MANNED MARS LANDING

PRESENTATION TO THE SPACE TASK GROUP

BY

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AUGUST 4, 1969

INTEGRATED PROGRAM

With the recent accomplishment of the manned lunar landing, the next frontier is manned exploration of the planets. Perhaps the most significant scientific question is the possibility of extraterrestrial life in our solar system. Manned planetary flight provides the opportunity to resolve this universal question thus capturing international interest and cooperation.

The information presented here describes a method of landing men on the planet Mars in 1982. The scientific goals of the mission are described and the key decision dates are identified. The unmanned planetary missions described in Part I are critical to the final designs selected.

The 1981 manned Mars mission (1982 landing on Mars) is shown as an integral part of the total space program for the next two decades. The systems and experience resulting from the Apollo program and the missions proposed for the 1970's provide the technical and programmatic foundation for this undertaking. A 1982 manned Mars landing is a logical focus for the programs of the next decade.

Although the undertaking of this mission will be a great national challenge, it represents no greater challenge than the commitment made in 1961 to land a man on the moon.

INTEGRATED PROGRAM:

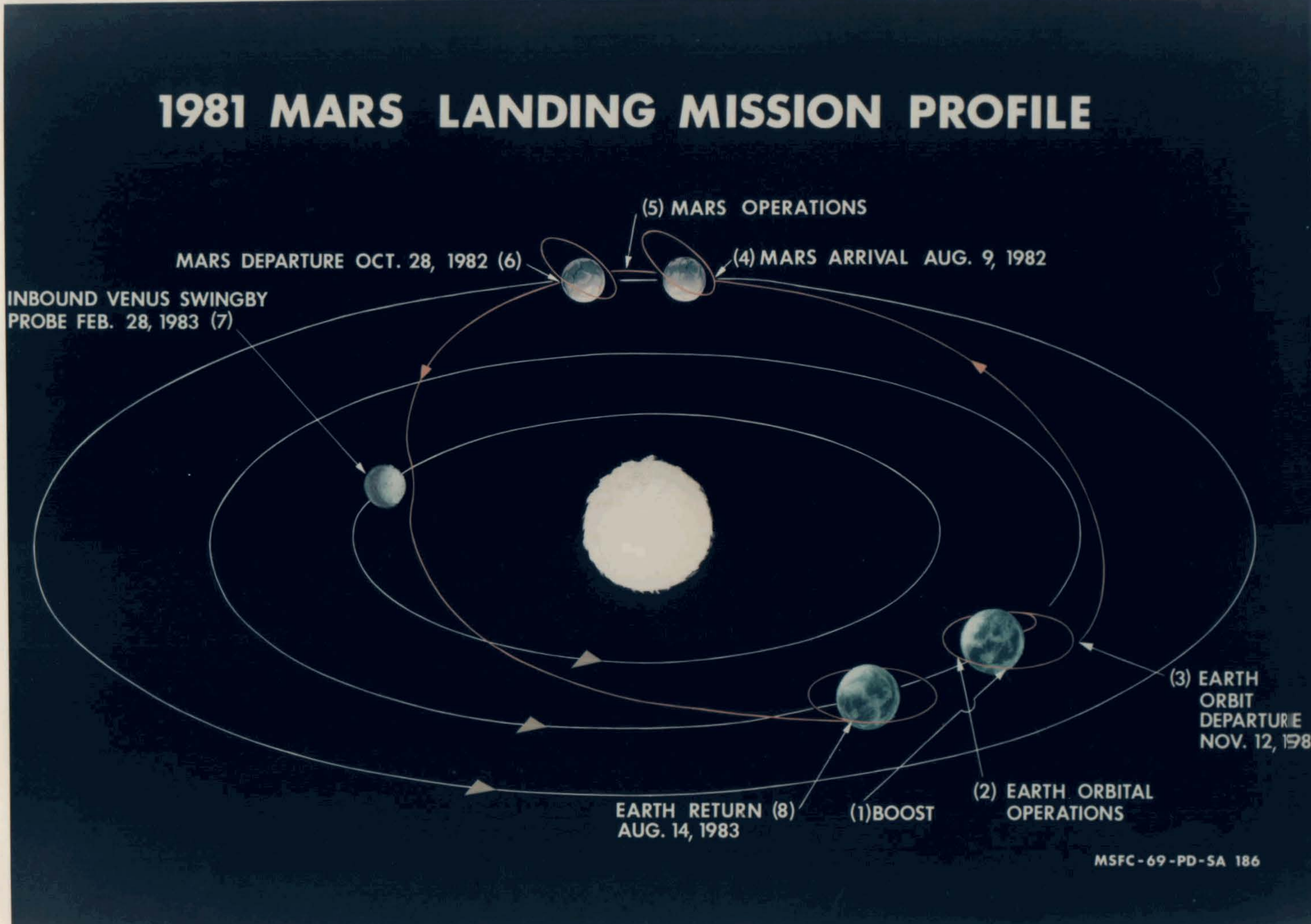
- MANNED PLANETARY MISSION

1981 MARS LANDING MISSION PROFILE

Several different modes are possible for accomplishing Mars landing missions, each with its peculiar advantages and disadvantages. The typical Mars Landing Mission begins with the boost of the planetary vehicle elements into Earth orbit (1) utilizing the Saturn V and Space Shuttle vehicles. Following assembly of the complete planetary vehicle in Earth orbit (2), the Earth departure phase of the mission is initiated (3). The Mars vehicle then begins a 270-day journey to Mars. This is by no means an idle phase of the mission. In addition to observations of Mars, many other experiments and measurements will be made on both the Earth-to-Mars and Mars-to-Earth legs of the trip that are of prime scientific importance. The spacecraft represents a manned laboratory in space, free of the disturbing influences of the Earth. The fact that there will be two observation points, Earth and the spacecraft, permits several possible experiments regarding the temporal and spatial features of the interplanetary environment. In addition, the spacecraft can be used to supplement and extend numerous observations conducted from Earth orbital space stations, particularly in the field of astronomy. It is possible, for example, that as yet unidentified comets might be observed for the first time.

Upon arriving at Mars, the space ship is propulsively braked into orbit (4) in the same fashion that the Apollo moon ship is placed into lunar orbit. The ship remains in Mars orbit for about 80 days (5), during which time the Mars Surface Sample Return (MSSR) probes and the Mars Excursion Modules (MEM) are deployed and the surface exploration takes place. At the end of the Mars capture period, the spacecraft is boosted out of Mars orbit (6). The return leg of the trip lasts about 290 days, during which many experiments and observations are again conducted. A unique feature of the homeward trip is a close encounter with Venus (7), about 120 days after departing Mars. Probes will be deployed at Venus during this passage, in addition to the radar mapping measurements that will be made.

The approximate two-year journey ends with the return to Earth orbit (8), and following medical examinations the crew will be returned to Earth via a Space Shuttle.

