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INTERIM REPORT TO THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

#219696

SPECIAL COMMITTEE ON SPACE TECHNOLOGY

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a national integrated missile and space vehicle development program

~~GROUP 3~~
~~Downgraded at 12 year intervals;~~
~~not automatically declassified~~

1Apr58

By

THE WORKING GROUP ON VEHICULAR PROGRAM

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INTERIM REPORT

To The

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS
SPECIAL COMMITTEE ON SPACE TECHNOLOGY

A NATIONAL INTEGRATED MISSILE
AND
SPACE VEHICLE DEVELOPMENT PROGRAM

~~GROUP 3~~
~~Downgraded at 12 year intervals;~~
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By

The Working Group on Vehicular Program

1 APR 1958

This document consists of 44 pages
No 16 of 150 copies, Series A

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ABSTRACT

The need for a national integrated missile and space-vehicle development program has become more apparent in recent months, and is fairly well agreed upon by both military and nonmilitary organizations. Since much of the information necessary to perform a study on a national scale was available at ABMA, the task of compiling and organizing the essential facts into a first draft of a national program was undertaken by this agency as a service to whatever organization is given the responsibility of directing the program.

The results of this study are presented in the form of a proposal with the intent that it be used as a guide or reference in planning for an integrated program. It should be emphasized that this report is not a proposal that any particular organization direct the national program, but rather a service that ABMA has performed in the interest of national welfare and security.

PURPOSE

① The purpose of this report is to review the U.S. missile program and to propose a national integrated missile and space-vehicle development program. The proposed program is designed to insure maximum security by utilizing all available research, development and manufacturing teams and by appropriate expenditure of manpower, facilities and money.

The need for an integrated missile and space-vehicle program within the U.S. has been accentuated by the recent Soviet satellite accomplishments and the resulting psychological intimidation of the West. These facts, combined with the launching of two Explorers and one Vanguard, demonstrate that the world is entering into an era of space travel and space research; therefore, it is mandatory that the U.S. consider the extension of the principles of earth warfare to space warfare. A review and revision of our scientific and military programs for the next 10 years will insure that provisions for space exploration and warfare are incorporated into the over-all program.

② One of the prime objectives established in preparing this report was that of accomplishing a manned lunar landing in advance of the Soviets. Such an accomplishment would firmly establish Western technological supremacy and be of great psychological value. Due to the strategic location of the moon for space travel and warfare, an even greater and more permanent value would be derived by such a landing - that of claiming the moon for the United Nations or the Western world.

This report is the second edition of a national integrated missile and space-vehicle development program. Later editions of this proposal will be published as additional information becomes available.

STATEMENT OF THE PROBLEM

1A The problem undertaken in preparing this report is that of compiling all available essential facts and outlining a feasible plan which will allow the U.S. to catch up with and ultimately surpass the Soviets in the race for leadership on this planet and for scientific and military supremacy in space. This must be done without upsetting the nation's economic stability, disrupting the manpower balance, or draining the national resources.

C&R The conclusions and recommendations presented in this report are based on a technical study; no effort has been made to propose a national space philosophy or to consider the political problems of space travel. However, in conducting a comprehensive study of this nature, it is necessary to make certain assumptions and establish objectives in order to prepare a proposal on a national scale. The following assumptions have been made as national objectives:

A (a) Reaffirmation of national scientific and technological supremacy.

(b) Provision of adequate defense against the Soviet capability to engage in space warfare.

(c) Expansion of the national deterrent capability to include space warfare techniques.

(d) Evolution of a national capability for space exploration.

These objectives will be accomplished by conducting a development program on a national basis, devoid of personal interests of any individual, military or civilian group or organization, and through maximum utilization of existing development teams and existing hardware.

DISCUSSION

The launching of Sputnik I on 4 October 1957, and the 1200-lb Sputnik II on 3 November 1957, demonstrated clearly the superior Soviet capability in the field of long-range missiles and orbital techniques. While the Explorers and the Vanguard point out our satellite capability, the U.S. carrier status emphasizes the lack of large-payload capacity.

The key to rapid improvement in the U.S. capability for orbital and space-flight missions lies in a unified and closely coordinated program utilizing all available development teams and facilities. Therefore, it is considered mandatory that a national integrated missile and space-vehicle program be established. Only through a well-coordinated single plan can the cost of hardware, facilities and operation of a space-vehicle program, which would be in addition to the present military-missile program, be maintained within a reasonable budget.

Objectives

The establishment of an integrated missile and space program requires a close look at the various missions which must be conducted. A study was made of all existing, and most of the proposed, missile and space-vehicle programs and a tentative over-all development schedule was established. Based on this tentative schedule a detailed study was made integrating the development of the following:

(a) Propulsion systems
(b) Ballistic-missile vehicles
(c) Orbital-carrier vehicles
(d) Satellite vehicles
1B
(e) Moon-flight vehicles
(f) Interplanetary vehicles
(g) Guidance and control systems
(h) Crew engineering equipment and techniques
(i) Ground and flight test facilities

This detailed study, based on present and projected development capabilities, indicated that the required objectives can be accomplished in time to allow the U.S. to catch up with and surpass the Soviet capability by 1962 to 1965.

A chronological listing, through 1980, of objectives or milestones for the U.S. space-flight program is found in Table I. A graphical representation is presented in Figs. 1 and 2 comparing the predicted U.S. and Soviet satellite and moon-flight payload capabilities. On the basis of the information presented in Fig. 2, the U.S. will have the capability of performing a manned lunar landing by about March 1967, or possibly earlier. If this schedule is met, and the assumptions of Soviet capabilities are correct, it could be possible that the U.S. will make the first manned lunar landing.

It should be emphasized that the above U.S. capabilities are based on the immediate establishment of a national integrated program and the allocation of the required funds.

Requirements

The system requirements for an integrated missile and space-vehicle program necessary to accomplish the objectives established above have been considered separately as well as integrated into an over-all schedule.

The orbital carriers or transportation vehicles required to fulfill the program objectives, together with operational dates, are listed in Table 2. Since many of the later vehicles, or programs, are not in existence, the "Mark" terminology has been used to designate future vehicles. Table 3 gives some of the basic criteria for the Mark-series vehicles and Figs. 3 through 11 give a pictorial representation of possible configurations. The vehicle numbers in Figs. 3 through 11 correspond to the listing in Table 2.

It is believed that the key to the success of a U.S. space-vehicle program lies in the availability of adequate propulsion systems. A recommended propulsion system development program with operational date requirements is listed in Table 4. As can be seen from this table, the R&D phase of a propulsion system requires considerable time. Unless immediate initiation of such a program is authorized, the U.S. will not have the necessary systems to accomplish the required objectives.

Each vehicle proposed in this integrated program will require a guidance and control system; however, there are various missions to be accomplished requiring different types of systems. An R&D program for guidance and control systems required to perform the necessary navigation task has been proposed and is listed in Table 5. This program will insure the required guidance systems to meet the objective schedule.

Some of the vehicles proposed in this integrated program will have crew members. Since very little is known about human or animal behavior and dangers during space flight, a separate R&D program for crew engineering has been proposed and is listed in Tables 6A and 6B. This program has been integrated into the national mission schedule and will provide the required equipment, techniques and procedures.

The magnitude of the proposed program is too great to be adequately handled by existing ground and flight test facilities. Therefore, a separate development program, based on the requirements established above, has been proposed. Table 7 indicates the expenditure necessary to provide the ground test facilities required for the respective Mark systems and the expenditure necessary for an equatorial operational firing range. The choice of an equatorial range is based on the advantages it would offer over a nonequatorial base for many of the future programs. The equatorial base would be in addition to the present flight test facilities which will be expanded. It has been assumed that expansion of present missile flight test facilities will be budgeted through normal military missile requirements. The flight test and operational facilities necessary for the integrated missile and space-vehicle program reflect the requirements imposed by the typical missile firing plan listed in Table 14.

The accomplishment of the above recommended programs will provide the U.S. with the necessary propulsion systems, orbital carrier vehicles, guidance and control systems, crew equipment and techniques, ground and flight test facilities, and operational bases to accomplish the national objectives. There is, however, another phase of the development program required to complete the vehicle system. This part of the program, the payload stage, has been divided into three categories - satellite vehicles, moon-flight vehicles, and interplanetary vehicles. The recommended development programs for the above payloads are given in Tables 3, 4 and 5, respectively. The manned space stations, listed in Table 3, have been designated "Terra"; the single weight is that of a completely constructed vehicle. Present plans call for various numbers of flights in order to construct a manned space station. The recommended programs for satellite and moon-flight vehicles correspond to the requirements as listed in Table I and would result in the capabilities shown in Figs. 1 and 2.

Schedule

The schedule of the national integrated program is based on present and proposed development schedules of both military and civilian organizations and has been extended through 1980. If this schedule is met and the assumed Soviet capability schedule is correct, the U.S. will be able to accomplish the objective of surpassing the Soviet capability by 1962 to 1965.

It should be understood, however, that the schedule information presented in this report is a compilation of data received from numerous organizations and no effort has been made to perform a detailed evaluation of proposed schedules. Possible minor revisions of schedule may be in order for certain programs; however, it is believed that no major revisions in the objective schedule will be required.

The schedule for each of the vehicles proposed in the national integrated program is given in Table 11. These schedules are divided into four phases - Preliminary Design, Engineering, R&D Firing and Operational. One of the assumptions of this report was that all available development teams be utilized. The schedule in Table 11 presents the workload for each vehicle and the respective contractors. This table can be very useful in determining the availability of each development team as well as to aid in planning the stabilized workloads of existing teams for a long-range program.

Table 12 indicates a typical R&D firing schedule for each vehicle and has been used in determining flight test-facility requirements as well as development-team manpower requirements during the testing phase. The numbers represent the missile fired per quarter for each mission.

The total missile production per quarter is listed for each vehicle in Table 13. The production quantity includes vehicles for R&D firing and ground test, training and stockpile for operational use. Table 13 is useful also in determining team manpower and production-facility requirements and availability for an integrated national program.

Funding

The total funding requirement for the proposed national integrated missile and space-vehicle development program will be approximately 30 billion dollars during the next 22 years. A breakdown of these expenses is presented in Tables 15 and 16. It should be understood that the cost for individual vehicle programs as well as over-all general and supporting research costs are approximate values and are presented in an effort to indicate an order of magnitude for the integrated program. The cost of the military long-range missile programs is given for comparison purposes and is not included in the total funding requirements for the integrated program.

In estimating the cost of vehicles for large-payload capabilities, such as the Mark X and Mark XI series, an extrapolation of present vehicle cost was performed to establish the basic cost per unit. Recovery cost of the boosters has been assumed with approximately 50% of the unit cost required for rejuvenation during the first two years of operation. The rejuvenation cost of recovered boosters was reduced to 30% of the unit cost by the fourth year of operation. Recovery of the orbital-carrier vehicle boosters has been assumed in estimating the cost of construction of permanent manned satellites and spaceships.

In estimating the cost for the subject program every possible effort has been made to utilize hardware and technology derived in the early phases of the program on later vehicle systems. For example, some of the first-stage boosters developed early in the program will be utilized wherever possible, with minor modification, as second and third-stage boosters on later vehicle systems.

A graphical representation of the results from Tables 15 and 16 is presented in Table 17, together with a proposed budget for the national integrated program.

CONCLUSIONS AND RECOMMENDATIONS

In conducting the study which led to the preparation of this report, various conclusions and recommendations were drawn based on the technical aspects of the problem. Some of the more outstanding conclusions and recommendations are presented below in an effort to give the viewpoint of this agency on a national integrated missile and space-vehicle development program.

Conclusions

1. A national integrated missile and space-vehicle development program is feasible and essential for national survival.

2. The immediate initiation of a development program for a large engine, in excess of one million pounds thrust, is considered a key to the success of the proposed program.

3. It will be possible to surpass the Soviet capability provided an adequate long-range space-flight program is instituted immediately.

4. The estimated annual cost of the program described in this report, which is over and above the present missile program, will be approximately 1.$\overset{8}{3}$ billion dollars over the next 22-year period.

5. The proposed integrated missile and space-vehicle program can be achieved without upsetting the nation's economic stability, manpower balance, or other national resources, if maximum utilization is made of existing teams and hardware developed under existing and future missile programs.

6. Much of the scientific data on upper atmosphere, space and celestial body environment, needed to solve the problems of space travel, can be obtained through this program.

Recommendations

1. That a national integrated missile and space-vehicle development program be authorized immediately.

2. That a development program be initiated immediately for a large engine, inexcess of one million pounds thrust, and the required test facilities with emphasis on early availability of the engine for flight test and operational use.

3. That long-range vehicle responsibility be assigned to individual development teams without delay, under the direction and coordination of a central agency.

4. That the objectives established in this report be accepted as goals for the national integrated program, with particular emphasis on a manned lunar landing within the next 10 years.

5. That maximum use be made of the transportation provided by the program for all types of scientific exploration of the upper atmosphere, space environment and celestial bodies.

6. That an early scientific exploration program be developed parallel to the space-vehicle program and coordinated with the individual development phases.

TABLE NO. I

MILESTONES OF A RECOMMENDED U. S. SPACE FLIGHT PROGRAM

1.	JAN 1958	FIRST 20-LB SATELLITE (ABMA/JPL)
2.	OCT 1958	FIRST 60-LB SATELLITE (ABMA/JPL)
3.	NOV 1958	FIRST 200 TO 300-LB RECOVERABLE SATELLITE (DOUGLAS/LOCKHEED/PHILCO)
4.	NOV 1958	FIRST 15-LB SPACE PROBE (JPL/ABMA)
5.	MAR 1959	FIRST VERTICAL MANNED ROCKET FLIGHT (AF/ABMA/WINZEN/COOK)
6.	APR 1959	FIRST MACH-7 MANNED FLIGHT WITH WINGED AIRPLANE X-15 (AF/NAA/NACA)
7.	MAY 1959	FIRST 500-LB ORBITAL OR 100-LB ESCAPE CAPABILITY (TEAM A/J)
8.	JUN 1959	FIRST 700-LB ORBITAL RECOVERY EXPERIMENT (TEAM A/K/R)
9.	AUG 1959	FIRST 100-LB LUNAR HARD LANDING (TEAM A/J)
10.	SEP 1959	FIRST 1500-LB ORBITAL CAPABILITY (CONVAIR/LOCKHEED)
11.	DEC 1959	FIRST 550/100-LB LUNAR SOFT LANDING (CONVAIR)
12.	JAN 1960	FIRST 300-LB LUNAR SATELLITE CAPABILITY (CONVAIR)
13.	JULY 1960	FIRST WINGLESS MANNED ORBITAL RETURN FLIGHT (TEAM M/R)
14.	AUG 1960	FIRST 2800/600-LB LUNAR SOFT LANDING CAPABILITY (TEAM C)
15.	OCT 1960	FIRST 2800 TO 8800-LB ORBITAL CAPABILITY (TEAM C)
16.	NOV 1960	FIRST 2500-LB CIS-MARTIAN PROBE (TEAM C)
17.	DEC 1960	FIRST 2400-LB VENUS PROBE (TEAM C)
18.	JUN 1961	FIRST 600-LB SOLAR PROBE (TEAM C)
19.	JUN 1962	FIRST WINGED MANNED ORBITAL RETURN FLIGHT (TEAM B/H/M/N)
20.	NOV 1962	FOUR-MAN EXPERIMENTAL SPACE STATION (TEAM B/C)
21.	APR 1963	FIRST 20,000 TO 30,000-LB ORBITAL CAPABILITY (TEAM A/E/D/P)
22.	SEP 1963	FIRST 5000-LB UNMANNED LUNAR CIRCUMNAVIGATION (TEAM A/E/D/P)
23.	APR 1964	FIRST 5000-LB MANNED LUNAR CIRCUMNAVIGATION (TEAM A/B/E/D/P)
24.	MAR 1966	ESTABLISHMENT OF INTERIM 20-MAN SATELLITE (TEAM A/B/E)
25	JAN 1967	FIRST 5000-LB MARTIAN PROBE (TEAM A/B/E)
26.	MAR 1967	FIRST MANNED LUNAR LANDING AND RETURN (TEAM A/B/E)
27.	MAY 1967	FIRST 5000-LB VENUS PROBE (TEAM A/B/E)
28.	1968	ESTABLISHMENT OF 50-MAN PERMANENT SATELLITE (TEAM A/B/E)
29.	1970	FIRST 50,000 TO 100,000-LB ORBITAL CAPABILITY (TEAM C)
30.	1972	LARGE SCIENTIFIC MOON EXPEDITION (TEAM M)
31.	1973/1974	ESTABLISHMENT OF A PERMANENT MOON BASE (TEAM M)
32.	1977	FIRST MANNED LANDING ON PLANET (TEAM A/B)
33.	1980	SECOND EXPEDITION TO A PLANET (TEAM C)

