0
1.5
2.0
2.5

FIGURE 5

SPACE - PAC CONCEPT



VOL. NO	LOCATION	VOLUME	PAYLOAD WEIGHT, LBS
1a	FWD. SKIRT - EXT.	78 FT^3	1,100
1b	FWD. SKIRT - EXT	78 FT^3	1,100
2	FWD. SKIRT - INT.	109 FT^3	1,000
3	FWD. SKIRT - INT.	24 FT^3	900
4a	FWD. SKIRT - INT.	45 FT^3	2,500
4b	I.U. - INT.	380 FT^3	
5	AFT SKIRT - INT.	8 FT^3	-
6	THRUST STRUCTURE	INDEF.	-
7	HYDROGEN TANK	-	-
7a-d	HYDROGEN TANK	3.5 FT^3 EA.	-

FIGURE 6

TYPICAL VOLUME 1 CONFIGURATIONS

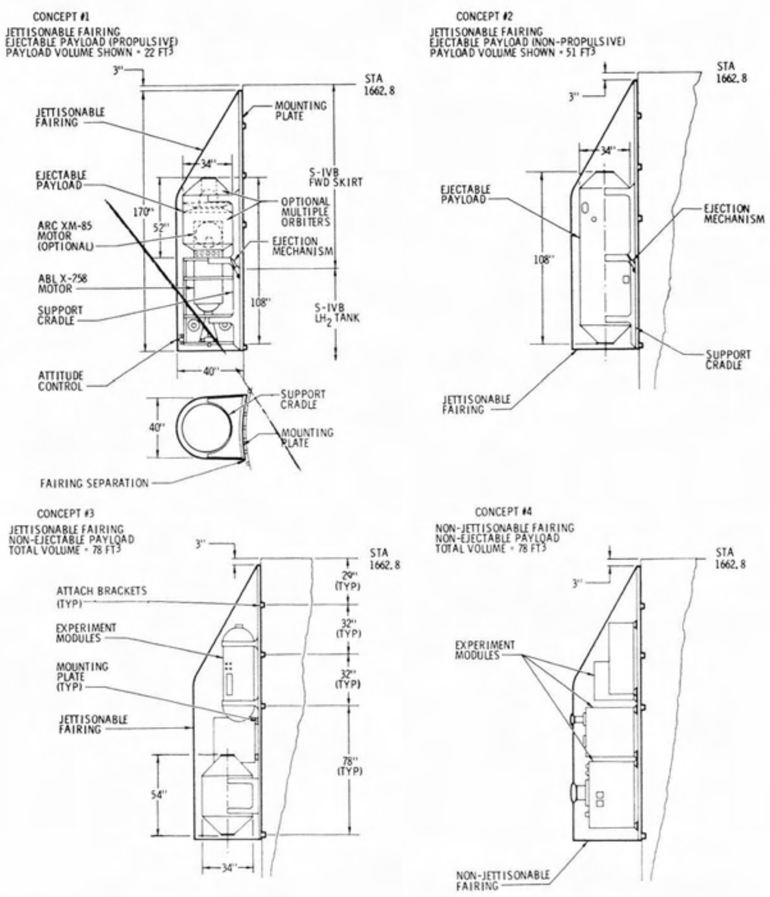


FIGURE 7

SUMMARY OF PAYLOAD ACCOMMODATIONS

2-STAGE AUXILIARY PAYLOADS

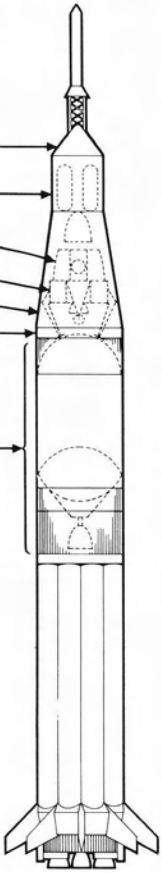
AREA		VOLUME (FT³)	WEIGHT (LBS)	EXPERIMENT CONTACT AGENCIES (5)
(1) COMMAND MODULE	BLOCK I	7.2	<80	NASA-MSC/NAA-S&ID
	BLOCK II	3	<80	
(1) SERVICE MODULE		NONE RESERVED	(3)	NASA-MSC/NAA-S&ID
(1) LEM ASCENT		3	<80	NASA-MSC/GRUMMAN
LEM DESCENT		15	210	NASA-MSC/GRUMMAN
LEM ADAPTER		UP TO 3230	7900 (2)	NASA-MSC/NAA-S&ID
INSTRUMENT UNIT	COLD PLATES	37	2400	NASA-MSFC/IBM/DAC
	CENTER	380	2000	
SATURN IB/IVB	VOL NO			NASA MSFC NASA - WASH DC DOUGLAS AIRCRAFT CO
	1a	78	1100	
	1b	78	1100	
	2	100	1000	
	3	24	900	
	4a	45	500	
	4b	(SEE IU)	-	
	5	<8 TOTAL	-	
	6	<5 TOTAL	-	
	7	-	-	