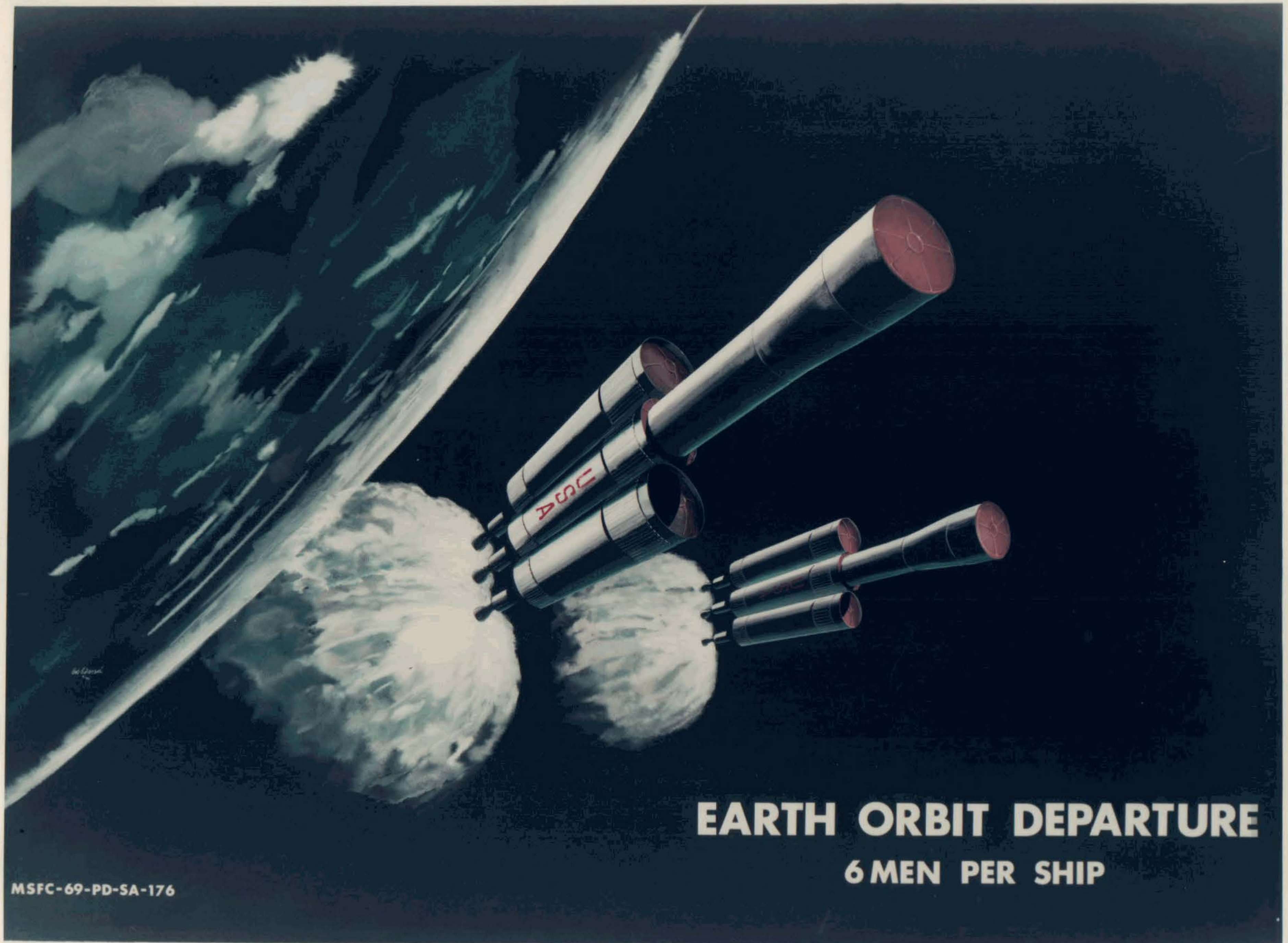

1981 MARS LANDING MISSION PROFILE
(5) MARS OPERATIONS
MARS DEPARTURE OCT. 28, 1982 (6)
(4) MARS ARRIVAL AUG. 9, 1982
INBOUND VENUS SWINGBY
PROBE FEB. 28, 1983 (7)
(3) EARTH
ORBIT
DEPARTURE
NOV. 12, 1981
(2) EARTH ORBITAL
OPERATIONS
(1)BOOST
EARTH RETURN (8)
AUG. 14, 1983
MSFC-69-PD-SA 186

EARTH ORBIT DEPARTURE

The Mars Landing Mission can be accomplished with a single planetary vehicle assembled in Earth orbit. There are, however, advantages in deploying two ships on the mission because of the long duration. One obvious advantage is crew safety, each spacecraft being designed to accept the crew of the sister ship in the event of a major failure. This approach also allows more exploration equipment to be carried on the expedition and enhances the probability of achieving mission objectives.

In the current concept, each vehicle assembled in earth orbit consists of three nuclear propulsion modules (Nuclear Shuttles) side-by-side, with the planetary spacecraft docked to the center module. Each spacecraft is nominally capable of sustaining a crew of six people for two years, or a crew of twelve for an extended period, in case of emergency.

The earth orbit departure maneuver is initiated with the firing of the outer two propulsion modules as illustrated.

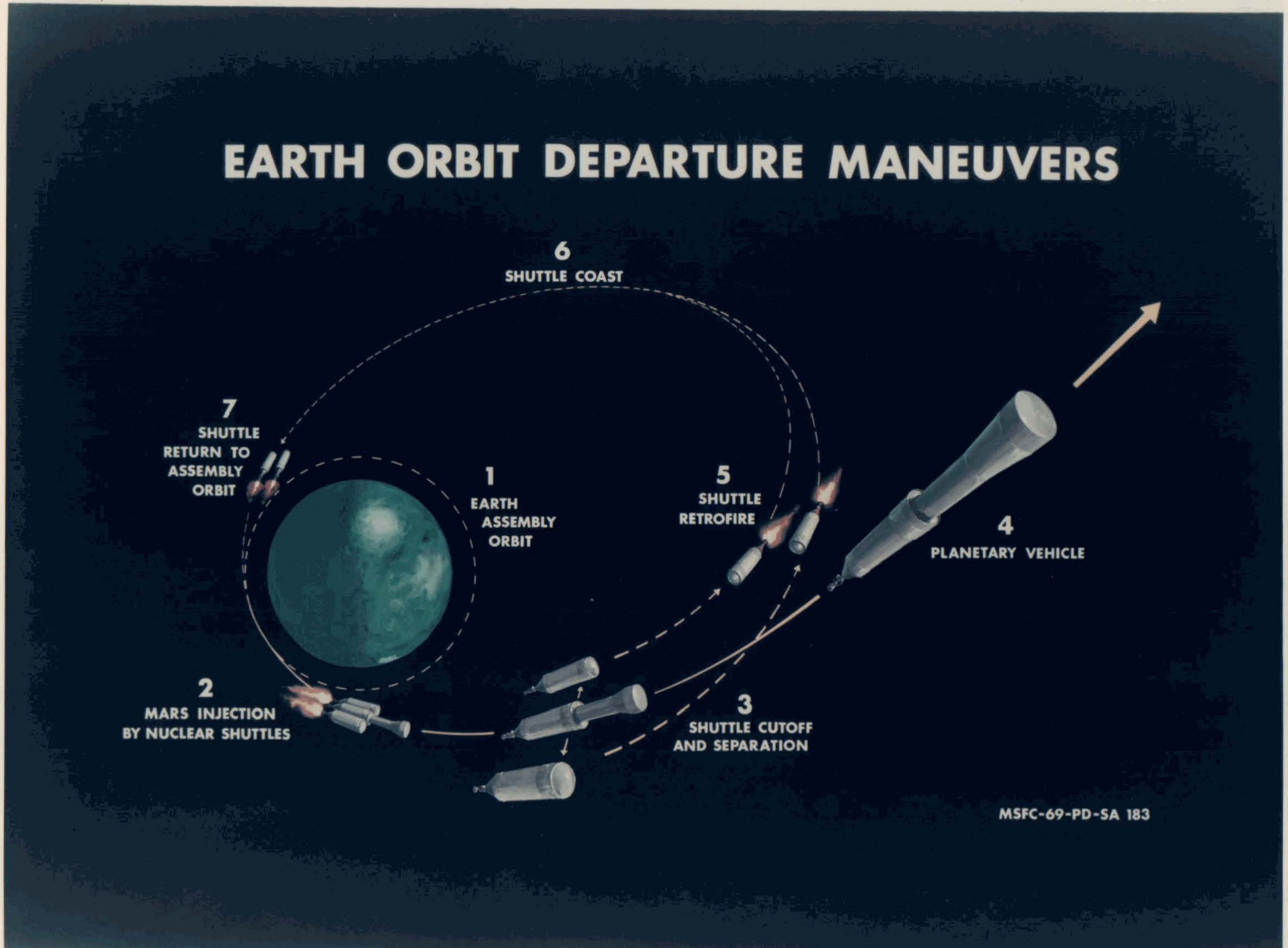

USA
EARTH ORBIT DEPARTURE
6 MEN PER SHIP
MSFC-69-PD-SA-176

EARTH ORBIT DEPARTURE MANEUVERS

The two planetary vehicles are assembled in a circular Earth orbit. Each vehicle consists of a spacecraft, two nuclear shuttle vehicles for Earth departure propulsion, and one nuclear shuttle for the remaining propulsion requirements through the Mars mission.

Following assembly and checkout in Earth orbit, each of the planetary ships is accelerated by the two outer nuclear shuttles to trans-Mars injection velocity. The two outer nuclear shuttles are then shut down, separated from the planetary vehicle, oriented for retro-fire, and then retro-fired to place them on a highly elliptic path returning to the original assembly orbit altitude. After a coast of several days, the nuclear shuttles arrive at the original assembly orbit altitude and are retro-fired again to place them into a circular orbit. The nuclear shuttles rendezvous with a space station to be checked out and refueled for further utilization.

The nuclear shuttles which return to Earth orbit will be available for transfer of fuel and supplies to geosynchronous orbit or to lunar orbit.


EARTH ORBIT DEPARTURE MANEUVERS
6
SHUTTLE COAST
7
SHUTTLE
RETURN TO
ASSEMBLY
ORBIT
1
EARTH
ASSEMBLY
ORBIT
5
SHUTTLE
RETROFIRE
4
PLANETARY VEHICLE
2
MARS INJECTION
BY NUCLEAR SHUTTLES
3
SHUTTLE CUTOFF
AND SEPARATION
MSFC-69-PD-SA 183