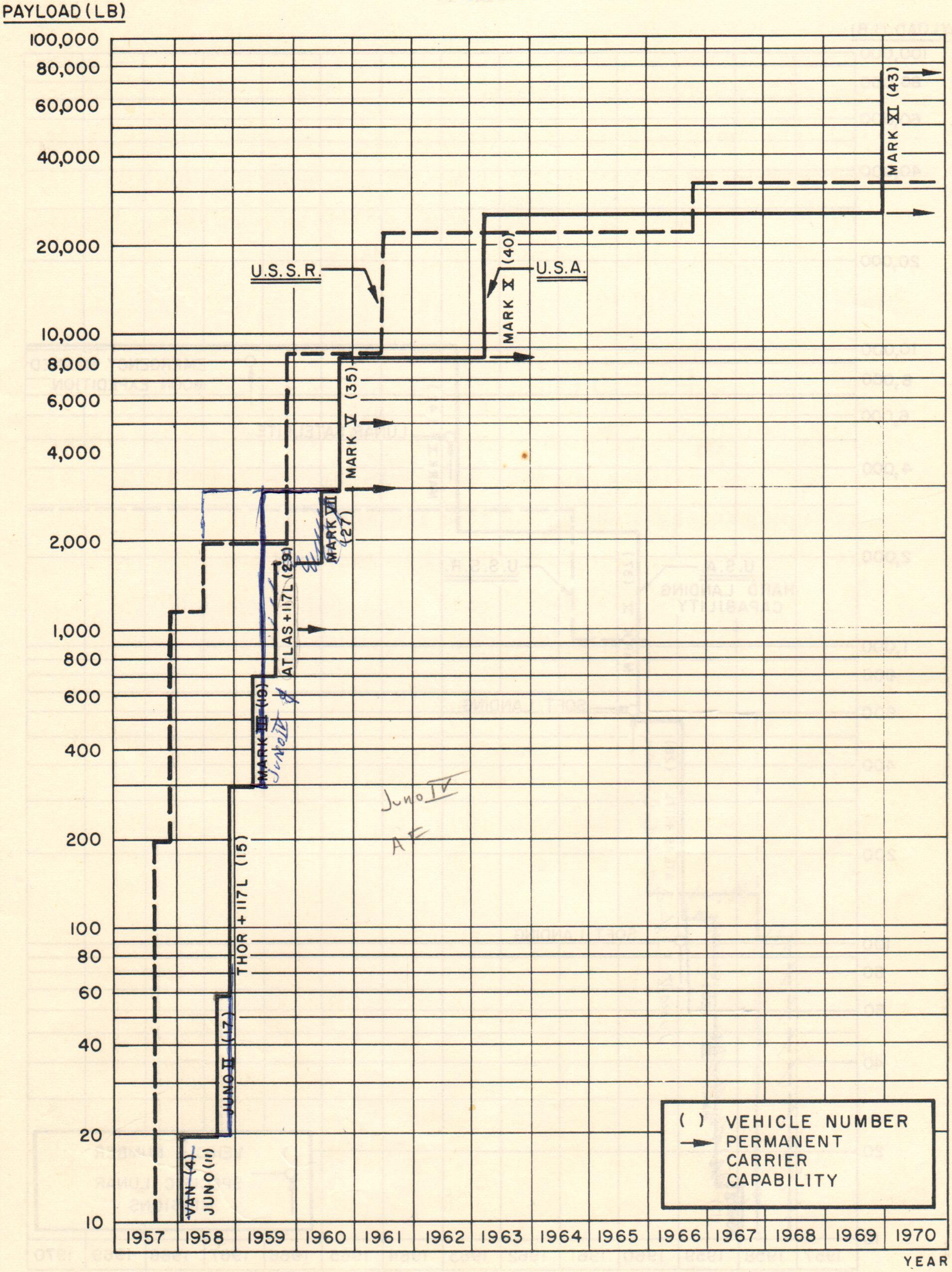

FIG.1 PRESENT AND ANTICIPATED SATELLITE PAYLOAD CAPABILITIES OF RUSSIAN AND AMERICAN SATELLITE CARRIERS (ONE WAY MISSION)

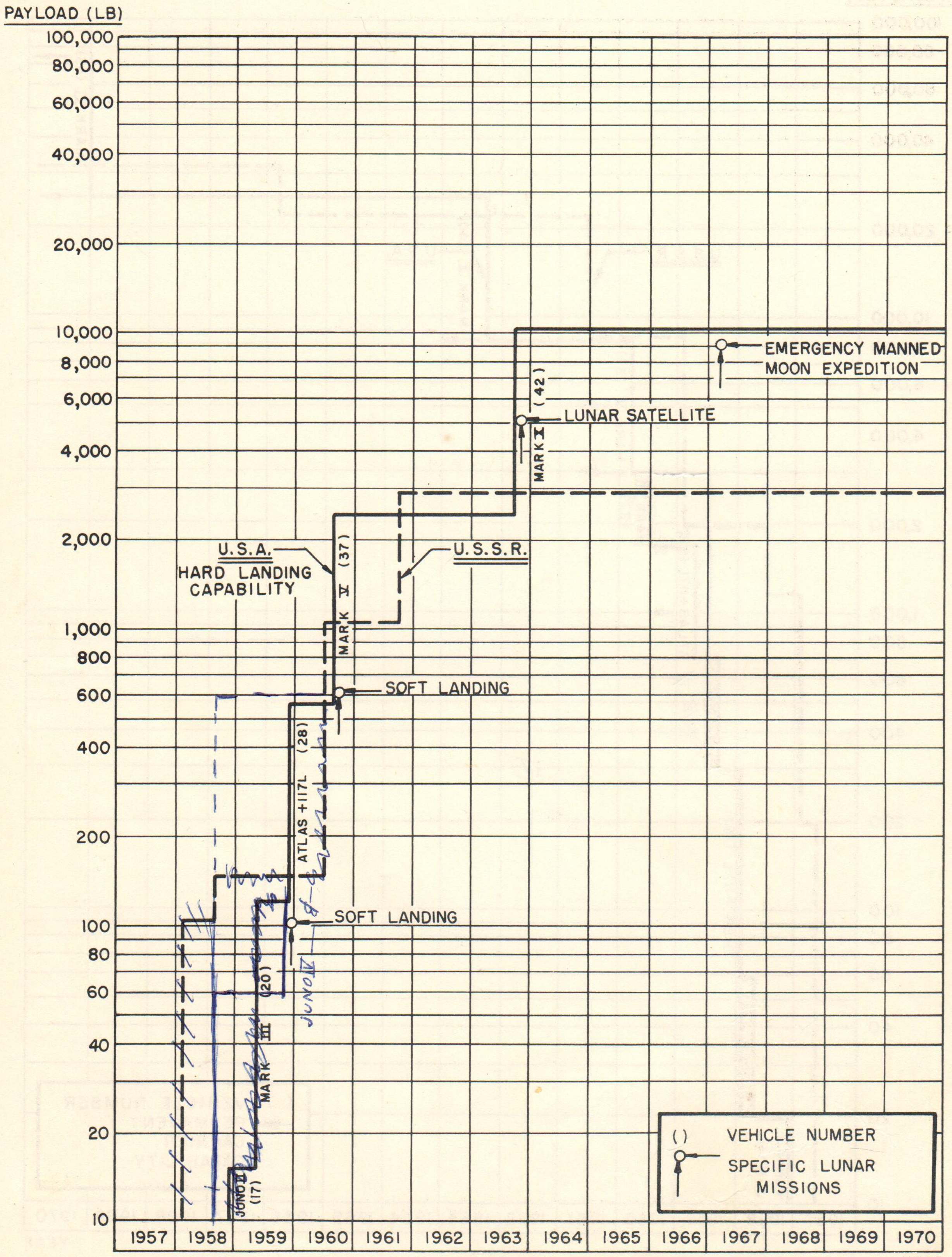

FIG. 2 – PRESENT AND ANTICIPATED MOON FLIGHT AND SPACE PROBE PAYLOAD CAPABILITIES OF RUSSIAN AND AMERICAN CARRIER VEHICLES (ONE WAY MISSION WITHOUT REFUELING)

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TABLE No. 2: RECOMMENDED DEVELOPMENT PROGRAMS FOR ORBITAL CARRIER ~~VEHICLES~~

Gen.	~~Mark~~	Civ(C) or Mil(M)	Name of Carrier Vehicle	R&D Phase	Oper. Phase	No. of R&D Missiles	Single Payload Capability (lbs)	Project Cost (millions)	Development Team	Remarks
I	I	C	VANGUARD	1955/58	1958	4	3.5-21.5	30	Martin/GE/AJ/GC	
	Ia	C	JUNO I	1956/57	1958	0	18-35	-	ABMA/JPL	Veh. available from mil. programs
	II	C	JUNO II	1958	1958/59	0	60-100	-	ABMA/JPL	do
II	IIa	M	THOR-117L	1957/58	1958/59	0	200-300	-	Douglas/Bell/Lockheed	do
out	~~III~~	~~C&M~~	~~JUNO III~~	~~1958/59~~	~~1959/62~~	~~0~~	~~300-700~~	-	A & J	~~Dev. cost paid by~~ mission payloads
		C&M	Juno IV	59/60	1961 –		500 – 3000		A, J GE, NAA	
	IV	M&C	ATLAS-117L	1957/61	1961/63	0	1,500-2,000	-	Lockheed/Convair	do
	V	M&C	?	1958/61	1961/64	0	2,500-8,800	-	C & F	do
	VI	M&C	?	1959/62	1962/64	0	500-1,000	-	A	Veh. available from mil. programs
III	VII	M&C	TITAN	1956/60	1960/80	12	1,000-3,000	60	M	Recov. & Reliab. Testing
	VIII	M&C	?	1958/62	1962/80	10	3,000-5,000	50	M	Mating & Recov. Tests
	IX	M&C	?	1960/65	1965/80	40	5,000 - 10,000	200	M	High-Perform. Propellant in upper stgs
IV	X	M&C	?	1958/64	1963/70	34	25,000 - 35,000	~~850~~ 410	A/E/D/P	Add'l R&D tests by other mil. programs
V	XI	M&C	?	1962/70	1969/80	58	50,000	1,800	C/E/F	Fully recov. system

?: or not determined

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TABLE NO. 3 TYPICAL LAYOUT OF THE MARK CARRIER VEHICLES LISTED ON TABLE NO. 2

✓ MARK I, (VANGUARD)	Well known orbital carrier vehicle
✓ MARK Ia, (JUNO I)	REDSTONE booster and (11 + 3 + 1) 6″ SERGEANT Rocket cluster by JPL $W_o = 62{,}500$ lb; $F_o = 80{,}400$ lb 18 to 36 lb orbital capability
✓ MARK II, (JUNO II)	JUPITER booster and (11 + 3 + 1) 6″ SERGEANT rocket cluster by JPL $W_o = 110{,}550$ lb; $F_o = 150{,}000$ lb
✓ MARK IIa, (THOR-117L)	THOR booster and the 117L thrust package from Bell Aircraft Co. as a second stage.
I. Stage:	$W_o = 115{,}000$ lb; $F_o = 150{,}000$ lb
II. Stage:	$W_o = 8{,}000$ lb; $F_o = 15{,}000$ lb
Mission:	Test vehicle for PIED PIPER project, 300 lb orbital payload including recovery equipment
✓ ~~MARK III, (JUNO III)~~ out	JUPITER booster and (12 + 3 + 1) cluster of Grand Central meteor rockets assembled by JPL $W_o = 117{,}700$ lb; $F_o = 150{,}000$ lb Limited control of payload stage only
✓ MARK IV, (ATLAS-117L)	Orbital carrier vehicle for PIED PIPER project
I. Stage:	$F_o = 360{,}000$ lb; $W_o = 275{,}000$ lb
II. Stage:	$F_o = 15{,}000$ lb; $W_o = 9{,}300$ lb
✓ MARK V	Orbital carrier vehicle for the GLOBAL SURVEILLANCE SYSTEM proposed by CONVAIR, or others. Could possibly consist of beefed-up ATLAS and a high performance propellant upper stage (Liquid H_2 + LOX in a pressure fed engine).
I. Stage:	$F_o = 390{,}000$ lb; $W_o = 303{,}000$ lb
II. Stage:	$F_o = 30{,}000$ lb; $W_o = 30{,}000$ lb
✓ ~~MARK VI~~ Juno IV	JUPITER or THOR booster and PERSHING missile or appropriate liquid propellant for upper stages, allows full control of payload stage. 800 lb orbital capability at 300 kilometers altitude.
I. Stage:	$F_o = 165{,}000$ lb; $W_o =$ ~~116,500 lb~~ 135,000
II. Stage:	$F_o = 42{,}000$ lb; $W_o = 10{,}000$ lb
III. Stage:	$F_o = 25{,}000$ lb; $W_o = 5{,}000$ lb
✓ MARK VII, (TITAN)	Unchanged two stage TITAN missile as orbital carrier with payload capabilities between 1000 and 3000 lb depending on altitude.
✓ MARK VIII, (TITAN + POLARIS II)	Three stage orbital carrier consisting of first and second stage TITAN and the second (solid propellant) stage of the POLARIS as a third stage. Provides full control of payload stage. Payload capabilities between 3000 lb and 5000 lb.
✓ MARK IX, (HIGH ENERGY TITAN)	First stage might be a recoverable LOX/JP TITAN first stage, second and third stages will employ high performance propellants such as LF_2 and Hydrazine or LH_2 and LOX. This carrier vehicle has potential payload capabilities up to 10,000 lb for orbital missions.
MARK X	Three stage orbital carrier
I. Stage:	4 x 380K cluster with LOX/JP, booster recoverable
II. Stage:	One 380K engine with LOX/JP or higher performance propellant if available, not recoverable
III. Stage:	ATLAS sustainer engine with high performance propellants (LF_2/Hydrazine with about 80K to 100K
(a) Instrumented cargo vehicle for orbital supply missions,	
(b) Manned vehicle for personnel transportation	
(c) Instrumented space probe	
(d) Manned vehicle for direct moon-circumnavigation and return	
MARK XI	Two stage second generation large orbital carrier. Both stages recoverable for highest economy.
I. Stage:	Possibly two 1.35K LOX/Hydrazine engines and delta wings for recovery, 20 ft. diameter.
II. Stage:	Possibly nuclear power plant with Ammonia or Hydrogen as a working fluid. Payload stage returnable with some stay time in orbit. $W_o = 2{,}300{,}000$ lb

III D-
12K flourine - Hydrazine

Put in 12K Fl

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TABLE NO. 4 RECOMMENDED PROPULSION SYSTEM DEVELOPMENT PROGRAM

PROJECT NO.	THRUST LEVEL	PROPELLANTS	R & D PHASE	OPERATIONAL PHASE	R & D COST ESTIMATE
✓ 1	400 K (SL) -E-1	LOX/RPI	1956 - 1961	1961 - 1970	$ 60 (MILLIONS)
✓ 2	CLUSTER 4 X 400 K (SL)	LOX/RPI	1958 - 1963	1963 - 1970	~~140~~ 40
✓ 3	80 TO 100 K (VAC)	HYDRAZINE/LF_2	1957 - 1961	1962 - 1970	50
✓ 4	500 K (VAC)	HYDRAZINE/LF_2 OR SIMILAR	1958 - 1963	1963 - 1970	60
✓ 5	6 000 10 TO 20 K (VAC) VERNIER 45 000	SPACE STORABLE PROPELLANT	1957 - 1961	1962 - 1970	5
✓ 6	2 30 K (VAC) PRESS. FED	HIGH ENERGY PROP. (LH_2/LOX)	1958 - 1960 1 63 PFRT	1960 2 - 1963	~~15~~ 30-35 Small engines 35
✓ 7	~~1000 TO~~ 1500 K (SL)	LOX/RPI OR HYDRAZINE	1960 - 1966	1967 - 1985	180 cell NAA Rep.
✓ 8	100 K (VAC)	SPACE STORABLE HIGH ENERGY	1960 - 1965	1966 - 1985	50
✓ 9	500 K (VAC)	SPACE STORABLE HIGH ENERGY	1960 - 1965	1966 - 1985	50
10	500 TO 1000 K (SL) ~~300 K (VAC)~~	NUCLEAR ~~FISSION~~ HYDROGEN HEAT EXCHANGER	1957 - 1965	1965 - ~~?~~	~~170~~ Possibly Small engines 360 2
11	0.001 TO 1 K (VAC) ~~0.001 K (VAC)~~ Discuss with will Jordan	ION - DRIVE *	1957 - 1966	?	25 200 ~~400~~ 2.5
~~12~~	~~0.01 K (VAC)~~	~~SOLAR POWER~~ Solar Thermal - Not competitive Solar electric not prop. system	~~1957 - 1964~~	~~?~~	~~10~~
12 ~~13~~	0.001 TO 1 K (VAC) ~~200 - 500 K~~	ARC-THERMO *	1958 - ?	?	~200 ? ~~250~~ ~~125~~ 2
13 ~~14~~	0.001 TO 1 K (VAC) ~~200 - 500 K~~	MAGNETO-HYDRO * Project Sherwood (AEC)	1958 - ?	?	~300 ? ~~600~~ 300 4
14	0.001 TO 1 K (VAC)	THERMONUCLEAR Prop. Device Heat Gen. Elec. "	1958 - ?	?	~ ? 750 5
	* Require Electrical Power Source SECRET		1958 - ?		200 ?