AUXILIARY PAYLOADS 3-STAGE

CENTAUR	(3)	(3)	NASA - LEWIS - MSFC/ GENERAL DYNAMICS

PRIME PAYLOADS CAPABILITY

VEHICLE CONFIG.	PAYLOAD (4) VOLUME FT³	PAYLOAD LBS	
2 STAGE 100 N. MI.	TO 5000	35,000	NASA - LEWIS - MSFC
2 STAGE 400 N. MI.	TO 5000	9,600	
3 STAGE ESCAPE	2990	12,300	NASA - WASH - DOUGLAS
3 STAGE SYNCHRONOUS	2990	9,800	



(1) NPC 500-9 APOLLO IN-FLIGHT EXPERIMENT GUIDE DATED SEPT 15, 1964.

(2) EQUAL TO TOTAL LEM WEIGHT.

(3) SEE CONTACT AGENCIES

(4) FINAL AUXILIARY PAYLOAD WEIGHT AND VOLUME DEPENDS ON PRIME MISSION

(5) INFORMATION ON EXPERIMENT SUBMITTAL PROCESS & ASSOCIATED VEHICLE DATA CAN BE OBTAINED FROM COGNIZANT NASA AGENCIES

FIGURE 8

the primary mission of an individual vehicle will determine the exact excess weight-carrying capability of that vehicle and each individual experiment will require negotiation with the proper Governmental agency.

The Saturn program today includes orbital flights and lunar flights, both manned and unmanned. The program will probably include at some future date, follow-on flights involving even more demanding missions. One such mission being planned currently is the unmanned payload Voyager mission to Mars that involves the three stage Saturn IB vehicle. Future missions beyond Voyager may include flights to synchronous earth orbit, solar probes, Jupiter/Mercury fly-by missions, escape from the solar system, out of the ecliptic probes, and probes to the surface of the Sun itself.

So we see that the Saturn/Apollo program has invited experiments which can be accommodated as part of the Apollo mission. These experiments can be mounted in the manned portion or in the unmanned portion of the spacecraft or vehicle, and the vehicle itself has a great potential for future mission use.

Why should you, as European industrialists, be interested in flying experiments? First, because this invitation represents a resource which might be available to you cheaply. Second, because this resource might furnish to you a unique means of development through which you could further your own work. Third, because successful flights of experiments identified with Europe can provide important motivation and stimulation to your national programs or to your international combined efforts.

In order for a foreign experimenter to present his planned experiment and request space on a Saturn vehicle, he will have to first contact Mr. A. W. Frutkin, Assistant Administrator for Internal Affairs, NASA Headquarters, Washington, D. C. Mr. Frutkin, in turn, will transmit the information presented to the proper NASA agency. This agency will review the experiment in context with others already planned and with space available. Some specific information which will be required during the initial presentation includes:

1. Experiment title
2. Proposal originator
3. Amount of astronaut time requested
4. Electrical power requirements
5. Control fuel requirements
6. Weight
7. Volume
8. Purpose and application of experiment
9. Description of experimental procedure
10. Description of equipment development
11. Description of development program by which flight hardware will be produced

If you have an experiment to propose, you should first contact Mr. Frutkin. You should realize that the payload will be competitive with those proposed from the United States. Your payload must, of course, be financed by your government or through some other European agency. Even with these conditions met, I cannot promise at this point that your payloads will be accepted.

Nevertheless, I hope the possibility of flight on our large launch vehicles will stimulate your thinking and your proposals to our Government.

With the regularity of the planned Saturn flight program and the high potential payloads available, it would appear that Saturn offers the European experimenter an opportunity to accomplish economic and expedient testing in the space environment.

NOTES