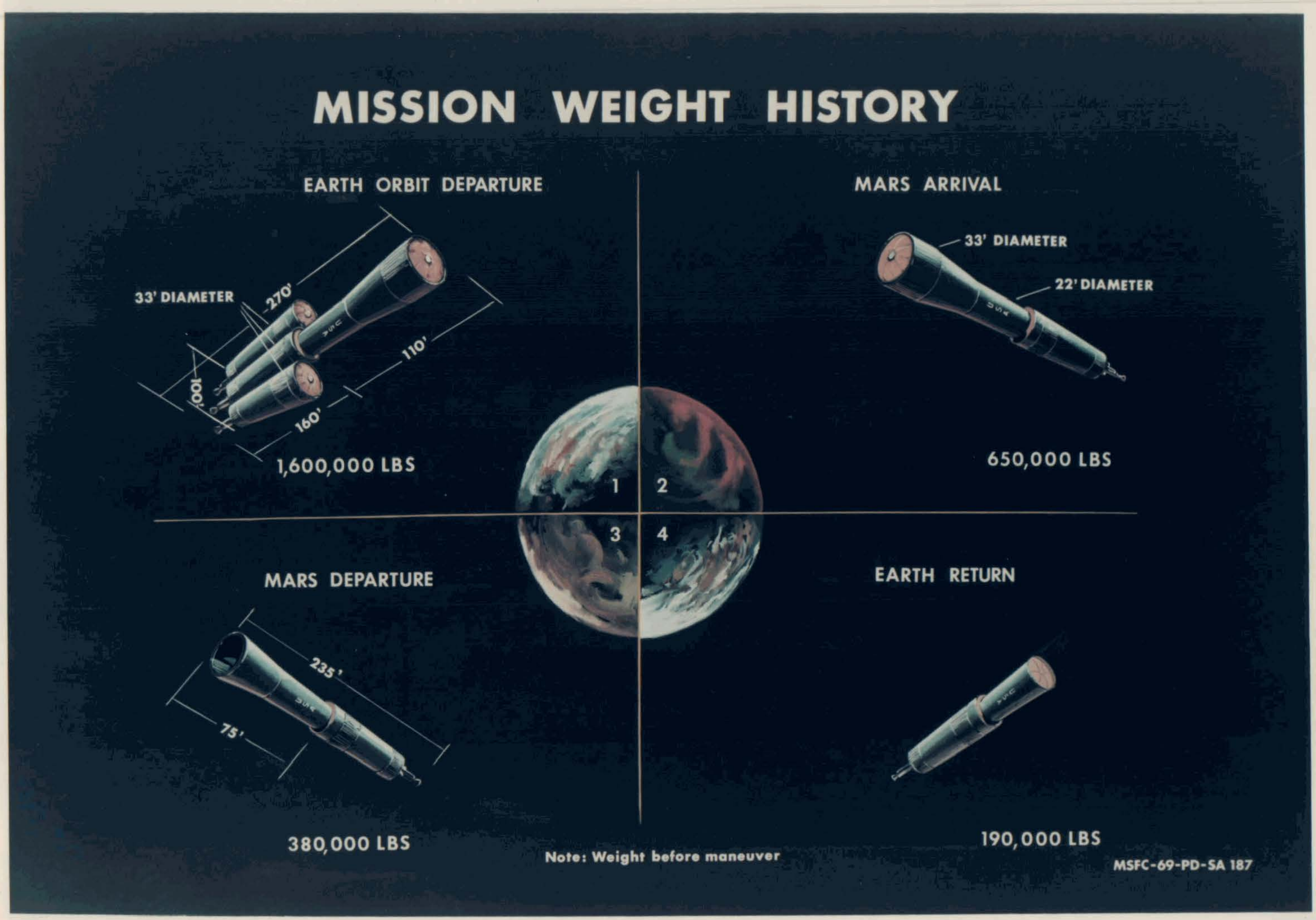
MISSION WEIGHT HISTORY

Each completely assembled and fueled vehicle for the 1981 Manned Mars Landing Mission weighs approximately 1.6 million pounds just prior to the Earth orbit departure maneuver. As the vehicle reaches the necessary earth departure velocity and the outer two Nuclear Shuttles are separated, its weight has decreased to 675,000 pounds. Thus nearly 60% of the initial vehicle weight is required for the Earth departure maneuver.

During the Earth-to-Mars phase of the mission, the only significant weight losses are due to midcourse corrections and life support consumables which amount to about 25,000 pounds. Thus at Mars arrival, just prior to the propulsive braking into Mars orbit, the vehicle weighs 650,000 pounds. While in Mars orbit, all the surface sample return probes and the Mars Excursion Module are deployed. These and other losses reduce the vehicle weight to 380,000 pounds just prior to Mars departure.

Midcourse corrections and life support consumables are again lost during the Mars-to-Earth phase of the trip. Also lost are the probes deployed at Venus encounter. As the vehicle approaches Earth for the final propulsive maneuver, it weighs 190,000 pounds. The total weight returned to earth orbit, consisting of the empty Nuclear Shuttle and the Mission Module (minus expendables) is about 160,000 pounds.

Of the initial weight of 1.6 million pounds in Earth orbit, approximately 1.2 million, or nearly 75%, are propellant.

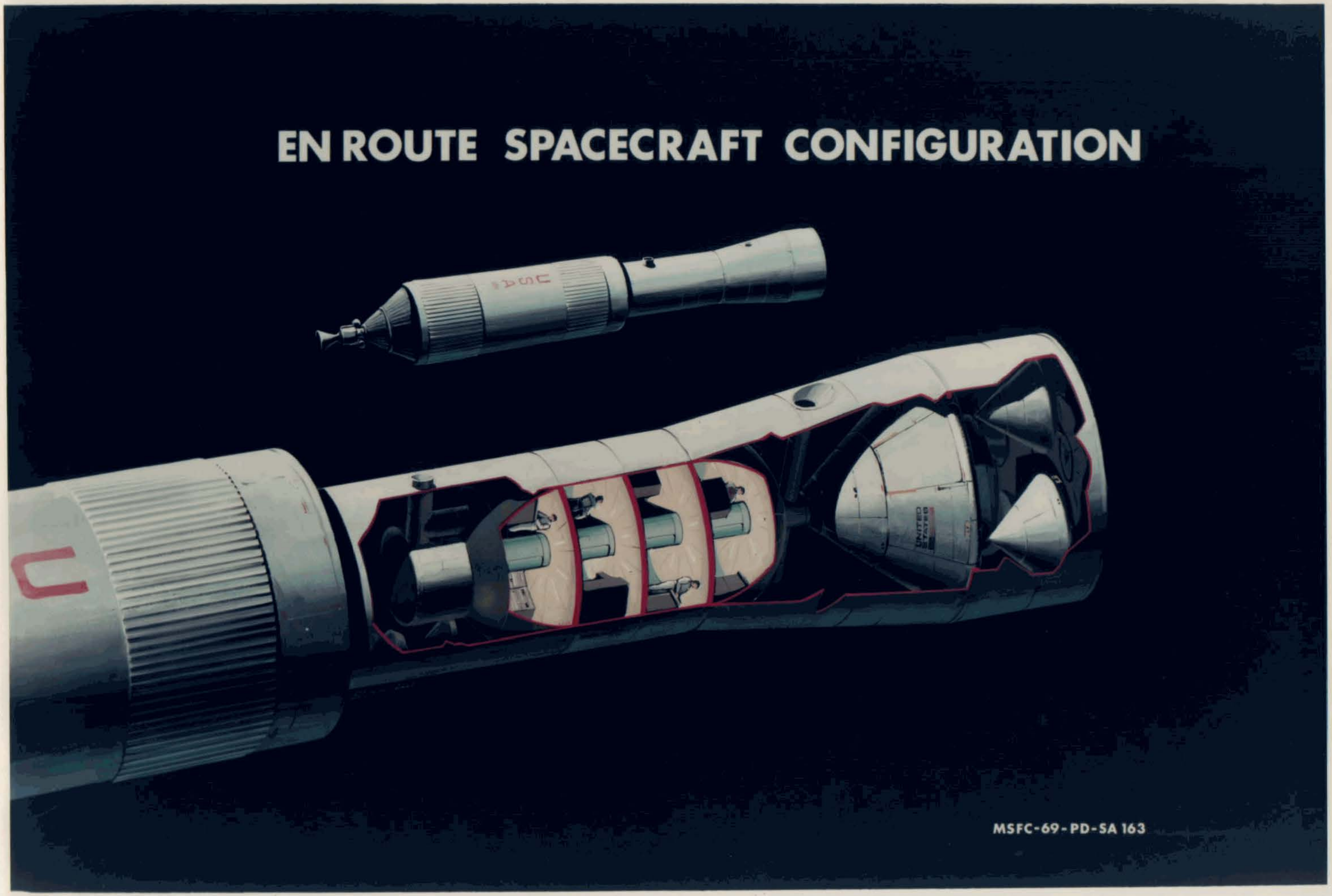

MISSION WEIGHT HISTORY
EARTH ORBIT DEPARTURE
33' DIAMETER
270'
110'
100'
160'
1,600,000 LBS
MARS ARRIVAL
33' DIAMETER
22' DIAMETER
650,000 LBS
1
2
3
4
MARS DEPARTURE
235'
75'
380,000 LBS
EARTH RETURN
190,000 LBS
Note: Weight before maneuver
MSFC-69-PD-SA 187

EN ROUTE SPACECRAFT CONFIGURATION

The forward compartment of the spacecraft is an unpressurized area housing the Mars Excursion Module (MEM), an airlock to provide for pressurized transfer to the MEM and for extra vehicular activities, and unmanned probes. Six Mars Surface Sample Return probes and two Venus probes are carried on each spacecraft.

Immediately aft of the airlock is the Mission Module which provides the crew with a shirt sleeve environment, living quarters, space vehicle control capability, experiment laboratories, radiation shelter, etc. The functional areas are distributed on four decks. This compartment is occupied by the crew of six for the entire mission except during the Mars surface activity.

At the aft end of the mission module adjacent to nuclear shuttle is a biological laboratory where the Mars surface samples are received and analyzed. The bio-lab is sterilized prior to Earth departure and remains sealed until initial remote analyses of the samples have been accomplished.