TABLE NO. 5 RECOMMENDED R&D PROGRAM FOR SPACE NAVIGATION SYSTEMS

(NON-MILITARY)

[illegible]

Call Dr. Hoisen

COST

Number	Mission	GENERATION ~~Over-all Project~~ ~~VEHICLE REQUIRED~~	Navigation Task	Time For R&D	First Application
1	TV and Communication System with Spin Stabilized Satellite. No recovery.	~~JUNO II~~ ~~MARK III~~ IB II	Spin rate control.	1958	1958/59
2	Close-to-Moon Path TV Mission. No recovery.	MARK III [illegible] II	Spin reduction control. RF transmission tests.	1958/59	1959
3	Moon Landing - Hard.	~~MARK III~~ II C III M	3-Axis attitude control after spin reduction to zero. RF control and guidance. Rocket pulses for velocity vector correction.	1958/59	1959
4	Moon Landing - Soft.	MARK III MARK VI II C III A IV	Attitude sensing as above, without gyros. Attitude control by jet vanes or swivelling of retrograde rocket for soft landing.	58/60 ~~1960~~	1960/61
5	Retrievable Instrument Satellite.	MARK III II M III M	Same as No. 4 above, plus use of surface control for re-entry into atmosphere. Ground guidance system development.	~~1960~~ 58/~~60~~ 59	~~1960/61~~ 59/60
6	Retrievable Satellite. Animal Recovery.	~~[illegible]~~? II C III M	Continuous 3-axis attitude control. Partially earth- and partially space-fixed control. RF control and guidance in re-entry phase. Ground guidance system.	~~1960~~ 58/~~59~~ 60	~~1961~~ ~~1960~~ 1959
7	Forerunner of Manned Satellites. Animal Recovery.	II ? III	Continuous 3-axis attitude control. Attitude sensing by stabilized platform. Supervised by space- or earth-fixed sensors. RF re-entry guidance as in No. 6.	~~1963~~ 58/63	~~1962/63~~ 1960-62
8	Manned Satellite 6G Maximum Allowance.	III ? IV	Same as No. 7 above.	~~1963~~ 1963	~~1963/64~~ 1961 [illegible]
9	Space Station Establishment.	? III ~~IV [illegible]~~ V	Approach guidance and control. Space station spin control. Spin axis control. Return alignment problems.	~~1967~~ 60-66	~~1967~~ 1964-

omit for time being

TABLE NO. 6a RECOMMENDED PROGRAM FOR CREW ENGINEERING

PART A - PROBLEM AREAS

Space Crew Selection & Trng.

Mission	Year	Time of weightlessness	Suits: Bail-out (B) Space (S) Moon (M)	Oxygen: Bottled (C) B Regenerative (R)	Water: Bottled (B) Regenerative (R)	Waste: Stored (S) Ejected (E) Algae Production	Food: Tubes (T) Kitchen (K)	Temperature: Controlled (C) Heater (H)	Air: + (ions) [illegible] Decontamination (D)	Protection: Cosmic rays and meteors (P)	Monitoring: TV & Tele. Continuous (C) Intermittent (I)	Air lock for vehicle exit: Hatch (H)	Food production: Algae (A)
Man in Rocket	1959	6 min	B	B	B	S	-	-	-	-	C	-	-
Man in X-15	1959	min	B	B	B	S	-	-	-	-	C	-	-
Animals in satellite	1959	hrs	-	B	B	S	T	C	-	-	C	-	-
Animals in satellite	1959	wks	-	B	B	E	T	C	D	P	C	-	-
Man in satellite	1960	hrs	B	B	B	S	T or K	C	-	-	C	-	-
Man in satellite (winged)	1962	hrs	B	B	B	S	T	C	-	-	C	-	-
4-Man satellite	1962	days	B	B C	R	S or E	T	C	D	P	C	-	-
Man around moon	1964	days	B	B C	R	E	T	H	D	P	I	-	-
20-Man satellite	1966	days-wks	B&S	R	R	E	T&K	C	D	P	I	H	-
Moon station	1967	days-mos	B&M	R	R	E	K	H	D	P	I	H	-
50-Man satellite	1968	mo-yr	B&S	R	R	E	K	C	D	P	I	H	-
Moon expedition	1972	wks	B&M	R	R	E	K	H	D	P	I	H	-
Planetary probes	1972	mo-yr	B&S	R	R	E	K	C	D	P	I	H	-
Perm. moon satellite	1973	mo-yr	B&M	R	R	E	K	H	D	P	I	H	A
Planet landing	1977	yrs	B&S	R	R	E	K	C	D	P	I	H	A

TABLE NO. 6b RECOMMENDED PROGRAM FOR CREW ENGINEERING

PART B - COST DATA

No.	Task	Capsule Volume (cu ft)	Year	Total Man Years	Cost (millions)
1	Capsules for animals (hours)	1 to 10	1959	15	$ 0.3
2	Suits: bail-out		1959	5	0.1
3	Air decontamination (animals)		1959	2	0.04
4	Protection against meteors and cosmic rays (animals)		1959	5	0.1
5	TV and telemeter monitoring (preliminary)		1959	100	2.0
6	Waste (storage)		1959	20	0.4
7	Food (tubes)		1959	50	1.0
8	Temperature (control)		1959	20	0.4
9	Capsules for animals (weeks)	20 to 50	1959	50	1.0
10	Capsules for man (hours)	50	1960	50	1.0
11	TV and telemeter monitoring (complete)		1960	300	6.0
12	Capsules for man (days)	150	1962	100	2.0
13	Water regeneration		1962	50	1.0
14	Waste (ejection)		1962	200	4.0
15	Air decontamination (humans)		1962	50	1.0
16	Protection against meteors and cosmic rays (humans)		1962	100	2.0
17	Temperature (heating system)		1964	300	6.0
18	Capsules for man (weeks)	5,000	1966	300	6.0
19	Suits: work in space (bottle suit)		1966 Looney	100	2.0
20	Oxygen regeneration (chemical or biological)		1966	100	2.0
21	Food (space kitchen)		1966	500	10.0
22	Air lock for vehicle escape		1966	100	2.0
23	Suits: moon		1967	150	3.0
24	Capsules for man (mos & yrs)	5,000,000	1968	600	12.0
25	Food production (algae)		1973	500	10.0
26	Suits: planets		1977	150	3.0

78.34

Call Duckett & Tessmann

GEN

rewols

TABLE NO. 7 : RECOMMENDED GROUND AND FLIGHT TEST FACILITY PROGRAM

(Millions of Dollars)

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	Orbital Carrier Vehicle	1958	1959	1960	1961	1962	1963	1964	1965	Total
Ground Test Facilities I	MARK II ~~MARK III~~	2.5								2.5
II	MARK IV	8	10							18
	MARK V	10	20	12						42
III	MARK VI		6.5							6.5
	MARK VII MARK VIII MARK IX	8	40	15	20	21	7	7	5	123
IV	MARK X	1	35	15	8	6	5	5	6	81
V	MARK XI		20	25	15	12	12	10	10	104
Flight Test Facil.	Equatorial Operational Firing Range	~~8~~	35 20	50 50	40 80	10 50	10 30	10 10	10 10	~~173~~ 250
	TOTAL	37.5	166.5	117	83	49	34	32	31	550

what about Cooke AFB + Patrick

SECRET

take another look / add; revise

review Army Prog

SECRET

TABLE NO. 8 RECOMMENDED DEVELOPMENT PROGRAM FOR SATELLITE ~~VEHICLES~~ Vehicles

No.	Civ(C) or Mil(M)	Name of Satellite	Mission	R&D Phase	Oper. Phase	Single Weight (lbs)	No. of Vehicles	Total Cost (millions)	Total Payload Weight (lbs)	Payload Cost ($/lb)	Team
1.	C(IGY)	VANGUARD	Research (IGY)	1955/57	1958	3.5 21.5	2 6	80	136	588,000	Martin/NRL
2.	C(IGY)	EXPLORER I - IV	Research (IGY)	1956/57	1958	18.3 35.5	2 2	4	107	37,000	JPL/ABMA
3.	M	INSTRUMENTS	Reconnaissance Component Test	1957/58	1958/59	200-300	10	60	3,000	20,000	Lockheed/Philco
4.	M C	~~JANUS-JR.~~ EXPLORER V	Component Test Research (IGY)	1957/58	1958/59	40-100	2	23	140	164,000	RCA/ABMA
5.	M C C&M	JANUS RES.- SAT. MAILBAG	Intelligence Scientific Res. & Recovery Communication	1957/59 1958/59 1959/60	1959/61 1959/60 1961/64	300-500 500-700 300-500	20 6 84	181 48 250	10,000 4,200 42,000	18,100 11,400 5,950	I A G
6.	M	PIED PIPER	Reconnaissance	1956/60	1961/63	1,700	30	200	51,000	3,920	Philco/Lockheed
7.	M	GSS	Global Surveil-lance System	1958/62	1962/64	2,800	42	280	117,600	~~2,500~~ 2400	C
8.	C	INSTRUMENTS & MANNED CAPSULE	Research & Comm. Manned Orbital Recovery	1958/60	1960/61	3,000	108	540	~~60,000~~ 324,000	~~1,670~~ 1,670	M
9.	C	TERRA I	Experimental Space Station	1959/61	Nov 1962	15,000	1	45	15,000	3,000	C
10.	M	DYNO SOAR I & II	Exp. Mil. Orb. Carrier	1959/6~~2~~4	196~~2~~4/6~~4~~6	9,000	42	500	300,000	~~1,290~~ 1,670	H
11.	M	DYNO SOAR III	Orb. Bomber & Reconnaissance	1959/6~~4~~6	196~~4~~6/6~~6~~8	25,000	30	500	750,000	667	H
12.	C&M	TERRA II	Interim Space Stn	1960/65	1966	300,000	1	150	300,000	500	B/A/E/F/I (15 Flights-Mark X)
13.	C&M	TERRA III	Permanent Space Station	1964/72	1972	1,000,000	1	400	1,000,000	400	B/E (50 Flights-Mark X)

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TABLE NO. 9 RECOMMENDED PROGRAM FOR MOON FLIGHT VEHICLES AND MISSIONS

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GENERATION	Mark	Carrier Vehicles	Year	No. of Missiles or Flights	Mission	Payload Capability (lbs)	Total Cost (millions)	Total Payload Weight (lbs)	Payload Cost ($/lb)	Team
		THOR -X 17	1958	~~6~~ 3	Space Probe	10	25	60	416,000	D/L/H
II	II	JUNO II	1958	2	Space Probe	14	15	28	535,000	A/J
	III	JUNO ~~III~~ IV	1959/60	~~4~~ 3	Lunar TV Circum-navigation Lunar ~~Hard~~ Landing LU HARD/SOFT	500 ~~100~~ 500 500/100	40 ~~26~~ [illegible]	2000 ~~400~~	~~65,000~~ 20,000	A/J
III	IV	ATLAS-117L	1959/60	2	Lunar Satellite Lunar ~~Soft~~ Landing HARD/SOFT	300 550/100	16	600 ~~400~~	~~40,000~~ 27,000	C/L/H
	V	?	1960/61	6	Lunar Soft Landing	2,500/600	48	3,600	13,400	C/F
IV	~~X~~ IX	?	1963/64	2	Unmanned Lunar Circumnavigation	~~5,000~~ 8000	20	10,000	2,000	A/F/D/P/B
	~~X*~~ IX	?	1967	250	Manned Lunar Land. ~~(Emergency Exp.)~~	~~10,000~~ 2500	1,350	~~10,000~~ 625,000	135,000	B/A/F/D/P
V	X~~I~~*	? check with Jordon	1972	400	Large Lunar Exp.	42 Tons	800	42 Tons	9,500	C/M/F
	X~~I~~*	?	1973/75	1000	Permanent Lunar Base	5,000 Tons	2,000	5,000 Tons	200	C/F/M

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* For orbital supply flights.

Change

TABLE NO. 10 RECOMMENDED PROGRAM FOR INTERPLANETARY PROBES

GENERATION	MARK CARRIER	YEAR	NUMBER OF VEHICLES	MISSION	TOTAL PAYLOAD, WT. (LB.)	COST (IN MILLIONS)	PAYLOAD COST ($/LB.)
III	MARK V. (OC)*	1960	2	MEASURING ASTERROID & CIS-MARTIAN PROBE	2 X 2400	$20	$ 4,175
		DEC. 1960	2	VENUS-PROBE I	2 X 2400	20	4,175
		1961	1	SOLAR PROBE I	600	10	16,700
		1962	1	SOLAR PROBE II	600	10	16,700
		AUG. 1962	1	VENUS PROBE II	2400	10	4,175
		OCT. 1962	1	MARS PROBE I	2200	10	4,550
IV	MARK IX. (OC)	JAN. 1967	1	MARS PROBE III	5000	20	4,000
		MAY 1967 or DEC. 1968	1	VENUS PROBE III	5000	20	4,000
V	MARK XI (OC)	1971/72	2	MARS SATELLITE	2 X 4000	40	5,000
		1973/74	2	VENUS SATELLITE	2 X 4000	40	5,000

* OC = ORBITAL CARRIER

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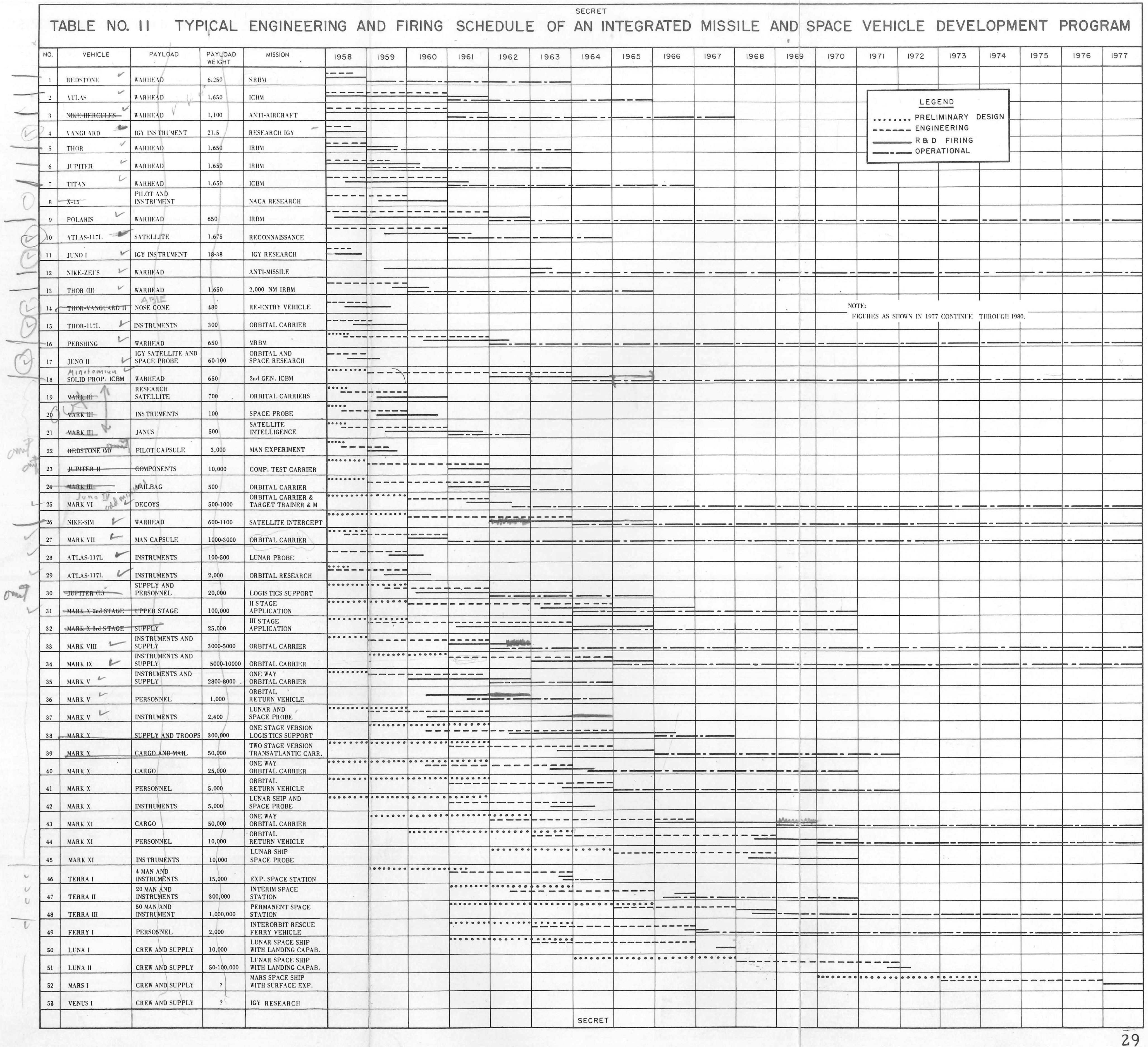
TABLE NO. II TYPICAL ENGINEERING AND FIRING SCHEDULE OF AN INTEGRATED MISSILE AND SPACE VEHICLE DEVELOPMENT PROGRAM



NO.	VEHICLE	PAYLOAD	PAYLOAD WEIGHT	MISSION
1	REDSTONE	WARHEAD	6,250	SRBM
2	ATLAS	WARHEAD	1,650	ICBM
3	~~NIKE-HERCULES~~	WARHEAD	1,100	ANTI-AIRCRAFT
4	VANGUARD	IGY INSTRUMENT	21.5	RESEARCH IGY
5	THOR	WARHEAD	1,650	IRBM
6	JUPITER	WARHEAD	1,650	IRBM
7	TITAN	WARHEAD	1,650	ICBM
8	~~X-15~~	PILOT AND INSTRUMENT		NACA RESEARCH
9	POLARIS	WARHEAD	650	IRBM
10	ATLAS-117L	SATELLITE	1,675	RECONNAISSANCE
11	JUNO I	IGY INSTRUMENT	18-38	IGY RESEARCH
12	NIKE-ZEUS	WARHEAD		ANTI-MISSILE
13	THOR (II)	WARHEAD	1,650	2,000 NM IRBM
14	~~THOR-VANGUARD II~~	ABLE NOSE CONE	480	RE-ENTRY VEHICLE
15	THOR-117L	INSTRUMENTS	300	ORBITAL CARRIER
16	PERSHING	WARHEAD	650	MRBM
17	JUNO II	IGY SATELLITE AND SPACE PROBE	60-100	ORBITAL AND SPACE RESEARCH
18	Minuteman SOLID PROP. ICBM	WARHEAD	650	2nd GEN. ICBM
19	~~MARK III~~	RESEARCH SATELLITE	700	ORBITAL CARRIERS
20	~~MARK III~~	INSTRUMENTS	100	SPACE PROBE
21	~~MARK III~~	JANUS	500	SATELLITE INTELLIGENCE
22	~~REDSTONE (M)~~ omit	PILOT CAPSULE	3,000	MAN EXPERIMENT
23	~~JUPITER II~~	~~COMPONENTS~~	10,000	COMP. TEST CARRIER
24	~~MARK III~~	MAILBAG	500	ORBITAL CARRIER
25	MARK VI Juno IV add missions	DECOYS	500-1000	ORBITAL CARRIER & TARGET TRAINER & M
26	NIKE-SIM	WARHEAD	600-1100	SATELLITE INTERCEPT
27	MARK VII	MAN CAPSULE	1000-3000	ORBITAL CARRIER
28	ATLAS-117L	INSTRUMENTS	100-500	LUNAR PROBE
29	ATLAS-117L	INSTRUMENTS	2,000	ORBITAL RESEARCH
30	~~JUPITER (L)~~	SUPPLY AND PERSONNEL	20,000	LOGISTICS SUPPORT
31	~~MARK X 2nd STAGE~~	~~UPPER STAGE~~	100,000	II STAGE APPLICATION
32	~~MARK X 3rd STAGE~~	~~SUPPLY~~	25,000	III STAGE APPLICATION
33	MARK VIII	INSTRUMENTS AND SUPPLY	3000-5000	ORBITAL CARRIER
34	MARK IX	INSTRUMENTS AND SUPPLY	5000-10000	ORBITAL CARRIER
35	MARK V	INSTRUMENTS AND SUPPLY	2800-8000	ONE WAY ORBITAL CARRIER
36	MARK V	PERSONNEL	1,000	ORBITAL RETURN VEHICLE
37	MARK V	INSTRUMENTS	2,400	LUNAR AND SPACE PROBE
38	~~MARK X~~	~~SUPPLY AND TROOPS~~	300,000	ONE STAGE VERSION LOGISTICS SUPPORT
39	~~MARK X~~	~~CARGO AND MAIL~~	50,000	TWO STAGE VERSION TRANSATLANTIC CARR.
40	MARK X	CARGO	25,000	ONE WAY ORBITAL CARRIER
41	MARK X	PERSONNEL	5,000	ORBITAL RETURN VEHICLE
42	MARK X	INSTRUMENTS	5,000	LUNAR SHIP AND SPACE PROBE
43	MARK XI	CARGO	50,000	ONE WAY ORBITAL CARRIER
44	MARK XI	PERSONNEL	10,000	ORBITAL RETURN VEHICLE
45	MARK XI	INSTRUMENTS	10,000	LUNAR SHIP SPACE PROBE
46	TERRA I	4 MAN AND INSTRUMENTS	15,000	EXP. SPACE STATION
47	TERRA II	20 MAN AND INSTRUMENTS	300,000	INTERIM SPACE STATION
48	TERRA III	50 MAN AND INSTRUMENT	1,000,000	PERMANENT SPACE STATION
49	FERRY I	PERSONNEL	2,000	INTERORBIT RESCUE FERRY VEHICLE
50	LUNA I	CREW AND SUPPLY	10,000	LUNAR SPACE SHIP WITH LANDING CAPAB.
51	LUNA II	CREW AND SUPPLY	50-100,000	LUNAR SPACE SHIP WITH LANDING CAPAB.
52	MARS I	CREW AND SUPPLY	?	MARS SPACE SHIP WITH SURFACE EXP.
53	VENUS I	CREW AND SUPPLY	?	IGY RESEARCH

LEGEND
- ⋯⋯ PRELIMINARY DESIGN
- - - - ENGINEERING
- ── R & D FIRING
- —·—· OPERATIONAL

NOTE:
FIGURES AS SHOWN IN 1977 CONTINUE THROUGH 1980.

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omit
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Non orbital carrier
"
"

2 Tab Mil & Space

11 A
11 B

Mission

Space

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TABLE NO. 12 TYPICAL MISSILE REQUIREMENTS FOR R&D FIRINGS OF AN INTEGRATED MISSILE AND SPACE VEHICLE DEVELOPMENT PROGRAM

NO.	VEHICLE	PAYLOAD	PAYLOAD WEIGHT	MISSION	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	REDSTONE	MILITARY WH.	6,250	SHORT RANGE BM	3 3 3 1														
2	ATLAS	WARHEAD	1,650	ICBM	4 3 4 5	6 5 6 7	7 8 7 6	6 6 3 0	0 0 0 1										
3	NIKE-HERCULES	WARHEAD	1,100	ANTI-AIRCRAFT	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24											
4	VANGUARD	VANGUARD SATELLITE	21.5	RESEARCH	3 3 3 1														
5	THOR (I)	WARHEAD	1,650	IRBM-IOC	5 4 2 8 7 8	6 4 4 0													
6	JUPITER	WARHEAD	1,650	IRBM	1 1 2 3	4 3 3 6	6 0 0 0												
7	TITAN	WARHEAD	1,650	ICBM	0 0 1 3	3 5 6 6	6 6 6 6	4 4 0 0											
8	X-15	PILOT AND INSTRUMENTS		RESEARCH		0 1 1 1													
9	POLARIS	WARHEAD	650	SUB-IRBM	0 3 3 4	9 15 21 27	39 51 33 45	42 30 42 30	14 14 14 14										
10	ATLAS-117L	INSTRUMENTS	1,650	RECONNAISSANCE		0 0 1 2	2 1 1 2	2 3 0 0											
11	JUNO I	EXPLORER SATELLITE	18-33	RE-ENTRY AND RESEARCH	2 1 1 0														
12	NIKE-ZEUS	WARHEAD		ANTI-MISSILE		0 0 8 9	9 9 9 11	15 13 14 10	11 15 14 15	15 16 0 0									
13	THOR (II)	WARHEAD	1,650	IRBM-2,000		0 0 0 4	4 2 0 0												
14	THOR-VANGUARD II	NOSE CONE	480	RE-ENTRY TEST	0 0 2 1	1 1 0 0													
15	THOR-117L	PHOTO-COMP.	300	INSTRUMENT TEST VEHICLE	0 0 0 2	3 3 2 0													
16	PERSHING	WARHEAD	650	MRBM			0 0 12 12	12 12 12 12	12 12 0 0										
17	JUNO II	INSTRUMENTS	15-100	SATELLITE AND LUNAR RESEARCH	0 0 0 3	1 0 0 0													
18	SOLID PROP. ICBM	WARHEAD AND CARGO	650	2nd GEN. ICBM CARGO & MAIL CARR.						3 6 6 9	12 12 12 12	12 12 9 9							
19	~~MARK III~~	ANIMALS AND INSTRUMENTS	200-700	ORBITAL RESEARCH		0 1 1 1	0 1 1 1												
20	~~MARK III~~	INSTRUMENTS	100	LUNAR PROBE		0 1 1 0	1 0 1 0												
21	~~MARK III~~	JANUS-C	500	INTELLIGENCE		0 1 1 1	2 2 1 0	1 1 0 0											
22	REDSTONE	MAN EXPER.	3,000	RESEARCH		1 2 1 0													
23	JUPITER II	TEST COMPONENTS	20,000	TEST WORKHORSE				1 1 1 1	1 1 1 1	1 1 0 0									
24	~~MARK III~~	MAILBAG AND DECOY	500	COMMUNICATION				1 1 2 1	1 1 1 1										
25	MARK VI	DECOY AND MAILBAG	500-1000	TARGET TRAINER AND ORBITAL CARRIER				0 0 1 1	1 1 0 0										
26	NIKE-SIM	WARHEAD		ANTI-SATELLITE						6 9 12 12	12 12 12 12	15 15 15 15							
27	MARK VII	MEN-EXPER. CARGO AND INSTRUMENTS	1,000-3,000	ORBITAL CARRIER			1 1 1 1												
28	ATLAS-117L	INSTRUMENTS	550	LUNAR PROBE		0 0 0 1	1 0 0 0												
29	ATLAS-117L	INSTRUMENTS	2,000	ORBITAL RESEARCH		0 0 1 1	1 1 0 0												
30	JUPITER	SUPPLY	20,000	LOGISTICS SUPPORT			0 3 3 3	3 3 3 3	3 3 1 1	2 2 1 1									
31	MARK X 2nd STAGE	UPPER STAGE	100,000	2nd STAGE APPLICATION						0 1 2 6	9 12 8 8	8 8 8 6							
32	MARK X 3rd STAGE	CARGO AND PERS.	5-25,000	3rd STAGE APPLICATION				0 1 2 2	2 2 2 2	3 6 7 11	9 12 8 8	5 5 5 3							
33	MARK VIII	CARGO AND INSTRUMENTS	3,000-5,000	ORBITAL CARRIER				1 1 2 2	1100										
34	MARK IX	CARGO	5,000-10,000	ORBITAL CARRIER						1 2 3 4	6 6 3 3	3 3 3 3							
35	MARK V	INSTRUMENTS AND CARGO	2,800-8,000	ONE WAY ORBITAL CARRIER			1 1 1 2	1 1 1 1	1 1 2 4										
36	MARK V	PERSONNEL	8,000	MANNED RECON. ORBITAL RETURN			0 0 2 3	3 4 4 2	0 0 0 2										
37	MARK V	INSTRUMENTS	2,500	LUNAR AND SPACE PROBE R&D OP- XXX XX			0 0 1 1	0 1 0 1	1 1 0 0	0 0 1 1	1 1 1 1								
38	MARK X	SUPPLY	300,000	LOGISTICS SUPPORT					0 0 0 1	2 2 3 3	4 1 1 1	3 3 3 3	1 1 0 0						
39	MARK X	CARGO MAIL	50,000	TRANSATLANTIC CARR.						0 0 0 1	1 2 2 2	3 3 3 3							
40	MARK X	RECON. VEHICLE CARRIER CARGO	25,000	ORBITAL CARRIER						0 1 1 2	1 2 0 0								
41	MARK X	PERSONNEL	5,000	ORBITAL RETURN VEHICLE						0 0 0 3	5 8 6 6								
42	MARK X	CREW INSTRUMENTS	5,000	SPACE PROBE LUNAR RESEARCH SHIP						0 0 1 0	2 1 0 0								
43	MARK XI	RECON. VEHICLE CARRIER CARGO	50,000	ORBITAL CARRIER									2 2 3 3	4 4 4 4	6 6 3 3				
44	MARK XI	PERSONNEL	10,000	ORBITAL RETURN VEHICLE											0 0 1 1	4 6 6 4	3 3 1 1		
45	MARK XI	CREW INSTRUMENTS	10,000	LUNAR SHIP AND SPACE PROBE											0 0 2 2	2 0 0 2	0 0 2 2		

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2 Tab Mil & space

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R&D & Operational - by Mission

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mission

TABLE NO. 13 TYPICAL TOTAL MISSILE PRODUCTION REQUIREMENTS (R&D AND OPERATIONAL)