EN ROUTE SPACECRAFT CONFIGURATION
MSFC-69-PD-SA 163

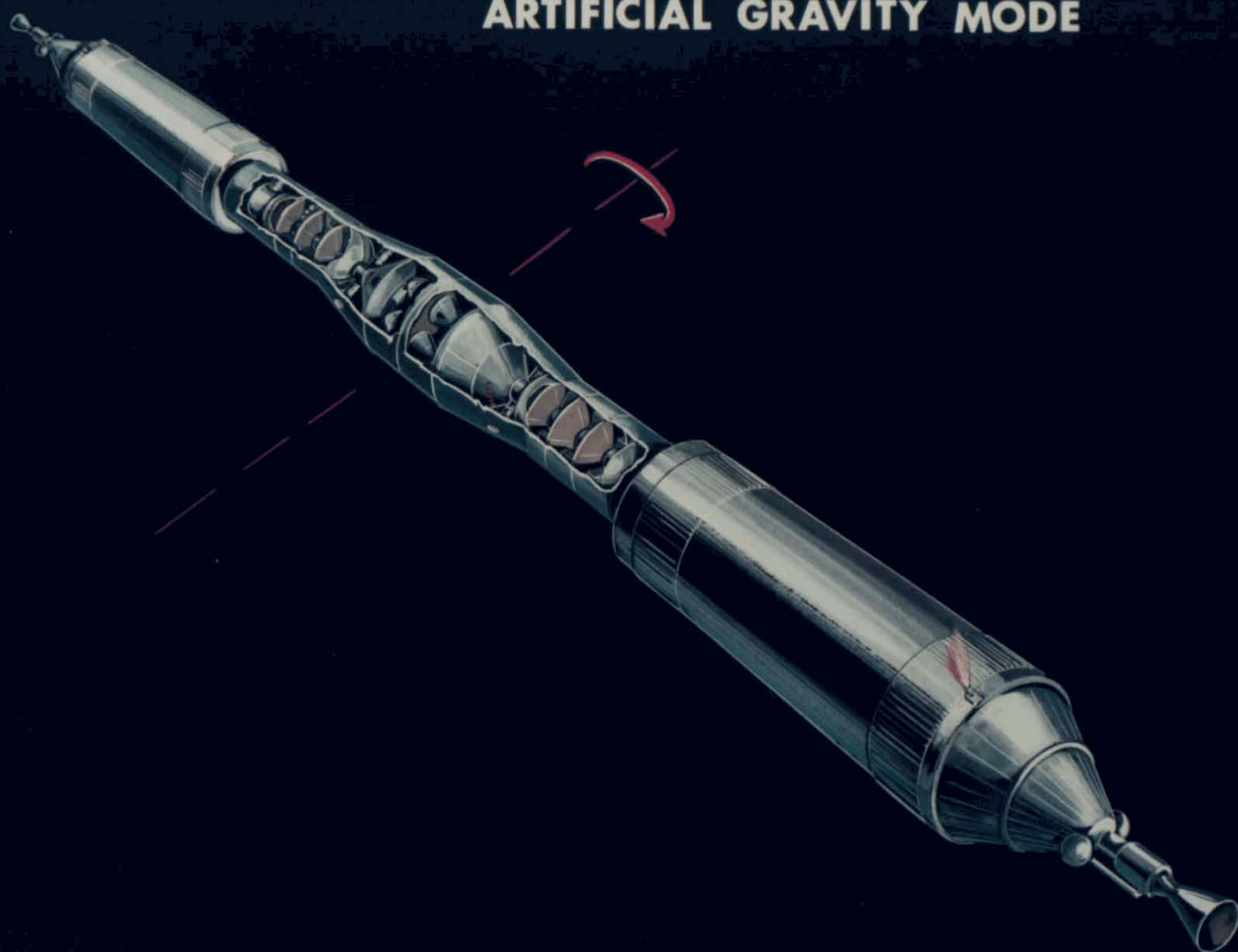
EN ROUTE SPACECRAFT CONFIGURATION

The ability of man to withstand a zero gravity environment for periods of time exceeding a few weeks is still an unknown. The Saturn Workshops to be flown in the early seventies will determine man's capabilities in a zero gravity environment for a few months. It will remain, however, for the Space Station to demonstrate man's capabilities for the longer periods required for the Manned Mars Landing Mission.

The option to provide artificial gravity for the crew during the planetary trip must be kept open until conclusive results of man's abilities are established. If early missions indicate the need for artificial gravity the two spaceships can be docked end-to-end and rotated in the plane of the longitudinal axis during extended cost periods.

EN ROUTE SPACECRAFT CONFIGURATION

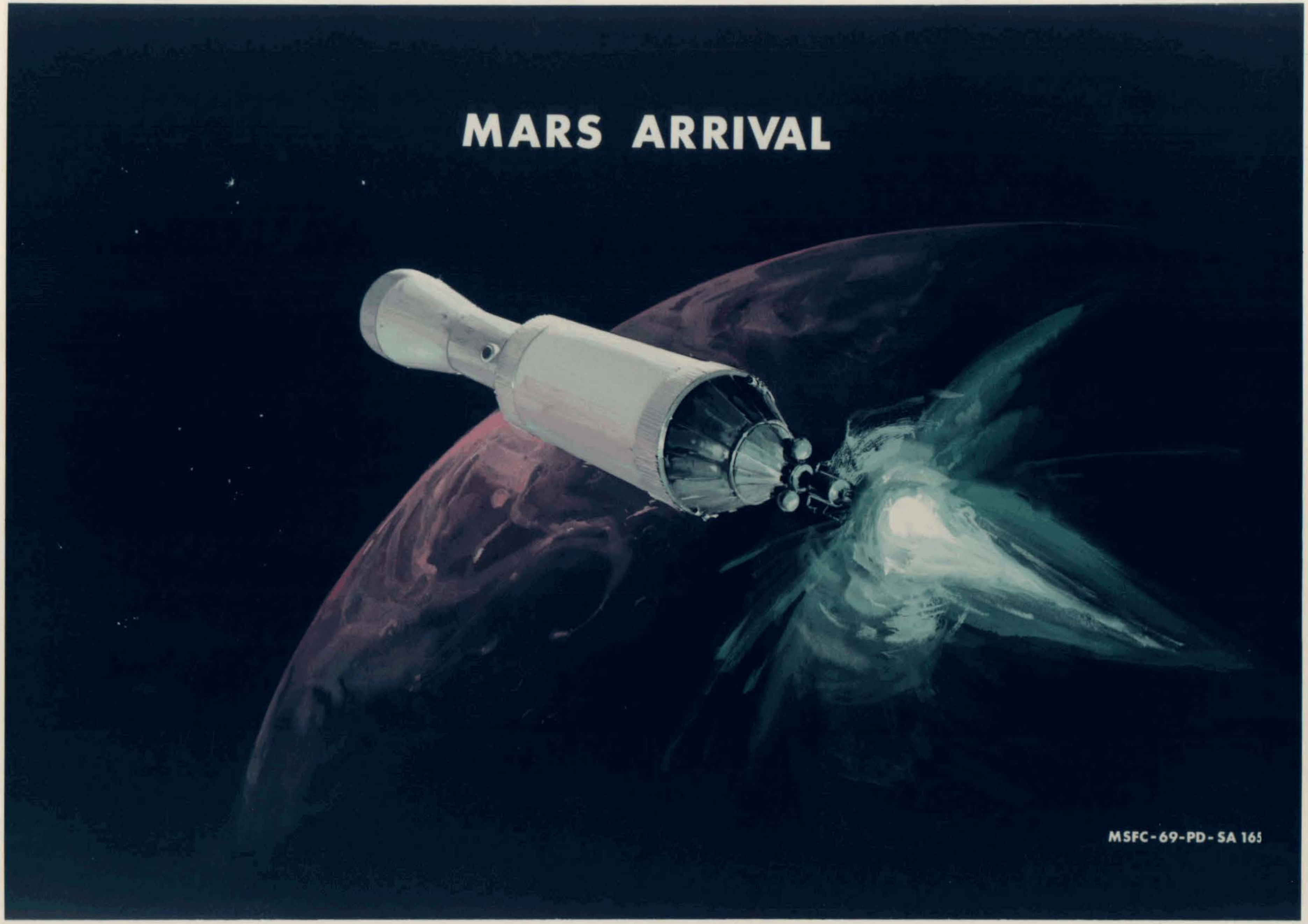
ARTIFICIAL GRAVITY MODE



MSFC-69 PD-SA-173

MARS ARRIVAL

During the outbound coast to Mars of approximately nine months, experimental activities such as solar and planetary observations, solar wind measurements, and biological monitoring of the crew, test plants, and animals will be conducted. At the end of this period, final space vehicle checkout for the Mars orbit insertion maneuver is followed by the retro-fire of the nuclear engine to place the planetary vehicle into an elliptical Mars orbit. The orbit at Mars is elliptical both to reduce energy requirements for the mission and allow a wider range of planet coverage by optical observations. The first two days in orbit are used to select landing sites for the unmanned sample return probes.