NO.	VEHICLE	PAYLOAD	PAYLOAD WEIGHT	MISSION	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	REDSTONE	MILITARY	6,250	SRBM	5 6 7 6	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6															
2	ATLAS	MILITARY	1,650	ICBM	4 3 4 5	8 7 12 12	16 15 13 16	14 18 17 18	15 13 15 15	14 14 14 14	12 12 12 12													
3	NIKE-HERCULES	MILITARY	1,100	ANTI-AIRCRAFT	112 591 51 350	738 739 721 738	741 716 741 741	336 336 486 336	312 312 312 312															
4	VANGUARD	RESEARCH	21.5	IGY	3 3 3 1																			
5	THOR	MILITARY	1,650	IRBM	2 8 11 24	14 15 4 0	Total 78																	
6	JUPITER	MILITARY	1,650	IRBM	1 1 6 12	15 15 14 13	17 15 4 0																	
7	TITAN	MILITARY	1,650	ICBM	0 0 1 3	3 5 18 18	20 19 20 19	20 19 20 19	22 22 22 22	22 20 22 21	14 14 14 14													
8	~~X-15~~	PILOT		NACA RESEARCH		0 1 1 1																		
9	~~POLARIS~~	MILITARY	650	IRBM	0 3 3 4	9 15 21 27	39 51 33 45	54 54 54 54	54 54 54 54	54 54 54 54	54 54 54 54													
10	ATLAS-117L	MILITARY	1,675	RECONNAISSANCE		0 0 1 2	2 1 1 2	2 3 2 2	2 2 2 2	1 1 1 1														
11	JUNO I	RESEARCH	18-35	IGY	2 1 1 0																			
12	~~NIKE-ZEUS~~	MILITARY		ANTI-MISSILE		0 0 8 9	9 9 9 11	24 24 24 24	30 30 30 30	30 30 30 30	30 30 30 30	54 54 54 54	54 54 54 54	30 30 30 30										
13	THOR (II)	MILITARY	1,650	2,000 NM IRBM		0 0 12 17	18 18 18 18	18 18 18 18	18 18 18 18															
14	THOR-VANGUARD II	NOSE CONE	480	RE-ENTRY VEHICLE	0 0 2 1	1 1 1 0																		
15	THOR-117L	MILITARY	300	ORBITAL TEST CARRIER	0 0 0 2	3 3 2 0																		
16	~~PERSHING~~	MILITARY	650	MRBM			0 0 12 12	12 12 12 12	12 12 12 12	12 21 12 16	61 75 36 75	75 75 75 75	75 75 75 75	75 75 75 75	75 75 75 75	75 75 75 75	75 75 0 0							
17	JUNO II	INSTRUMENTS	60-120	ORBITAL RESEARCH	0 0 0 3	1 0 0 0																		
18	~~SOLID PROP. ICBM~~	MILITARY	650	ICBM						3 6 6 9	12 12 12 12	15 15 15 15	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24	24 24 24 24
19	~~MARK III~~	INSTRUMENTS	700	RESEARCH SATELLITE		0 1 1 1	0 1 1 1																	
20	~~MARK III~~	INSTRUMENTS	100	SPACE PROBE		0 1 1 0	1 0 1 0																	
21	~~MARK III~~	MILITARY	500	INTELLIGENCE		0 1 1 1	2 2 1 2	2 2 1 1	22 1 1 1 1															
22	REDSTONE (M)	PILOT	3,000	RESEARCH		1 2 1 0																		
23	JUPITER II	COMPONENTS	10,000	TEST CARRIER				1 1 1 1	1 1 1 1	1 1 0 0														
24	~~MARK III~~	MAILBAG	500	ORBITAL CARRIER				1 1 2 2	1 1 2 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
25	MARK VI	DECOYS	800	ORBITAL CARRIER AND TARGET TRAINER				1 1 2 2	3 3 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2
26	~~NIKE-SIM~~	MILITARY	600-1,100	SATELLITE INTERCEPT						6 9 12 12	24 24 24 24	30 30 30 30	15 15 15 15											
27	MARK VII	MAN CAPSULE INSTRUMENTS	1,000-3,000	ORBITAL CARRIER			1 1 2 2	3 3 3 3	3 3 2 2	1 1 1 1	1 1 1 1	3 3 3 3	3 3 3 3	2 2 2 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
28	ATLAS-117L	INSTRUMENTS	100-500	LUNAR PROBE		0 0 0 1	1 0 0 0																	
29	ATLAS-117L	INSTRUMENTS	2,000	ORBITAL RESEARCH		0 0 1 1	1 1 0 0																	
30	JUPITER (L)	SUPPLY AND PERSONNEL	20,000	LOGISTICS SUPPORT			0 3 3 3	3 3 3 3	4 4 4 4	6 6 6 6														
31	MARK X 2nd STAGE	UPPER STAGE	100,000	II STAGE APPLICATION						0 1 2 6 0 1 2 6	9 12 8 8 9 12 14 14	8 8 6 13 18 13 15	30 30 30 30	30 30 30 30	24 12 24 12	2 2 2 2	2 2 2 2							
32	MARK X 3rd STAGE	SUPPLY	25,000	III STAGE APPLICATION				0 1 2 2	2 2 2 2	3 7 9 17	25 22 18 22	26 27 26 28	30 30 30 30	30 30 30 30	30 18 30 18	12 12 12 12	6 6 6 6							
33	MARK VIII	INSTRUMENTS AND SUPPLY	3-5,000	ORBITAL CARRIER				1 1 2 3	2 2 2 2	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	2 2 2 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
34	MARK IX	INSTRUMENTS AND SUPPLY	5-10,000	ORBITAL CARRIER						1 2 3 4	6 6 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3
35	MARK V	INSTRUMENTS AND SUPPLY	3-8,000	ONE WAY ORBITAL CARRIER			1 1 1 2	2 2 2 2	2 2 3 4	3 3 3 3	3 3 3 3													
36	MARK V	PERSONNEL	1,000	ORBITAL RETURN VEHICLE			0 0 2 3	3 4 4 2	2 2 2 2	2 2 2 2	2 2 2 2													
37	MARK V	INSTRUMENTS	2,400	SPACE PROBE			0 0 1 1	1 0 0 1	1 1 0 0	0 0 1 1	1 1 1 1													
38	MARK X	SUPPLY	300,000	SINGLE STAGE LOGISTICS SUPPORT					0 0 0 1	2 2 3 3	Recovery 4 1 1 1	3 3 3 3	3 3 3 3	3 3 3 3										
39	MARK X	CARGO AND MAIL	50,000	TWO STAGE TRANS-ATLANTIC CARRIER					2nd Stage	0 0 0 1	1 2 2 2	3 3 3 3	3 3 3 3	3 3 3 3	6 6 6 6									
40	MARK X	CARGO	25,000	ONE WAY ORBITAL CARRIER						0 1 1 2	1 2 6 6	4 4 4 4	4 4 4 4	4 4 4 4	2 2 0 0									
41	MARK X	PERSONNEL	5,000	ORBITAL RETURN VEHICLE						0 0 0 3	5 8 6 6	2 2 2 2	2 2 2 2	2 2 2 2	2 2 2 2									
42	MARK X	INSTRUMENTS	5,000	SPACE PROBE						0 0 1 0	2 1 0 0													
43	MARK XI	CARGO	50,000	ONE WAY ORBITAL CARRIER									2 2 3 3	4 4 4 4	6 6 6 6	9 9 9 9	12 12 12 12	12 12 12 12	9 9 9 9	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6
44	MARK XI	PERSONNEL	10,000	ORBITAL RETURN VEHICLE																				
45	MARK XI	PILOT AND INSTRUMENTS	10,000	SPACE PROBE																				

NOTE:
FIGURES AS SHOWN IN 1977 CONTINUE THROUGH 1980.

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prod. 23 of Feb 58 (23)

Total Production 171 91 R&D 74 operational 6 Production improvement

171
23
148

18
8/148
8
6
68

Put in vehicle (~~Generation~~ type)

100
300
1000

omit ✓

Same as Table 12

Juno IV orb. Carrier

orbital Carrier

① ①② ①②③ ①②③ ①②③

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IRBM
ICBM ~~MISS~~
1st Gen
2 "
3, 4, 5 "

list 25 per vehicle Type

TABLE NO. 14 TYPICAL MISSILE FIRING PLAN OF AN INTEGRATED MISSILE AND SPACE VEHICLE PROGRAM

GEN.	NO.	VEHICLE	PAYLOAD	PAYLOAD WEIGHT	MISSION	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
✓	✓ 1	REDSTONE	MILITARY	6,250	SRBM/MVH	3 5 3 1	4 5 5 3	4 3 0 0	0 2 0 0	0 2 0 0										
1	2	JUNO I	RESEARCH	18 - 35	ORBITAL CARRIER	2 1 1 0														
1	3	VANGUARD	RESEARCH	21.5	ORBITAL CARRIER	3 3 3 1														
	4	X - 15	PILOT		RESEARCH		0 1 2 3	3 3 6 6	6 6 6 6											
✓	✓ 5	JUPITER 3 ...	MILITARY	1,650	IRBM	1 1 2 3	4 3 3 6	6 3 3 3	0 2 0 0	0 2 0 0	0 2 0 0									
✓	6	JUPITER (L)	MILITARY	20,000	LOGISTICS/SUPPORT			0 3 3 3	3 3 3 3	4 4 2 2	2 2 1 1									
2	7	JUNO II	RESEARCH	60-120	ORBITAL CARRIER	0 0 0 3	1 0 0 0													
2	8	~~MARK III~~ JUNO IV	RESEARCH AND MILITARY	300 - 700	ORBITAL CARRIER		0 3 3 2	3 3 3 3	3 3 3 3	3 3 3 3										
✓	9	JUPITER II	COMPONENTS	10,000	TEST WORKHORSE				1 1 1 1	1 1 1 1	1 1 0 0									
3	10	MARK VI	INSTRUMENT AND MILITARY	800	TARGET TR./~~MAILBAG~~ ORBITAL CARRIER 515				1 1 2 2	2 2 2 2	2 2 2 2	2 2 2 2								
✓	✓ 11	THOR	MILITARY	1,650	IRBM	2 8 7 8	6 4 4 7	7 5 3 3	2 2 2 2	0 2 0 2	0 2 0 ~~2~~ 0	80								
2	12	THOR-VANGUARD II	NOSE CONE	480	RE-ENTRY TEST	0 0 2 1	1 1 0 0													
2	13	THOR - 117L	MILITARY	300	ORBITAL CARRIER	0 0 0 2	3 3 2 0													
✓	14	POLARIS	MILITARY	650	SUB-IRBM	0 3 3 4	$9^{15}\ 21^{27}$	$33^{39}\ 45^{51}$	$42^{42}\ 30^{30}$	$14^{14}\ 14^{14}$										
✓	15	PERSHING	MILITARY	650	MRBM			0 0 12 12	$12^{12}\ 12^{12}$	12 12 0 0										
✓	16	ATLAS	MILITARY	1,650	ICBM	5 6 6 9	7 7 7 7	7 7 7 7	7 7 0 0	0 0 0 1										
3	17	ATLAS-117L	MILITARY	1,670	RECON. SATELLITE		0 0 2 4	4 2 1 2	2 3 2 2	2 2 2 2	1 1 1 1									
3	18	MARK V	MILITARY AND RESEARCH	3-8800	ORBITAL CARRIER			1 1 4 6	5 7 6 5	5 5 5 6 9 9 9 10	5 5 6 6 5 4 9 9	6 6 6 6								
✓	19	TITAN	MILITARY	1,650	ICBM	0 0 1 3	3 5 6 6	6 6 6 6	4 4 0 0			4 4 4 4								
3	20	MARK VII	INSTRUMENT AND MILITARY	1000-3000	ORBITAL CARRIER			1 1 2 2	3 3 3 3	3 3 2 1	2 1 1 1	1 1 1 1	3 3 3 3	3 3 3 3	3 3 3 3	2 2 2 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
3	21	MARK VIII	INSTRUMENT AND MILITARY	3000-5000	ORBITAL CARRIER				1 1 2 2	2 2 3 4	2 2 2 2	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	2 2 2 2	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
3	22	MARK IX	INSTRUMENT AND MILITARY	5-10,000	ORBITAL CARRIER						1 2 3 4	6 6 3 3	6 6 6 6	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3	3 3 3 3
✓	23	SOLID PROP. ICBM	MILITARY	650	ICBM AND CARGO						3 6 6 9	$12^{12}\ 12^{12}$	$15^{15}\ 15^{15}$	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6	6 6 6 6
4	24	MARK X	CARGO	300,000	ONE STAGE VERSION LOGISTICS AND R & D					0 0 0 1	2 2 3 3	4 4 4 4	4 4 4 4	2 2 0 0						
4	25	MARK X 2nd STAGE	UPPER STAGE	100,000	2nd STAGE ORBITAL CARRIER						0 1 2 6	9 12 8 8	8 8 8 6	NOT SEPARATELY FIRED						
4	26	MARK X 3rd STAGE	CARGO	25,000	3rd STAGE ORBITAL CARRIER				0 1 2 2	2 2 2 2	3 5 5 5									
4	27	MARK X	MAIL AND CARGO	50,000	TRANSATLANTIC CARRIER 2 STAGES						0 0 0 1	1 2 2 2	3 3 3 3	0 0 0 0	0 0 0 0	3 3 3 3	6 6 3 3	3 3 3 3		
4	28	MARK X	CARGO AND PERSONNEL	25,000	ORBITAL CARRIER					Change →	0 1 2 6	$8^{10}\ 12^{12}$	$18^{18}\ 20^{21}$	$30^{30}\ 30^{30}$	$30^{30}\ 30^{30}$	$30^{30}\ 18^{18}$	$12^{12}\ 12^{12}$	6 6 6 6		
5	29	MARK XI	CARGO	50,000	ONE WAY ORBITAL CARRIER									2233 ~~1111~~	4444 ~~1233~~	6666 ~~4566~~	12 12	24 24	30 30	30 30
5	30	MARK XI	PERSONNEL	5,000	ORBITAL RETURN VEHICLE												12 12	24 24	30 30	30 30

NOTE:
FIGURES AS SHOWN IN 1972 CONTINUE THROUGH 1980.

Redstone
Vanguard
Jupiter
Thor
Atlas
Titan
Sup Titan (IX)
IV A
V A&B

Total

20 veh/yr

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TABLE NO. 15 OVER-ALL FUNDING PLAN FOR SPACE FLIGHT MISSIONS (MILLIONS OF DOLLARS)

2 Tables Mil $ Space

By mission

omit See Tab #12

use Gen phology

NO.	VEHICLE	PAYLOAD	PAYLOAD WEIGHT	MISSION	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
✓ 1	REDSTONE	WARHEAD	6,250	SRBM	(106)	(122)	(119)	(101)	(90)															
✓ 2	ATLAS	WARHEAD	1,650	ICBM	?	?	?	?	?	?	?													
✓ 3	NIKE-HERCULES	WARHEAD	1,100	ANTI-AIRCRAFT	(505)	(200)	(212)	(187)	(169)	(15)	(15)	(15)												
I 4	VANGUARD	IGY INSTRUMENT	21.5	RESEARCH IGY	110																			
✓ 5	THOR	WARHEAD	1,650	IRBM	(142)	(193)	(197)	(127)	(27)															
✓ 6	JUPITER	WARHEAD	1,650	IRBM	(390)	(305)	(99)																	
✓ 7	TITAN	WARHEAD	1,650	ICBM	?	?	?	?	?	?	?													
8	X-15	PILOT AND INSTRUMENT		NACA RESEARCH	?	?	?																	
✓ 9	POLARIS	WARHEAD	650	IRBM	(178)	(350)	?	?	?	?	?													
III 10	ATLAS-117L*	SATELLITE	1,675	RECONNAISSANCE	26	48	54	40	20	10														
I 11	JUNO I	IGY INSTRUMENT	18-38	IGY RESEARCH	5																			
✓ 12	NIKE-ZEUS	WARHEAD		ANTI-MISSILE	(154)	(912)	(1,689)	(2,156)	(1,877)	(1,694)	(1,441)	(891)	(356)	(317)										
✓ 13	THOR II	WARHEAD	1,650	2,000 NM IRBM	COVERED BY LINE NO. 5																			
II 14	THOR-VANGUARD II*	NOSE-CONE	480	RE-ENTRY VEHICLE	(24)	(12)																		
II 15	THOR-117L*	INSTRUMENTS	300	ORBITAL CARRIER	40	20																		
✓ 16	PERSHING	WARHEAD	650	MRBM	(17)	(116)	(172)	(125)	(219)	(176)	(175)	(175)	(175)	(175)	(175)									
II 17	JUNO II	IGY SATELLITE AND SPACE PROBE	60-100	ORBITAL AND SPACE RESEARCH	21	2																		
✓ 18	SOLID PROP. ICBM	WARHEAD	650	2nd GEN. ICBM		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
II 19	~~MARK III~~	RESEARCH SATELLITE	700	ORBITAL CARRIERS	172	132	105	40	34															
20	~~MARK III~~ JUNO IV	INSTRUMENTS	100	SPACE PROBE																				
21	~~MARK III~~	JANUS	500	SATELLITE INTELLIGENCE																				
✓ 22	REDSTONE (M)	PILOT CAPSULE	3,000	MAN EXPERIMENT	3	4	2																	
✓ 23	JUPITER II	COMPONENTS	10,000	COMP. TEST CARRIER		10	20	20	20	10														
24	~~MARK III~~	MAILBAG	500	ORBITAL CARRIER	COVERED BY LINES 19-21																			
II 25	~~MARK VI~~ JUNO 2+IV	DECOYS	500-1,000	ORBITAL CARRIER & TARGET TRAINER & M		27	45	36	54	54	52	52	52	50	50	50	50	50	50	50	50	50	50	50
✓ 26	NIKE-SIM	WARHEAD	600-1,100	SATELLITE INTERCEPT				?	?	?	?	?	?											
III 27	MARK VII	MAN CAPSULE	1,000-3,000	ORBITAL CARRIER	72	120	90	36	36	96	96	64	36	36	36	36	36	36	36	36	36	36	36	36
III 28	ATLAS-117L	INSTRUMENTS	100-500	LUNAR PROBE	15	15																		
III 29	ATLAS-117L	INSTRUMENTS	2,000	ORBITAL RESEARCH	25	25	10																	
✓ 30	JUPITER (L)	SUPPLY AND PERSONNEL	20,000	LOGISTICS SUPPORT	(54)	(72)	(96)	(144)																
IV 31	MARK X (2nd stage)	UPPER STAGE	100,000	II STAGE APPLICATION				90	294	236	240	240	144	24	20	10	5							
IV 32	MARK X (3rd stage)	SUPPLY	25,000	III STAGE APPLICATION		50	64	216	261	160	180	180	144	72	36	10	5							
III 33	MARK VIII	INSTRUMENTS AND SUPPLY	3,000-5,000	ORBITAL CARRIER		105	96	120	72	36	36	36	24	12	12	12	12	12	12	12	12	12	12	12
III 34	MARK IX	INSTRUMENTS AND SUPPLY	5,000-10,000	ORBITAL CARRIER				150	216	120	84	42	42	42	42	42	42	42	42	42	42	42	42	42
III 35	MARK V	INSTRUMENTS AND SUPPLY	2,800-8,000	ONE WAY ORBITAL CARRIER	50	64	77	72	72															
III 36	MARK V	PERSONNEL	1,000	ORBITAL RETURN VEHICLE	60	143	80	80	80															
III 37	MARK V	INSTRUMENTS	2,400	LUNAR AND SPACE PROBE	16	16	16	16	32															
IV 38	MARK X	SUPPLY AND TROOPS	300,000	ONE STAGE VERSION LOGISTICS SUPPORT			15	120	70	(96)	(84)	(72)												
IV 39	MARK X	CARGO AND MAIL	50,000	TWO STAGE VERSION TRANSATLANTIC CARR.				(15)	(84)	(120)	(96)	(84)	(144)											
IV 40	MARK X	CARGO	25,000	ONE WAY ORBITAL CARRIER				131	416	356	528	528	408	192	96									
IV 41	MARK X	PERSONNEL	5,000	ORBITAL RETURN VEHICLE																				
IV 42	MARK X	INSTRUMENTS	5,000	LUNAR SHIP AND SPACE PROBE				10	30															
V 43	MARK XI	CARGO	50,000	ONE WAY ORBITAL CARRIER							250	390	550	684	1008	840	780	720	720	720	720	720	720	720
V 44	MARK XI	PERSONNEL	10,000	ORBITAL RETURN VEHICLE																				
V 45	MARK XI	INSTRUMENTS	10,000	LUNAR SHIP AND SPACE PROBE																				
46	TERRA I	4 MEN AND INSTRUMENTS	15,000	EXP. SPACE STATION			8	2																
47	TERRA II	20 MEN AND INSTRUMENTS	300,000	INTERIM SPACE STATION				2	8	20	20	10												
48	TERRA III	50 MEN AND INSTRUMENTS	1,000,000	PERMANENT SPACE STATION				8	12	20	30	30	30	20										
49	FERRY I	PERSONNEL	2,000	INTER-ORBIT RESCUE FERRY VEHICLE					10	20	30	20												
50	LUNA I	CREW AND SUPPLY	10,000	LUNAR SPACE SHIP WITH LANDING CAPAB.				4	6	15	25	20	10											
51	LUNA II	CREW AND SUPPLY	50-100,000	LUNAR SPACE SHIP WITH LANDING CAPAB.							8	12	30	50	40	20								
52	MARS I	CREW AND SUPPLY	?	MARS SPACE SHIP WITH SURFACE EXP.									5	10	10	20	20	30	40	50	70	60	40	
53	VENUS I	CREW AND SUPPLY	?	IGY RESEARCH													10	10	10	10	10	20	20	30
	TOTAL (See Note)				615	781	682	1,193	1,743	1,153	1,579	~~1,614~~ 1624	1,475	1,192	1,350	1,040	960	900	910	920	940	940	920	890
	GRAND TOTAL (Through 1980)																							~~24,467~~ 24,477