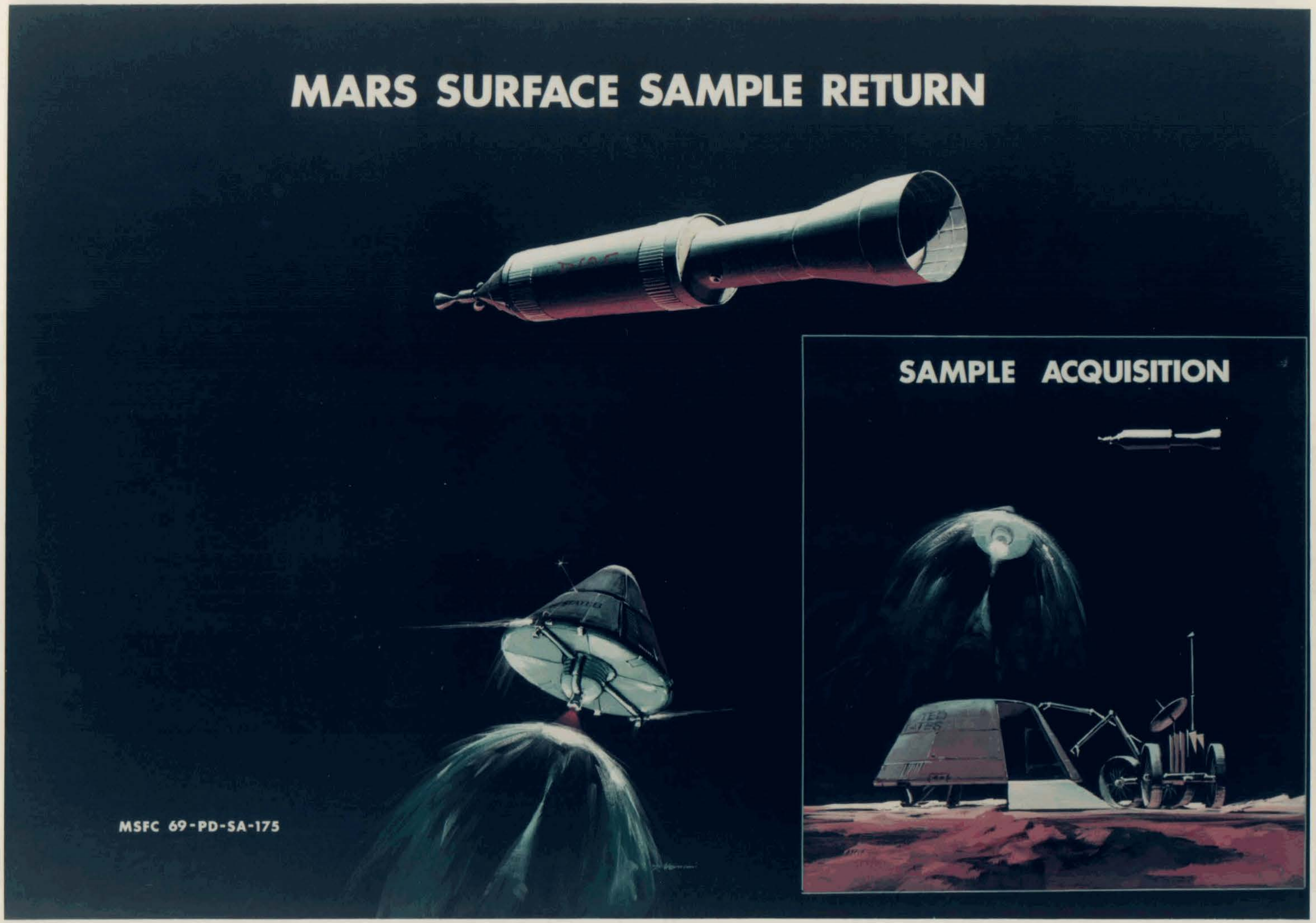

MARS ARRIVAL
MSFC-69-PD-SA 165

MARS SURFACE SAMPLE RETURN

The currently funded Viking Project is aimed at placing soft landers on the surface of Mars in 1973 and perhaps in follow-on opportunities. These probes will provide important clues concerning the existence of life on Mars, but will not fully answer the questions as to the possible pathogenic nature of such life. Hence, on the first manned mission, it may be desirable to obtain surface samples prior to the actual landing of man and subsequent contamination of the planet.

Surface samples can be obtained with sterile unmanned probes deployed from the manned spacecraft. The probe would descend from the orbiting spacecraft, land on the Martian surface, automatically gather a sample and return it to the biological laboratory in the spacecraft for analysis. If the analysis revealed no significant biological hazards, man can then proceed to the surface and the samples could be returned to Earth for more detailed analysis, along with the more selective (but perhaps Earth-contaminated) samples obtained by man.

To provide a reasonably representative coverage of the various sections of the planet, six surface sample probes are carried in each spacecraft.

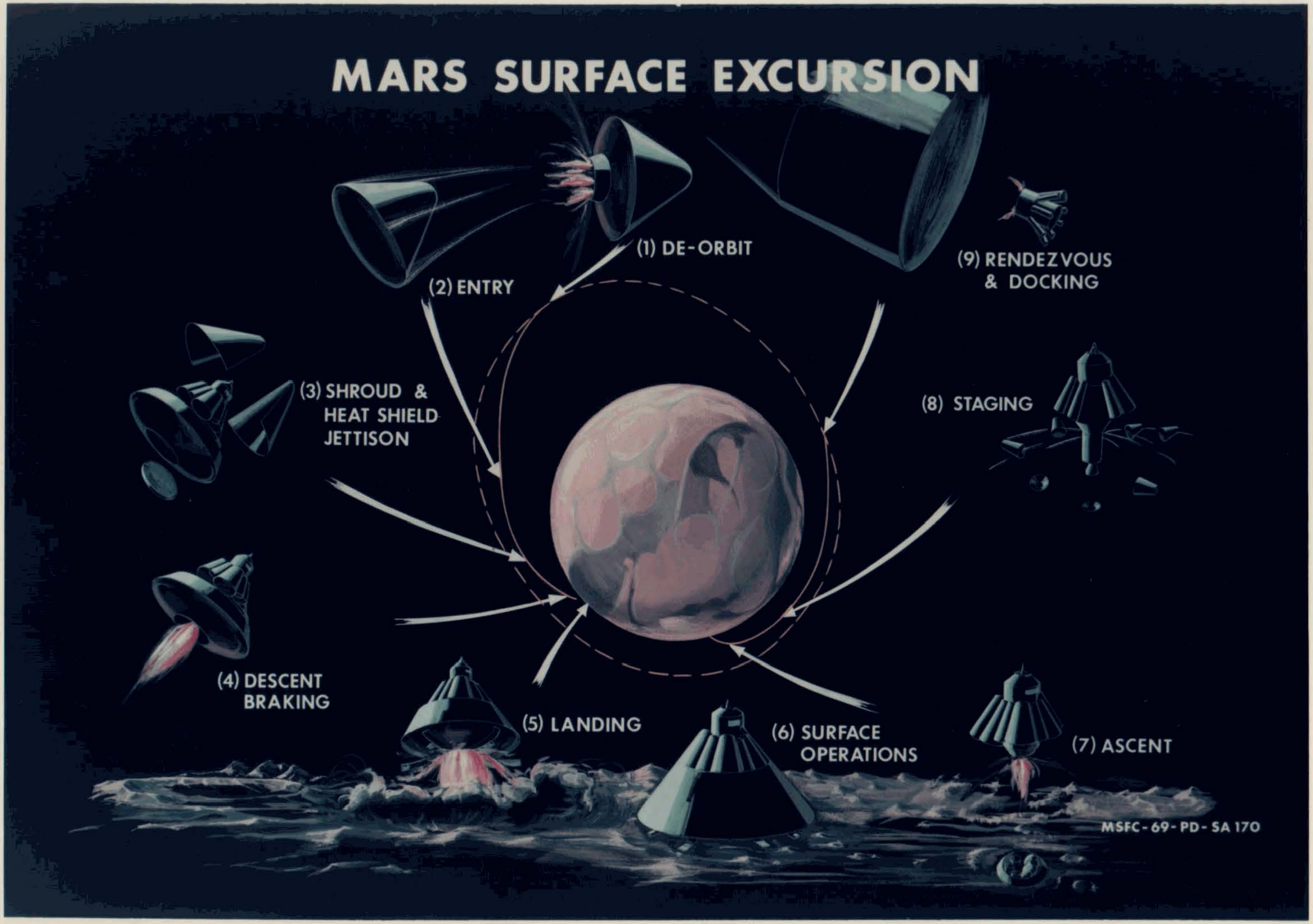

MARS SURFACE SAMPLE RETURN
SAMPLE ACQUISITION
MSFC 69-PD-SA-175

MARS SURFACE EXCURSION

The three-man landing party from each ship is carried from the orbiting spacecraft to the surface in the Mars Excursion Module (MEM). Except for the effects of the Martian atmosphere, the landing and return to orbit sequence is analogous to the Apollo lunar landing operation utilizing the Lunar Module. In the case of Apollo 11, the Mars orbit spacecraft is analogous to Columbia and the MEM is analogous to Eagle.

Following final checkout, the MEM is separated from the spacecraft and de-orbited (1) by the retro-firing of a small rocket motor. The MEM is then aerodynamically decelerated (2) as it falls toward the surface. As the MEM approaches the surface, the protective shroud and a portion of the heat shield are jettisoned (3). Jettisoning of the shroud allows use of the ascent stage as an abort vehicle, if required before landing. The descent stage engine then provides terminal braking (4) and hovering just prior to touchdown (5). The MEM then spends 30 to 60 days on the surface of Mars (6).

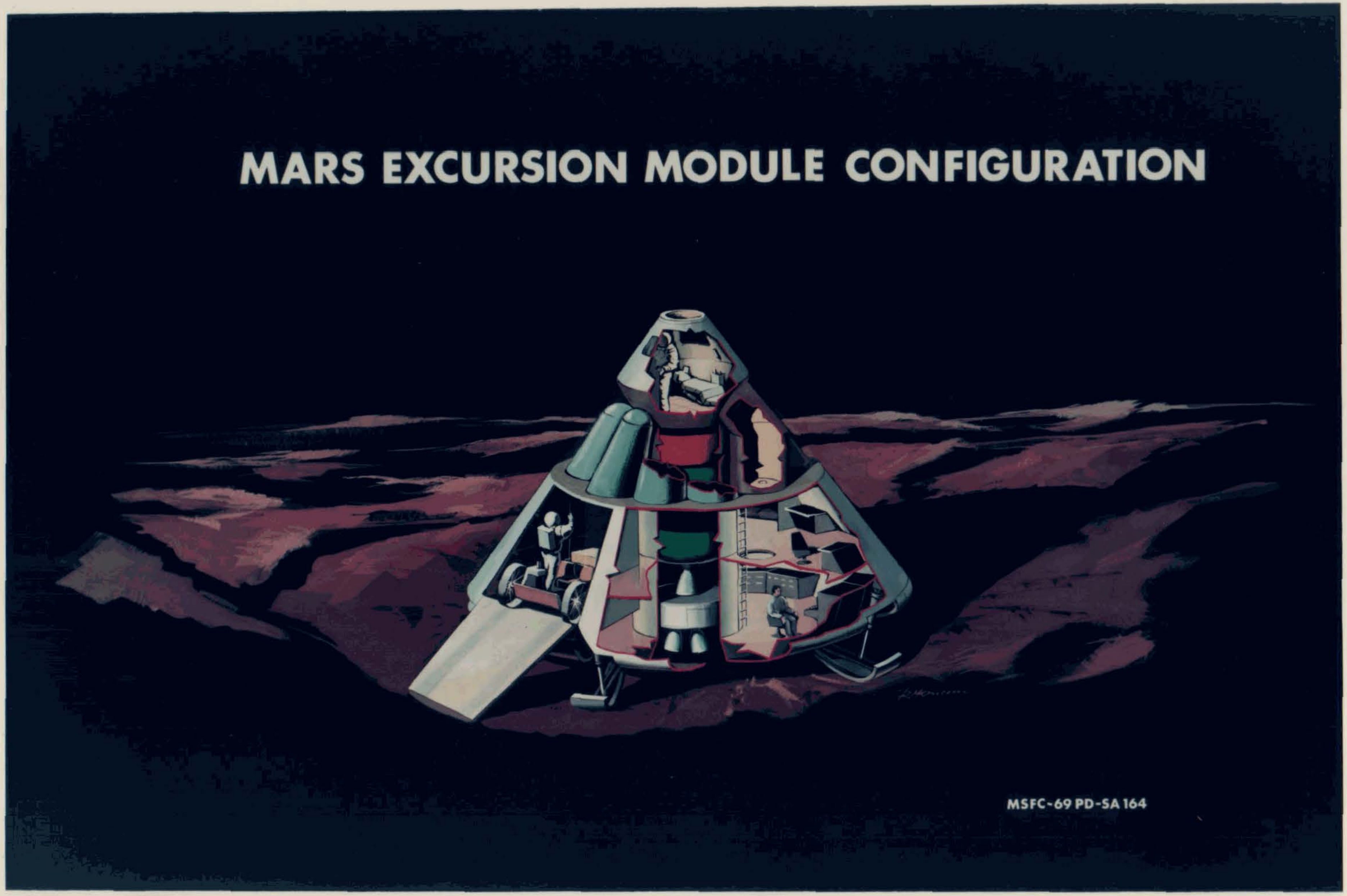
At the conclusion of surface operations, the ascent stage is fired (7) to initiate the return to Mars orbit and the waiting spacecraft. Propellant tanks are staged (discarded) during ascent to effect weight saving (8). After achieving proper orbit conditions, the MEM will rendezvous and dock with the spacecraft (9). Following docking, the crew will transfer to the Mission Module, and the MEM will be discarded.


MARS SURFACE EXCURSION
(1) DE-ORBIT
(2) ENTRY
(3) SHROUD & HEAT SHIELD JETTISON
(4) DESCENT BRAKING
(5) LANDING
(6) SURFACE OPERATIONS
(7) ASCENT
(8) STAGING
(9) RENDEZVOUS & DOCKING
MSFC-69-PD-SA 170

MARS EXCURSION MODULE CONFIGURATION

The Apollo-shaped Mars Excursion Module (MEM) is designed to carry three men to the surface of Mars and return the crew, scientific data, and samples to the spaceship. It provides living quarters and a laboratory during the 30-60 day stay on the Mars surface. The MEM consists of descent and ascent stages. The ascent stage houses the three-man crew during entry, descent, landing, and ascent. The ascent stage consists of the control center, ascent engine and propellant tanks. The descent stage contains the crew living quarters and laboratory for use while on Mars, the descent engine and propellant tanks, landing gear and an outer heat shield for the aerodynamic entry phase of the descent. A small one-man rover vehicle is provided in the descent stage for surface mobility. All descent stage equipment is left on the Martian surface. The capability is provided for one man to land a MEM and bring a stranded crew back to the ship orbiting Mars.

The diameter of the MEM at its base is 30 feet. At departure from the spacecraft, the MEM weighs about 95,000 pounds.


MARS EXCURSION MODULE CONFIGURATION
MSFC-69 PD-SA 164

MARS SURFACE ACTIVITY

Man's first step on Mars will be no less exciting than Neil Armstrong's first step on the moon. The Mars surface activity on the first mission will be similar in many ways to the Apollo 11 moon surface activity. Notable, however, is the much longer stay time (30-60 days per MEM), thus allowing more extensive observations, experimentation and execution of mission scientific objectives. The small rover vehicle allows trips to interesting surface features beyond the immediate landing area. Surface operations include experiments to be performed in the MEM laboratory as well as the external operations on Mars' surface.

During the planetary surface operations, the men in the orbiting spacecraft continue their experimentation observations, monitor the surface operations, and maintain the necessary spacecraft operations.


MARS
SURFACE ACTIVITY
UNITED
STATES
MSFC-69-PD-SA 166

SCIENTIFIC OBJECTIVES - MANNED MARS LANDING MISSION

Geological and geophysical investigations of Mars are significant because Mars probably closely paralleled the earth in origin and the development. Basically the data required about Mars are: (1) its physical, mineralogical, and chemical composition, (2) distribution of surface material and the processes by which features and material were formed, altered, transported, and distorted, (3) the record of any life there, and (4) any major events preserved in Martian rocks. These investigations require the presence of a skilled observer functioning as an interpretative scientist.

Perhaps the single, most consuming scientific question of the space program is: "Does extraterrestrial life exist in our solar system?" Has life ever existed on Mars? Does it exist now? Are conditions such that some form of life could exist? Preliminary data indicate that some lower forms of life can survive in the Martian environment, and conceivably in isolated areas higher forms of life may exist. Man on Mars will be able to study not only the forms of life indigenous to Mars, but also the behavior of terrestrial life forms transplanted to the Martian environment.

Drilling for or locating water will be an early objective on Mars, and its discovery would open many possibilities for utilization of Mars. For example, it might become possible to produce rocket fuel for the return trip on later missions.

SCIENTIFIC OBJECTIVES MANNED MARS LANDING MISSION

- MAKE GEOPHYSICAL OBSERVATIONS
- COLLECT SOIL AND ATMOSPHERIC SAMPLES
- STUDY LIFE FORMS
- STUDY BEHAVIOR OF TERRESTRIAL LIFE FORMS IN MARS ENVIRONMENT
- SEARCH FOR WATER AND USABLE NATURAL RESOURCES

ASCENT FROM MARS SURFACE TO MARS ORBIT

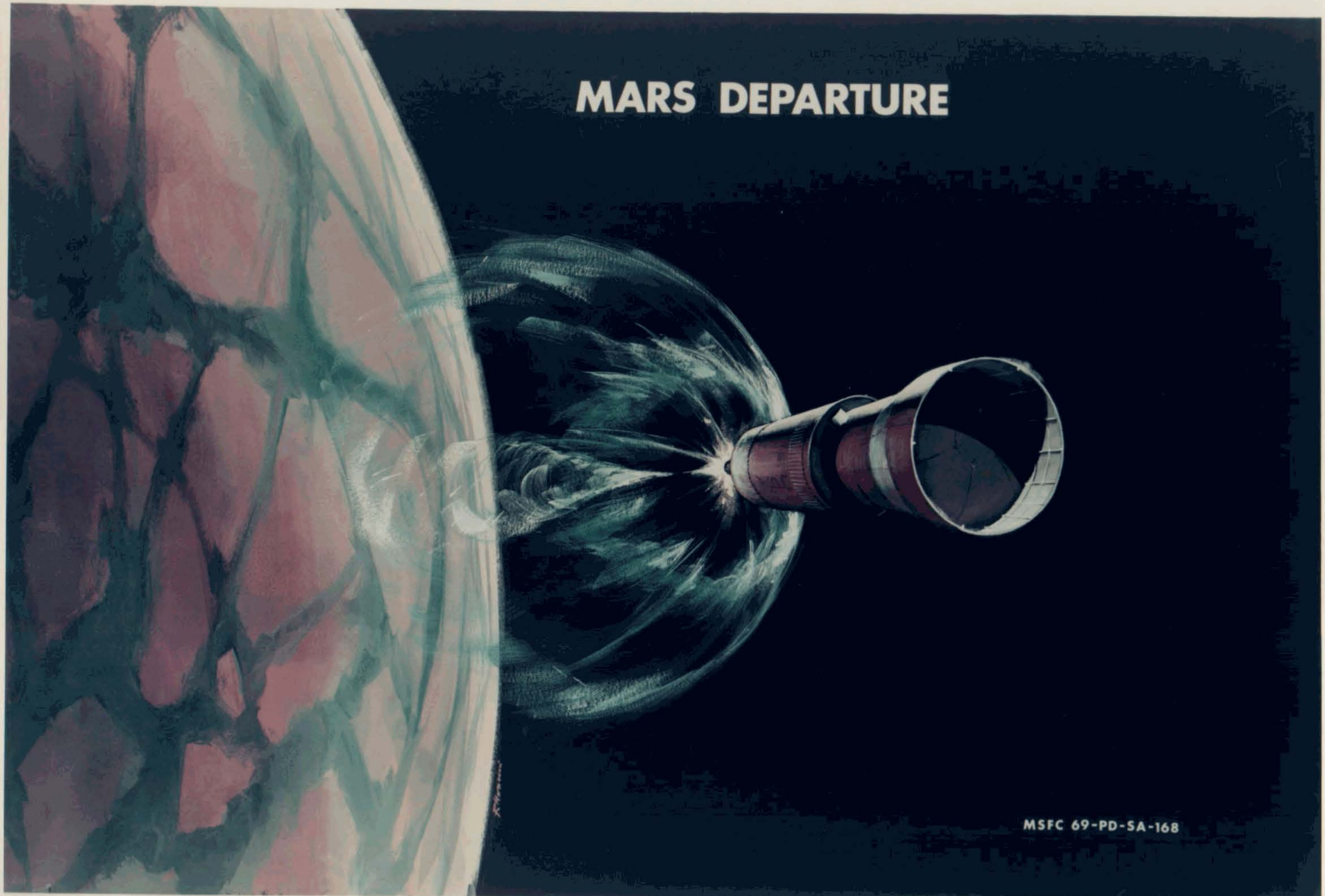
Using the MEM descent stage as a launch platform, the ascent stage delivers the crew, scientific data and samples back to the orbiting spaceship. The return payload, consisting mainly of samples, data, and miscellaneous equipment weighs approximately 900 pounds.