NOTE: BUDGET FIGURES OF MILITARY LONG-RANGE MISSILE PROGRAMS HAVE BEEN INCLUDED ONLY FOR COMPARISON PURPOSES. THEY HAVE BEEN PUT IN PARENTHESES AND ARE NOT INCLUDED IN THE YEARLY TOTALS.

* ESTIMATED

FIGURES AS SHOWN IN 1977 CONTINUE THROUGH 1980.

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TABLE NO. 16 SUMMARY OF COST ESTIMATES FOR RECOMMENDED SPACE FLIGHT PROGRAM (1958 thru 1980)

A. INDIVIDUAL SUB-PROGRAMS

1. Orbital Carrier Development Program	\$ 2,990 x 10^6
2. Satellite Vehicle Program	3,261
3. Moon Flight Program	4,300
4. Interplanetary Probes	200
5. (a) Supply and Maintenance of 20 Man Satellite (60 Million per Year)	900
(b) Supply and Maintenance of 50 Man Satellite (140 Million per Year)	1,820
6. Two interplanetary Expeditions (Mars and Venus)	6,766
	\$20,237 x 10^6

B. GENERAL COST ITEMS

1. Ground Operation and Organization (Average 100 Million per Year)	\$ 2,300 x 10^6
2. Component Development	
a. Propulsion System Development	1,215
b. Navigation Systems	85
c. Crew Engineering	80
3. Additional Facilities	550
	\$ 4,230 x 10^6

TOTALS A + B	\$24,467 x 10^6

C. SUPPORTING RESEARCH

(12 Percent of Totals A + B)	\$ 2,933 x 10^6
TOTALS A + B + C	\$27,400 x 10^6
Inflation Rate: 10 Percent	\$ 2,740 x 10^6
Total Cost Estimate for a 23 Year Program	\$30,140 x 10^6
Average Per Year	\$ 1,310 x 10^6

NOTE: (a) The totals of A and B (\$24,467 x 10^6) are identical to the sum of yearly budgets as listed in Table No.15 if continued thru 1980.

(b) These costs do not include any long-range missile programs like in the MRBM, IRBM or ICBM class.

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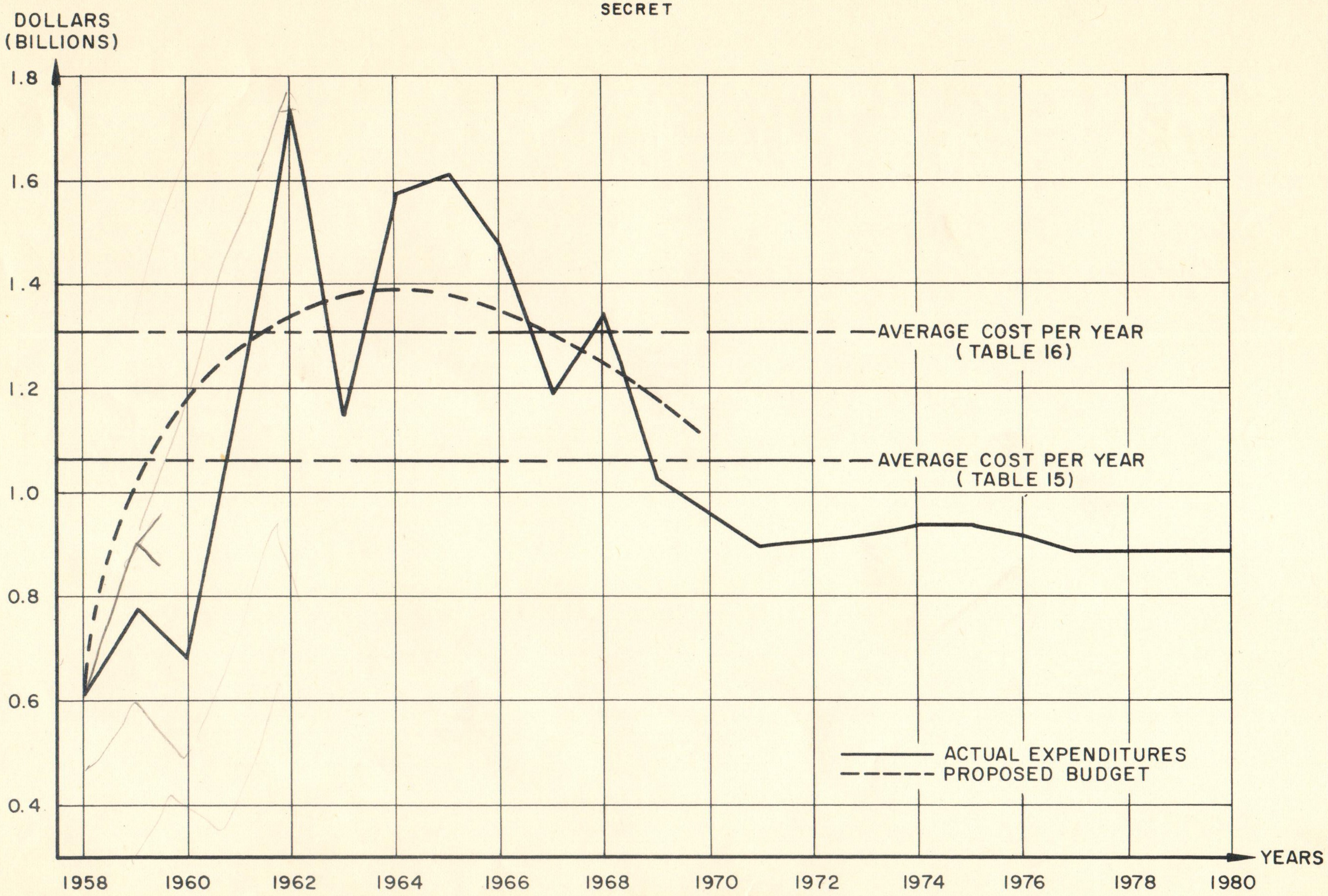

TABLE NO.17 RESULTS FROM PRESENT PROGRAM STUDY

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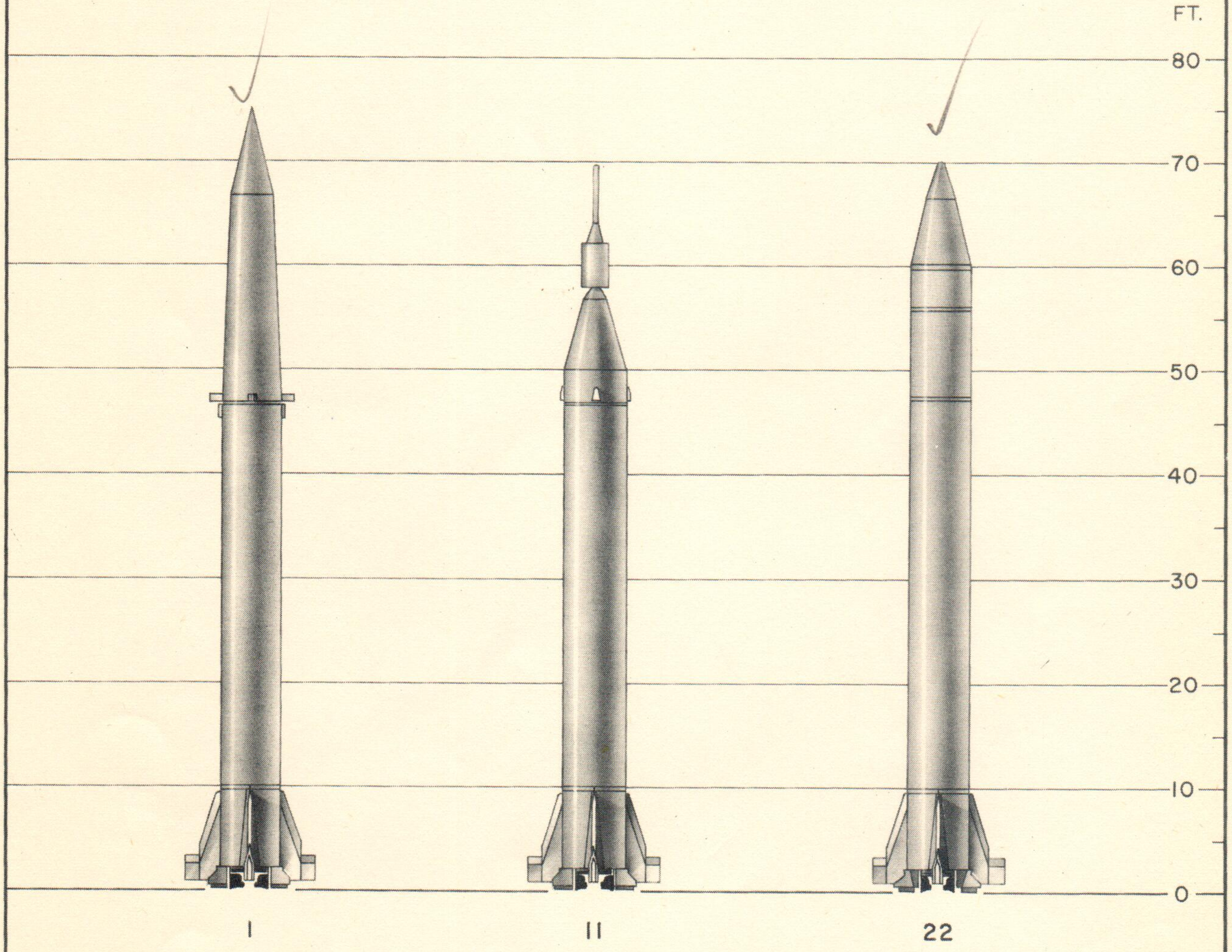
FIG. 3

REDSTONE FAMILY



	REDSTONE SRBM	JUNO I ORBITAL CARRIER	REDSTONE PROJECT "ADAM"
PAYLOAD WT. CAPABILITY (LB.)	6250	18–38	3000

FIG. 4
ATLAS AND MARK V FAMILY

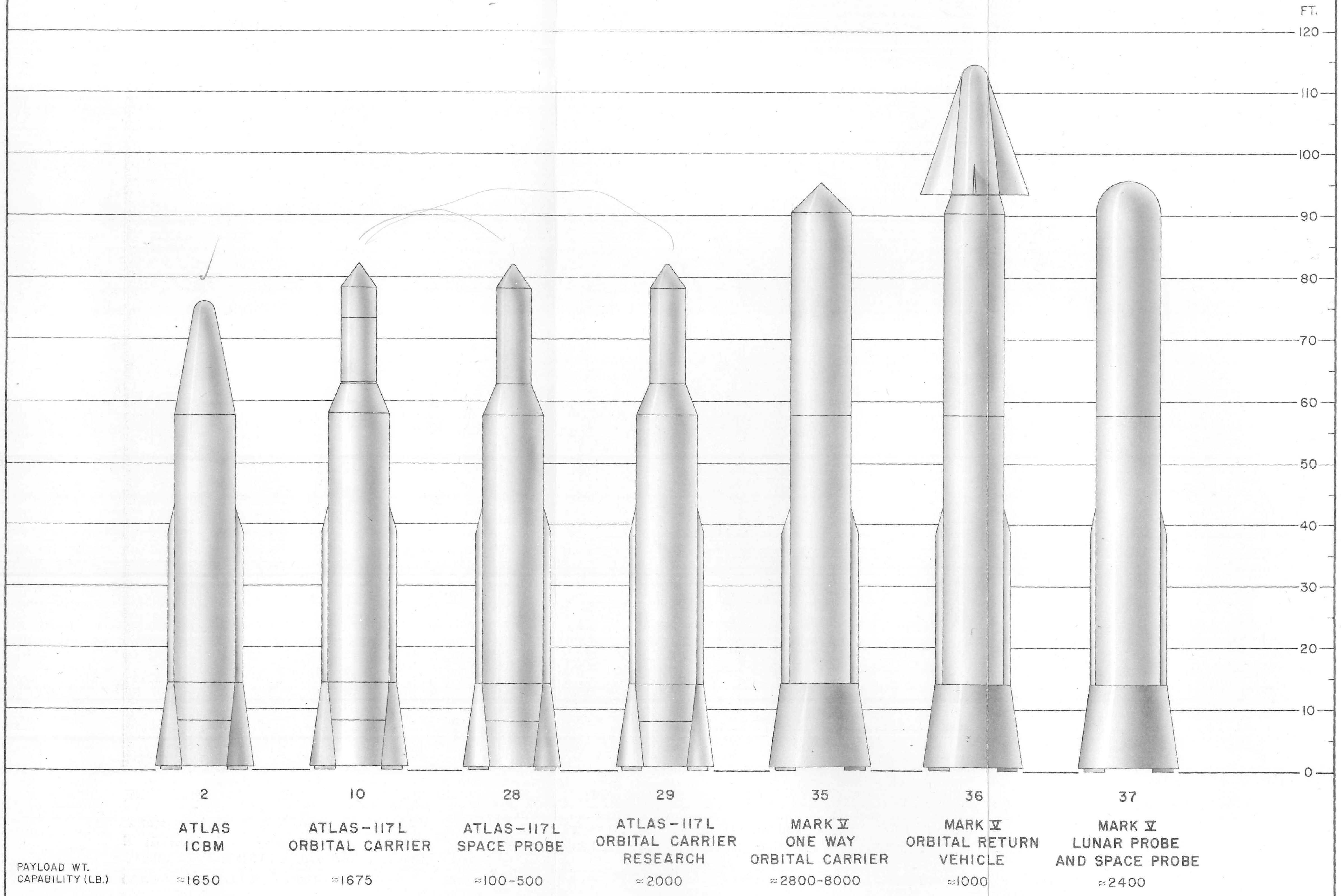


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FIG 5
NIKE AND SOLID PROPELLANT FAMILY