ASCENT FROM MARS SURFACE
TO MARS ORBIT
MSFC-69-PD-SA 169

MARS DEPARTURE

At the completion of the 80-day period at Mars, the planetary spaceships will begin the return leg of the journey. The nuclear stage is ignited for this propulsive maneuver, boosting each spaceship out of Mars orbit.

With the extensive Mars exploration activities behind them, the crew at this point can begin a more thorough analysis of the data and samples gathered at Mars, and prepare for the next major milestone of the trip -- a close encounter with the planet Venus.


MARS DEPARTURE
MSFC 69-PD-SA-168

RELEASE VENUS PROBES

In this mission profile, a passage close to Venus during the return leg results in lower approach velocities upon Earth return, and thus lower weight requirements. In addition, this provides an opportunity for close-proximity observations and experiments at Venus.

Since clouds obscure the surface of Venus, radar mapping will be conducted to obtain information on surface features. Two probes are provided on each spacecraft, and will be deployed during the Venus passage.


RELEASE OF VENUS PROBE
MSFC-69-PD-SA-193

EARTH RETURN

The manned Mars landing mission concludes with the return to earth orbit, using the last of the propellant in the nuclear stage for the braking maneuver. An optional earth return mode would allow the crew to make direct aerodynamic entry (Apollo-style). Until a better assessment can be made of the back contamination hazard (the return by man of pathogens that might prove harmful to earth inhabitants), a more conservative approach has been planned, i.e., the return of the crew to earth orbit for a quarantine period. Another advantage of the orbit return mode is that the nuclear stage and mission module are available for possible reuse.

Once the spacecraft achieves the desired earth orbit, it will rendezvous with the waiting space base, where the crew will receive thorough medical examinations before returning to Earth via the Space Shuttle. The return samples could also be further examined prior to their return to Earth.


RETURN EARTH
MSFC-69-PD-SA 194

EARTH LAUNCH AND ORBITAL ASSEMBLY

The Mars spacecraft and the Nuclear Shuttles will be launched into Earth orbit using two-stage Saturn V's. The Mars mission crews, expendables (food, water, etc.) and a portion of the fuel for the Nuclear Shuttles are carried to orbit with Space Shuttles.

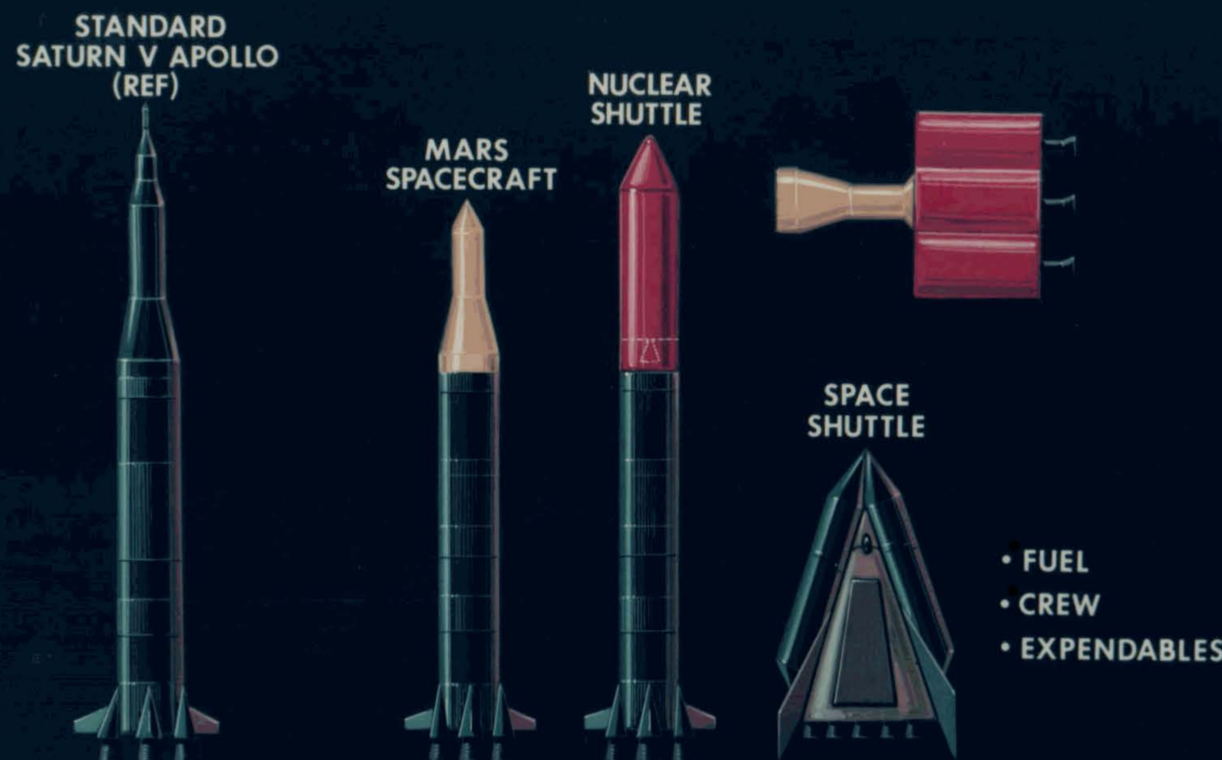
Nuclear Shuttles for the maneuvers at Mars and for Earth-return (the center shuttle) will be launched from Earth surface, with approximately one-half of its propellant on board. The remaining fuel will be provided via Space Shuttle flights.

It is envisioned that Nuclear Shuttles already in orbit for other uses can be employed for the Earth-escape maneuver (the outer shuttles). Fuel for these shuttles will also be provided from Earth surface via Space Shuttle flights.

The Mars spacecraft would be assembled and checked out on the ground prior to (unmanned) launch.

Then after orbital assembly, checkout, and crew boarding, the vehicles are ready for departure.