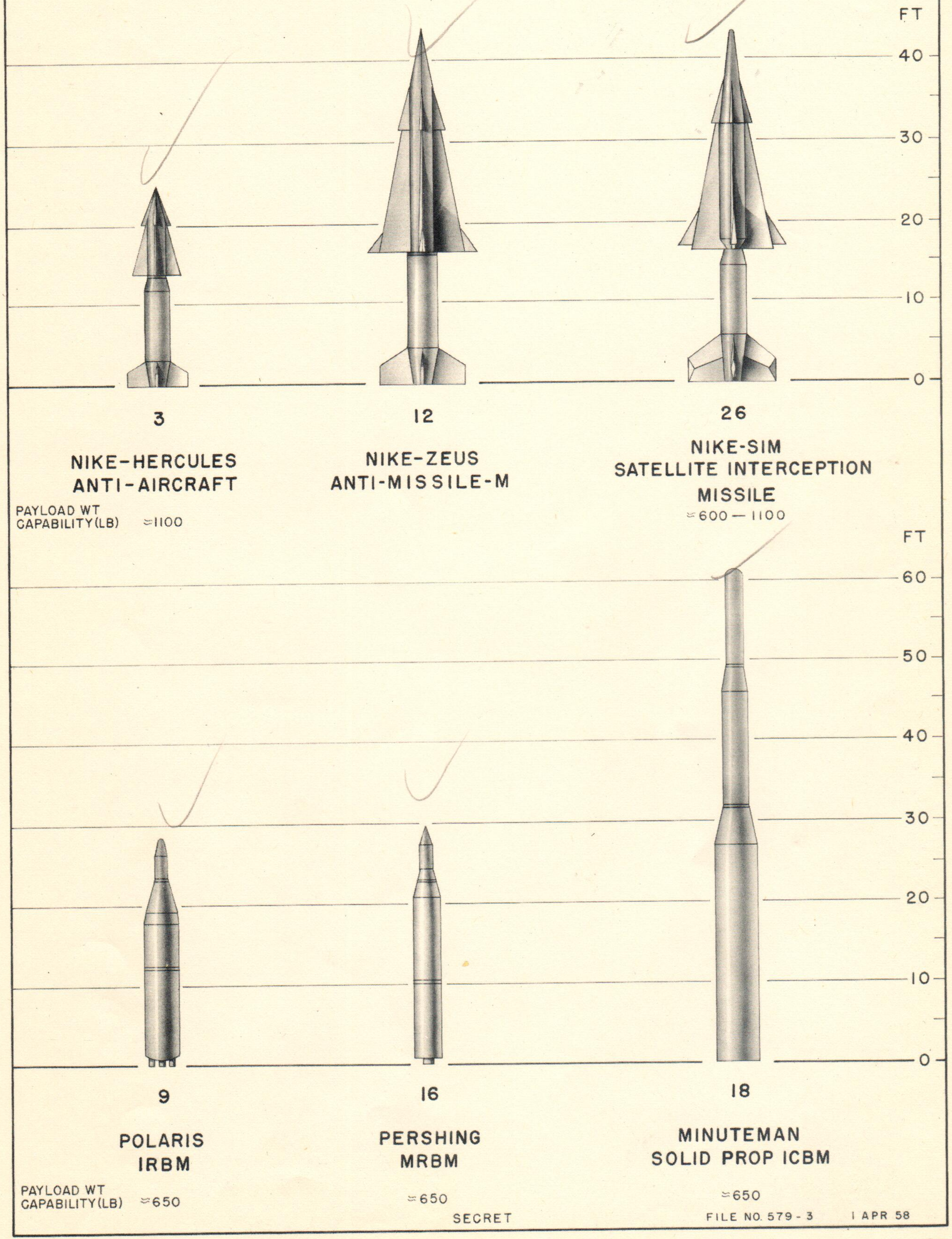

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FIG. 6

THOR AND MISCELLANEOUS FAMILY

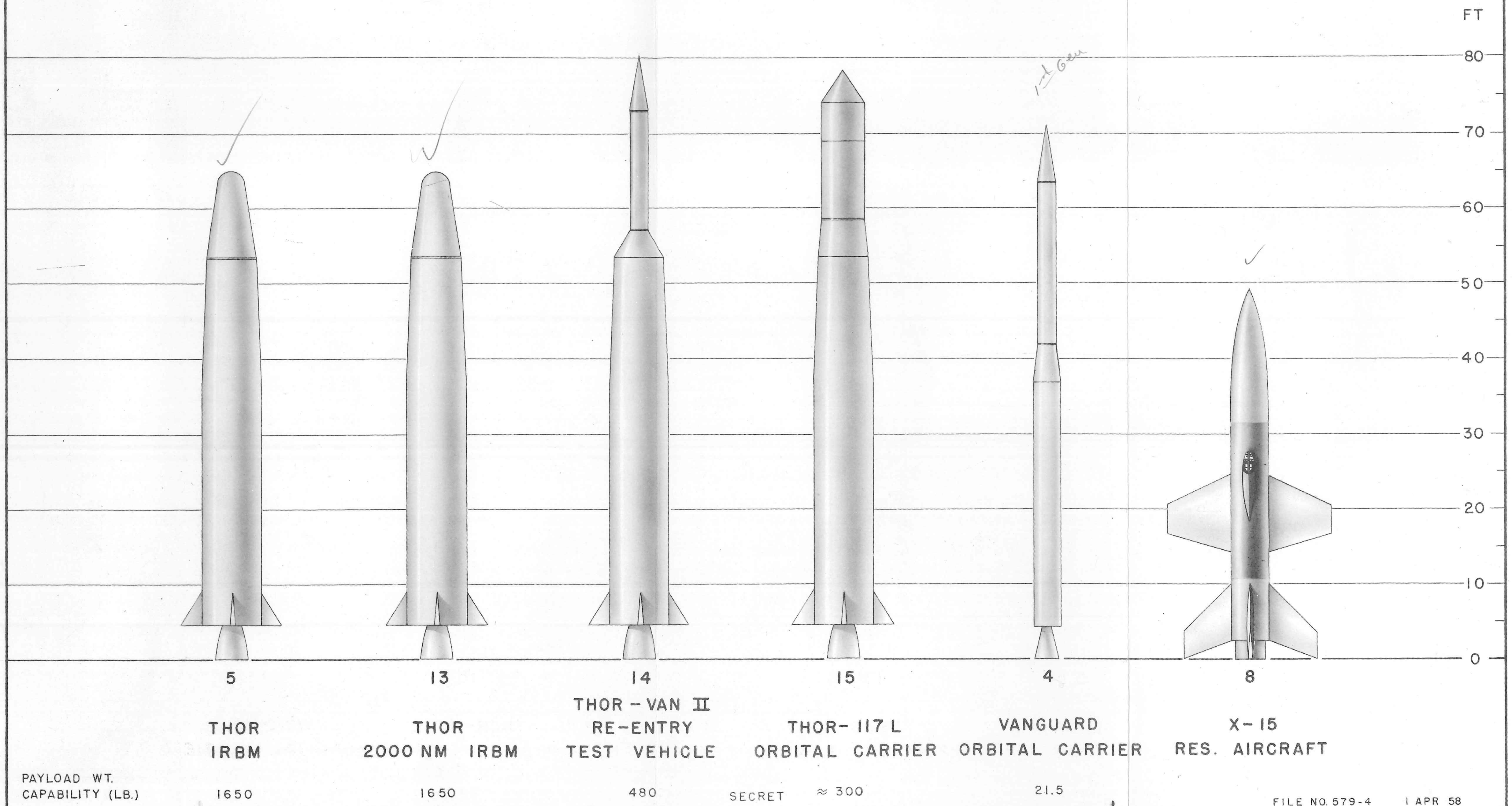

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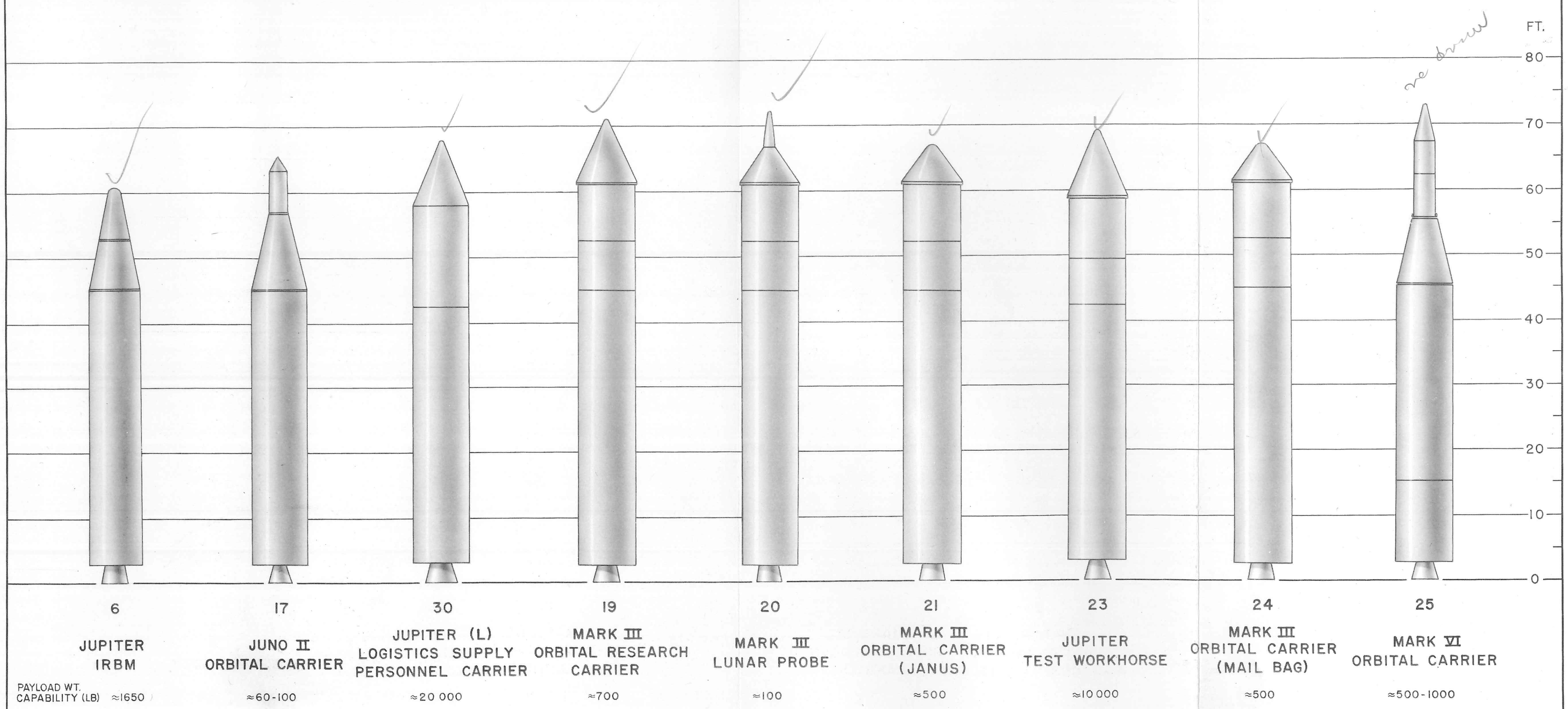
FIG. 7

JUPITER, MARK III AND MARK VI FAMILY



FILE NO. 579-5 1 APR 58

FIG. 8
TITAN, MARK VII, MARK VIII AND MARK IX FAMILY

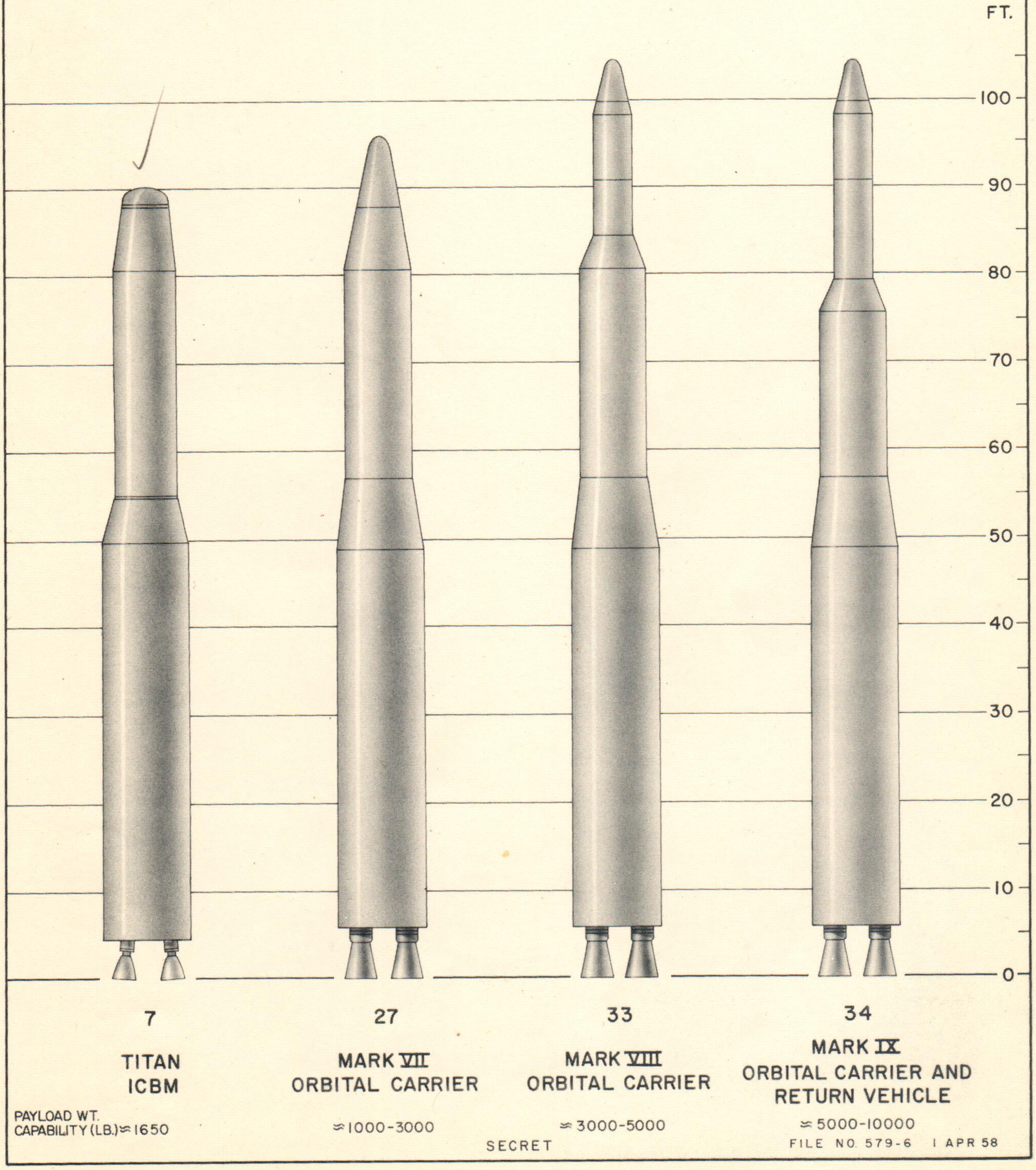


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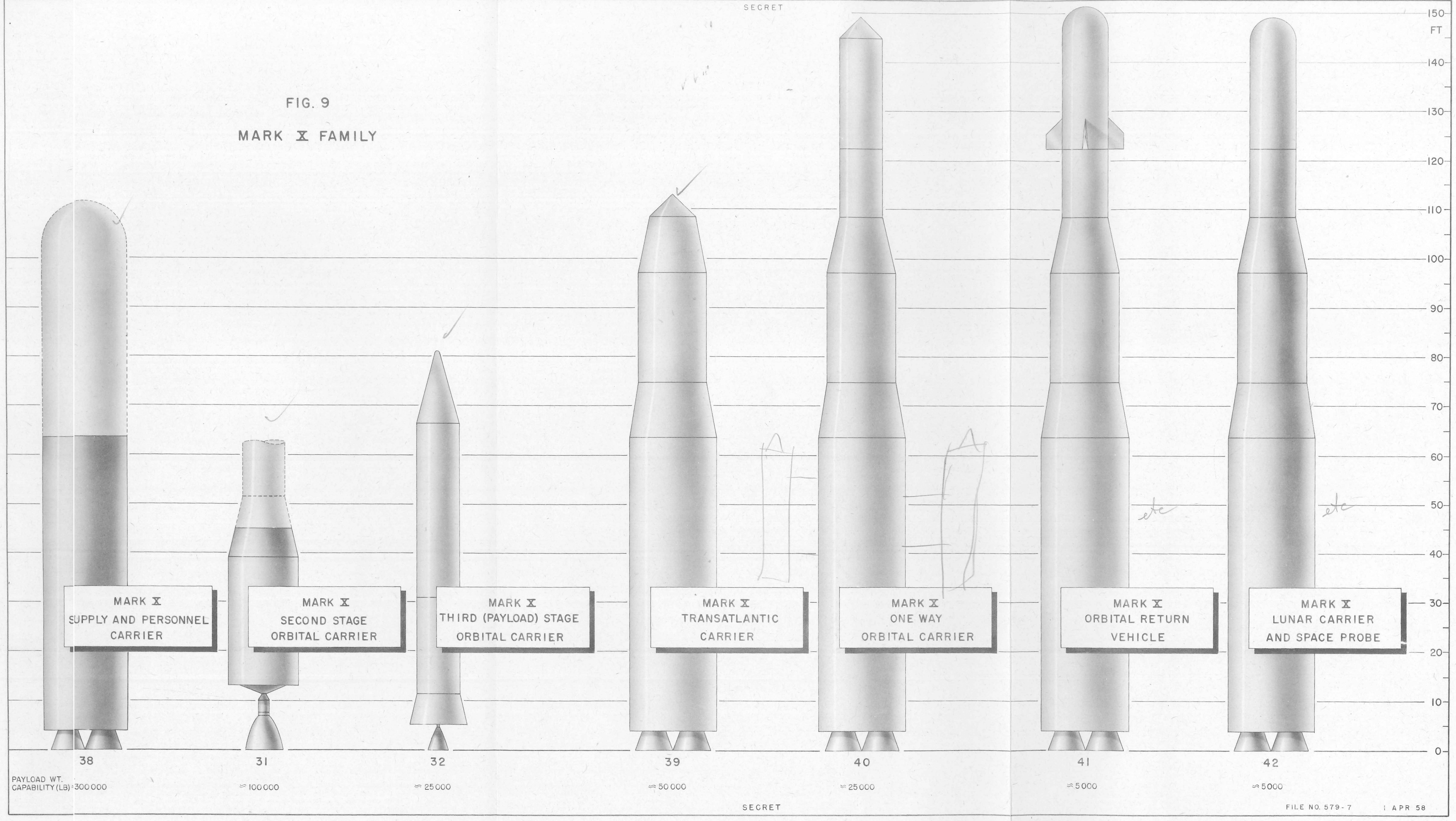
FIG. 9

MARK X FAMILY



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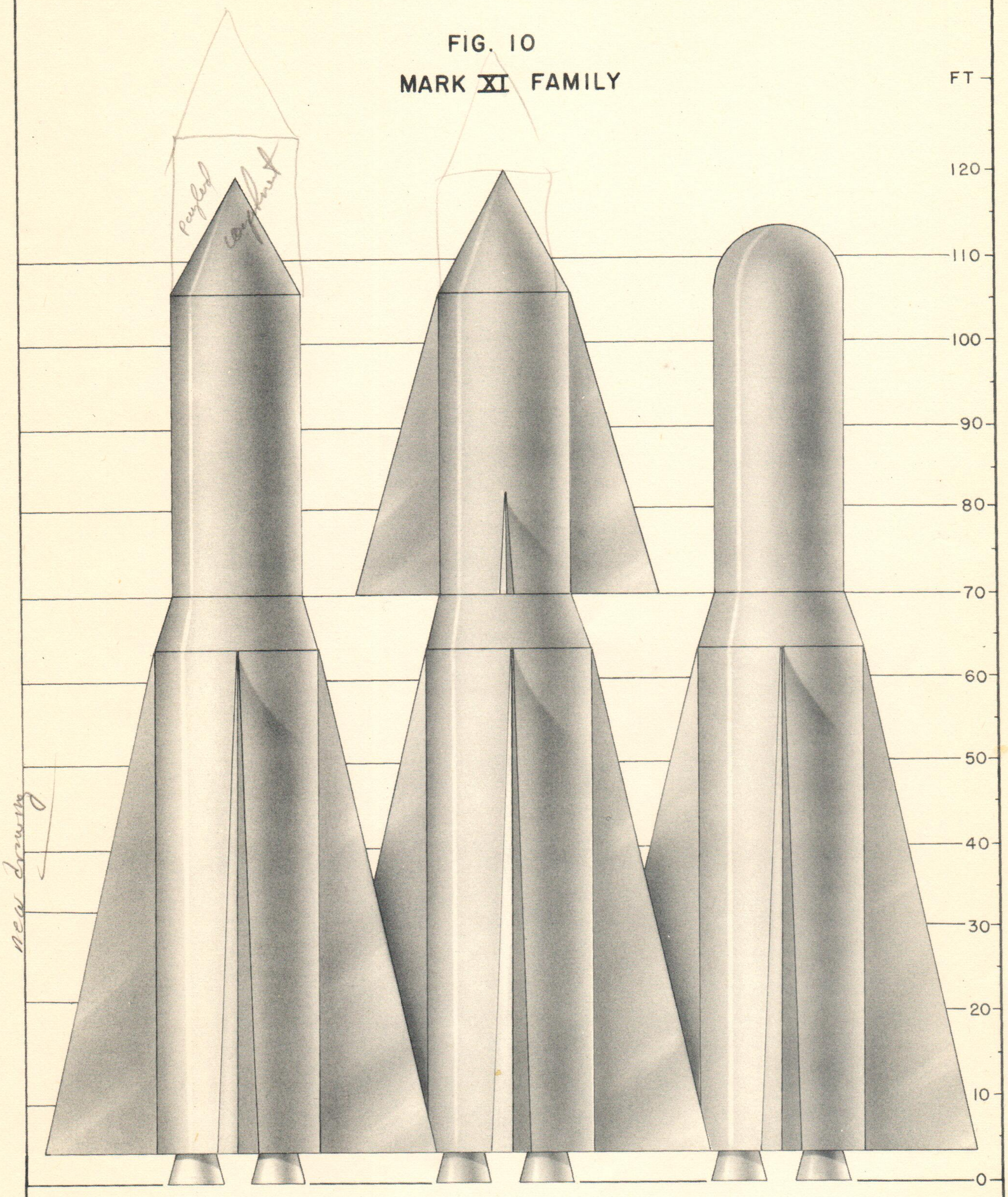
discuss Dyna Soar w/ Kavanau

FIG. 10

MARK XI FAMILY



PAYLOAD WT. CAPABILITIES (LB.)	≈50,000	≈10,000	≈10,000

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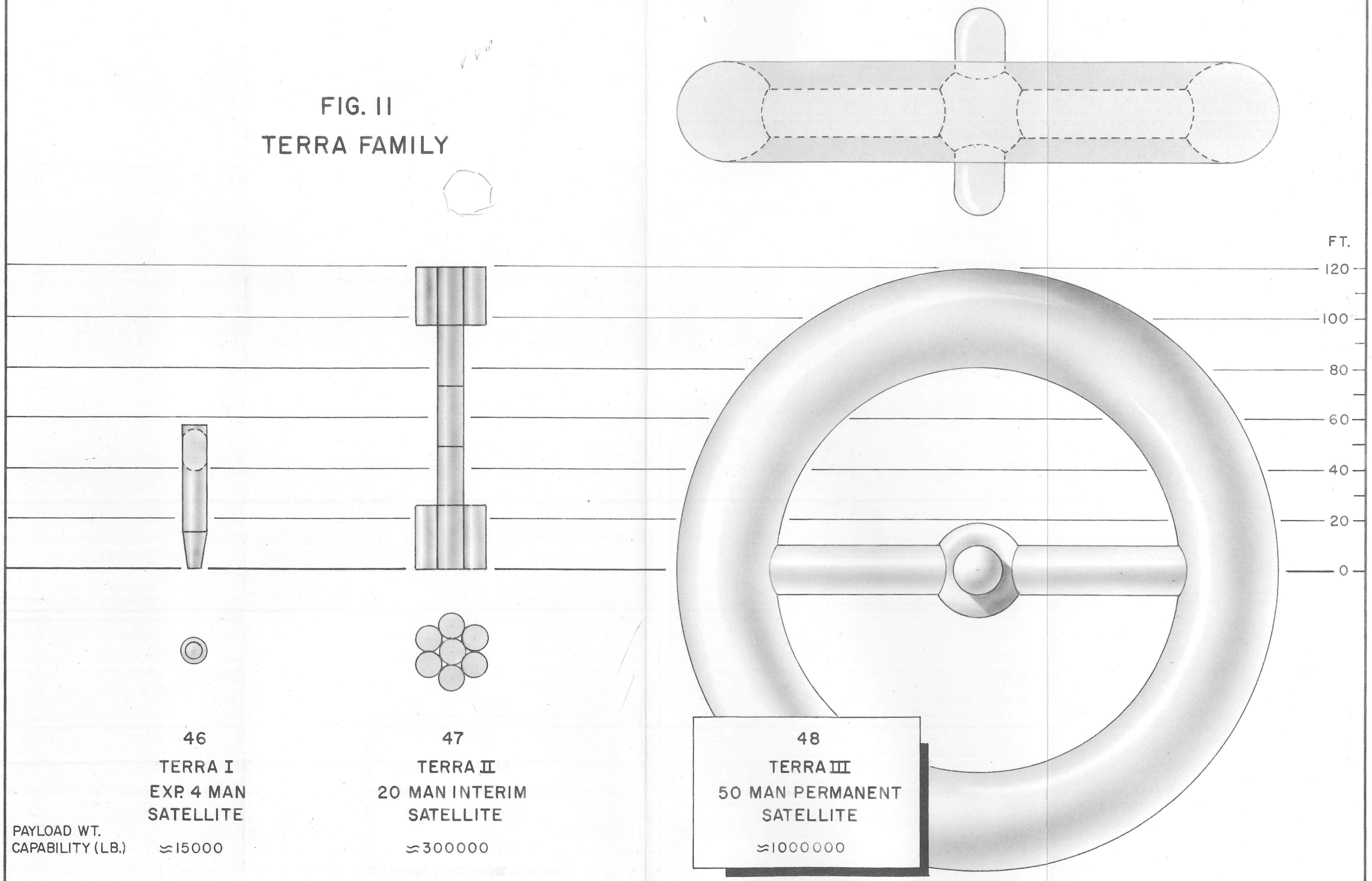
FIG. 11
TERRA FAMILY



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U.S. SPACE FLIGHT PROGRAM

(PAYLOAD-LB, COST, SCHEDULE)

VEHICLE		SPACE PROBE	EARTH SATELLITE		LUNAR CIRCUMNAV.	LUNAR SATELLITE	LUNAR LANDING		PLANETARY		TOTAL DEVELOPMENT $×10^6	COST/ VEHICLE & FIRING $×10^6	AVAILABILITY
NAME	DATA		ONE WAY	RETURN			HARD	SOFT	PROBE	SATELLITE			
JUNO I	REDSTONE BOOSTER+(11+3+1) 6"SERGEANTS	—	18 — 38	—	—	—	—	—	—	—	—	2	JAN 1958
VANGUARD	WELL KNOWN CONFIGURATION	—	3.5 — 21	—	—	—	—	—	—	—	30	8	MAR 1958
THOR-ABLE I	THOR+VANGUARD SECOND STAGE	—	—	—	50 — 60	—	50 — 60	—	—	—	—	5	JUL 1958
JUNO II	JUPITER BOOSTER+(11+3+1) 6"SERGEANTS	—	60 - 100	—	15	—	15	—	—	—	—	3	OCT 1958
THOR-117 L	WELL KNOWN CONFIGURATION	—	300 - 400	—	50	—	50	—	—	—	—	5	JAN 1959
ADAM	REDSTONE BOOSTER FOR NON-ORBITAL MAN RECOVERY	3,000	—	—	—	—	—	—	—	—	1	2	JAN 1959
JUNO IV	JUPITER (165K) BOOSTER+33K 2ND STAGE+15K 3RD STAGE Thor/Flux.	—	1,800 - 2,900	1,000	500	—	500	100	400	—	30	5	MAY 1959
MARK IV Approx M1	ATLAS+117L	—	2,000	—	500	300	500	100	—	—	—	6	JUL 1959
MARK VII	TITAN (UNCHANGED)	—	1750 3,000	1,000	—	—	—	—	—	—	60	4	JAN 1960
MARK V	SUPER ATLAS+HIGH ENERGY UPPER STAGES	—	3,000 - 8,800	1,000 - 3,000	2,500	1,500	2,500	600	2,400	700	—	9	OCT 1960
MARK VIII	TITAN+VANGUARD OR POLARIS	—	2,000 - 5,000	—	1,200	—	1,200	—	1,000	—	50	6	JAN 1961
MARK IX	3 STAGE HIGH ENERGY TITAN	—	5,000 - 10,000	—	3,000	—	—	900	—	1,000	200	12	JAN 1963
MARK X	1ST STAGE = 4 X 380K THRUST, 2ND = 380K THRUST, 3RD = 100K THRUST	—	25,000 - 35,000	5,000 - 8,000	8,000	5,500	8,000	2,500	5,000	2,500	1,500	20	JUN 1963
MARK XI	1ST STAGE = 2+1500K THRUST 2ND STAGE = CHEMICAL	—	50,000 - 80,000	10,000 — 15,000	20,000	14,000	20,000	6,500	20,000	10,000	2,000	40	JAN 1965
MARK XII	1ST STAGE = 2+1500K THRUST 2ND STAGE = NUCLEAR ROCKET (I_{SP} 800)	—	160,000	—	—	—	—	22,000 OR 7000 WITH RETURN CAP	—	30,000	3,000	50	JAN 1968

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Washington 25, D.C. Ext 6399~~5~~
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Feb. 25, 1958

TENTATIVE NOMINATIONS
TO
WORKING GROUPS

No. 1 - Working Group on Objectives

Chairman: Dr. J. A. Van Allen
Vice-Chairman: Prof. Dale R. Corson
SCST members: Col. Norman C. Appold

Outside members: Robert Cornog, R-W
Robert Haviland, GE-Phila
John Pierce, Bell Labs.
I nominated Stuhlinger.

No. 2 - Working Group on Vehicular Program

✓ Has copy of D-R-46

Chairman: ✓ Dr. Wernher von Braun
Vice-Chairman: ✓ Mr. S. K. Hoffman
SCST members: ✓ Mr. Abraham Hyatt
✓ Mr. Abe Silverstein
✓ Col. Norman C. Appold
✓ Dr. Louis Ridenour

Sec: Wm. H. Woodward
NACA Wash.
Ext 63267
62169

Outside members: ok M. W. Hunter, Douglas
ok George S. Trimble, Jr., Martin
ok Krafft A. Ehricke, Convair
ok Mr. Homer J. Stewart, Cal Tech
ok C. C. Ross, Aerojet

Next meeting Working Group Veh. Progr
16 April, 9:30 am
Inst. Aeronaut. Sciences
Beverly Bvd.
Los Angeles

No. 3 - Working Group on Reentry

Chairman: Dr. Milton U. Clauser
Vice-Chairman: Mr. H. Julian Allen
SCST members:

Outside members: Dr. Alexander Flax - Cornell Aero. Lab.
Prof. Lester Lees - Cal Tech
Dr. Mac C. Adams - AVCO
Dr. Krafft A. Ehricke - Convair
Prof. S. A. Schaaf - U. Calif.
Mr. Harlowe Longfelder - Boeing
Dr. Al Eggers - NACA
Mr. Max Faget - NACA

26/27 May Cleveland
next meeting of Committee.

No. 4 - Working Group on Range, Launch and Tracking Facilities

Chairman: Mr. J. R. Dempsey
Vice-Chairman: Mr. Robert H. Gilruth
SCST members:

Outside members: Jack Mengel, NRL de Bey BRL
J. Allen Hynek, Smithsonian A. Ob.
Col. Paul Cooper, Air Force range
Grayson Merrill, Fairchild
Cdr. Freitag, Navy range
Duckett, ABMA

No. 5 - Working Group on Instrumentation

Chairman: Dr. W. H. Pickering
Vice-Chairman: Dr. Louis N. Ridenour
SCST members: Dr. H. W. Bode

Outside members: Harry J. Goett, NACA
Bill Russell, R-W
Dr. Robert C. Seamans, Jr., RCA
Al Hall, Martin
E. Rechten, JPL
Robert W. Bucheim, Rand

No. 6 - Working Group on Space Surveillance

Chairman: Dr. H. W. Bode
Vice-Chairman: Dr. W. H. Pickering
SCST members:

Outside members: W. B. Hebenstreit - R-W
Richard Leghorn, formerly with Eastman,
now on own
W. B. Davenport, Lincoln Laboratory
Fred Whipple, Harvard
Allen H. Shapley, Bu Std Boulder, Colo.

No. 7 - Working Group on Human Factors and Training

Chairman: Dr. W. Randolph Lovelace, II
Vice-Chairman:
SCST members:

Outside members: Scott Crossfield, North American
Wright Langham, Los Alamos
Dr. Ulrich Luft, Lovelace Found.
Dave Simons
1 Rand. Man.