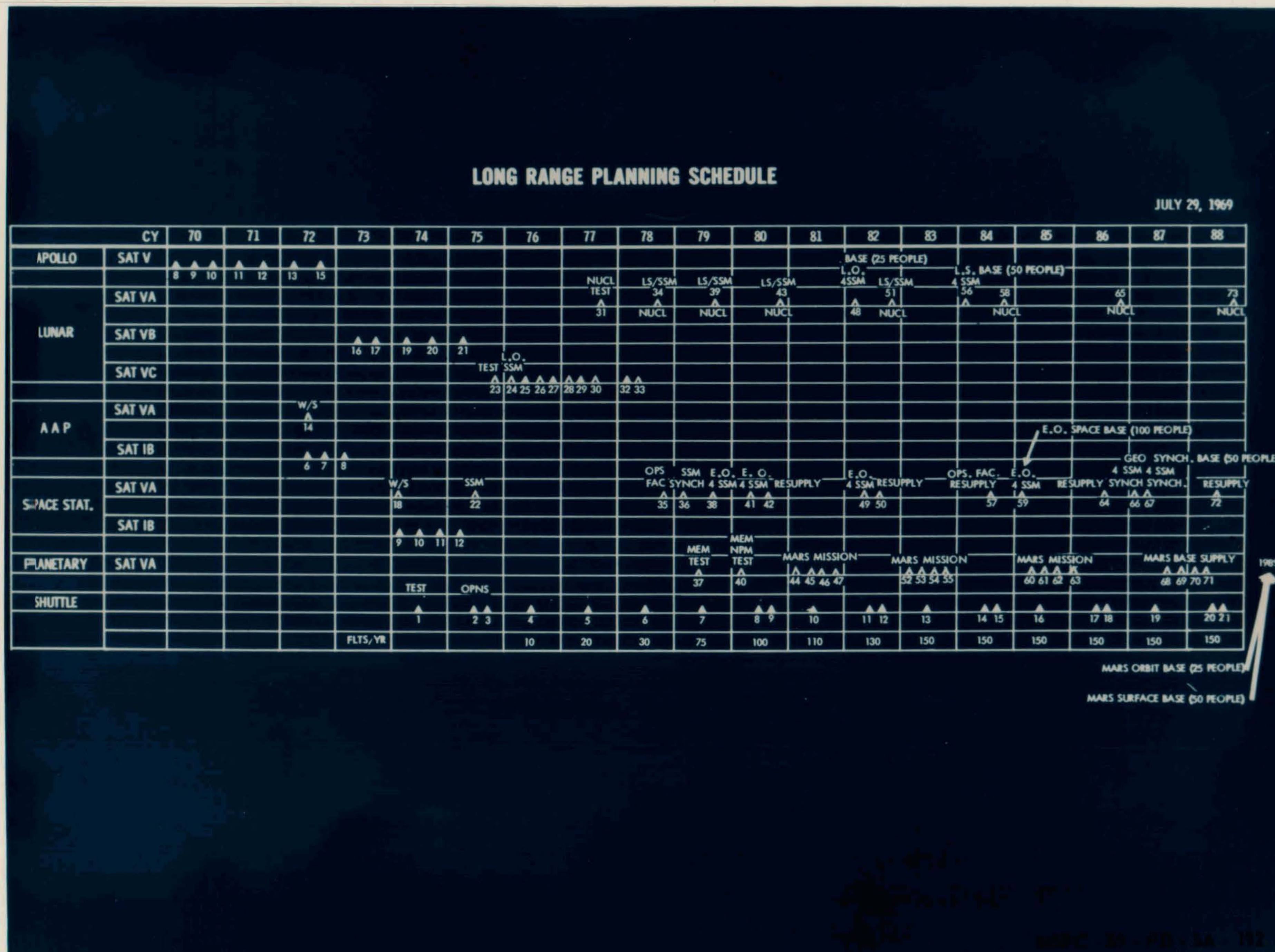
EARTH LAUNCH AND ORBITAL ASSEMBLY



MSFC-69-PD-SA 174

LONG RANGE PLANNING SCHEDULE

The manned Mars landing mission that has been presented is but one mission in a total space program. It is desirable at this time to consider this mission in context of the total program. This is shown on the facing page. Missions depicted for the decade of the 1970's are taken from the Integrated Space Program presented recently to the Space Task Group. These missions have been extrapolated into the 1980's in order to give a continuous program which could be used in determining funding requirements for the 1970-80 time period. The rationale for the extrapolation was to project an aggressive manned program in all areas utilizing the systems developed in the 1970's. Annual funding requirements for this program are shown on the following chart.



LONG RANGE PLANNING SCHEDULE
JULY 29, 1969
CY 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
APOLLO SAT V
8 9 10 11 12 13 15
LUNAR
SAT VA
SAT VB
SAT VC
BASE (25 PEOPLE)
L.O. 4SSM
L.S. BASE (50 PEOPLE)
4 SSM
NUCL TEST
31
LS/SSM 34 NUCL
LS/SSM 39 NUCL
LS/SSM 43 NUCL
48
LS/SSM 51 NUCL
56
58 NUCL
65 NUCL
73 NUCL
16 17 19 20 21
L.O. TEST SSM
23 24 25 26 27 28 29 30 32 33
AAP
SAT VA
W/S
14
SAT IB
6 7 8
E.O. SPACE BASE (100 PEOPLE)
GEO SYNCH. BASE (50 PEOPLE)
SPACE STAT.
SAT VA
SAT IB
W/S
18
SSM
22
OPS FAC
35
SSM SYNCH
36
E.O. 4 SSM
38
E.O. 4 SSM
41 42
RESUPPLY
E.O. 4 SSM
49 50
RESUPPLY
OPS. FAC. RESUPPLY
57
E.O. 4 SSM
59
RESUPPLY
64
4 SSM SYNCH
4 SSM SYNCH.
66 67
RESUPPLY
72
9 10 11 12
PLANETARY SAT VA
MEM TEST
37
MEM NPM TEST
40
MARS MISSION
44 45 46 47
MARS MISSION
52 53 54 55
MARS MISSION
60 61 62 63
MARS BASE SUPPLY
68 69 70 71
1989
SHUTTLE
TEST
OPNS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
FLTS/YR
10 20 30 75 100 110 130 150 150 150 150 150 150
MARS ORBIT BASE (25 PEOPLE)
MARS SURFACE BASE (50 PEOPLE)

LONG RANGE PLAN FUNDING

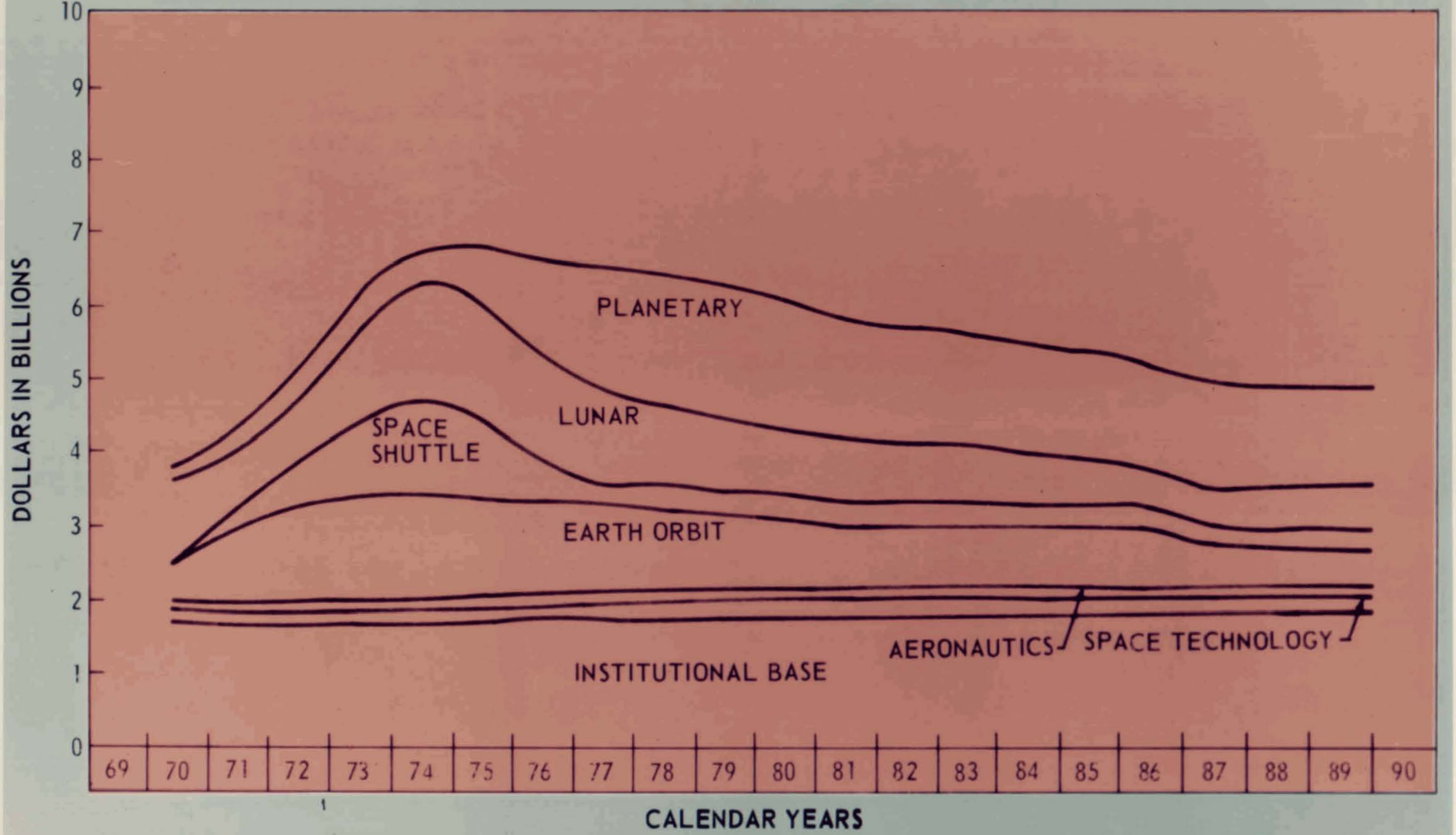
This funding shown in 1969 dollars reflects major emphasis in the mid 1970's on an expanding Earth orbital and lunar program. By 1980 the planetary program becomes prominent in the funding requirements while the lunar and Earth orbital funding remain essentially constant.

Major Earth orbital cost items include development of the common mission module, space shuttle, earth orbital experiments, and the operational costs associated with these items. The lunar costs include funds for development and operation of the nuclear shuttle, space tug, common mission module modifications for lunar surface, and accompanying lunar experiment costs.

The planetary costs include funds for development and operation of the Mars excursion module and planetary experiments plus the operation of the nuclear stage, mission module, launch vehicles and unmanned payloads.

An institutional NASA base approximately equal to that which exists today is included in the funding. Additionally, funds for continuing technical efforts in the areas of aeronautics and space technology are shown.

LONG RANGE PLAN FUNDING



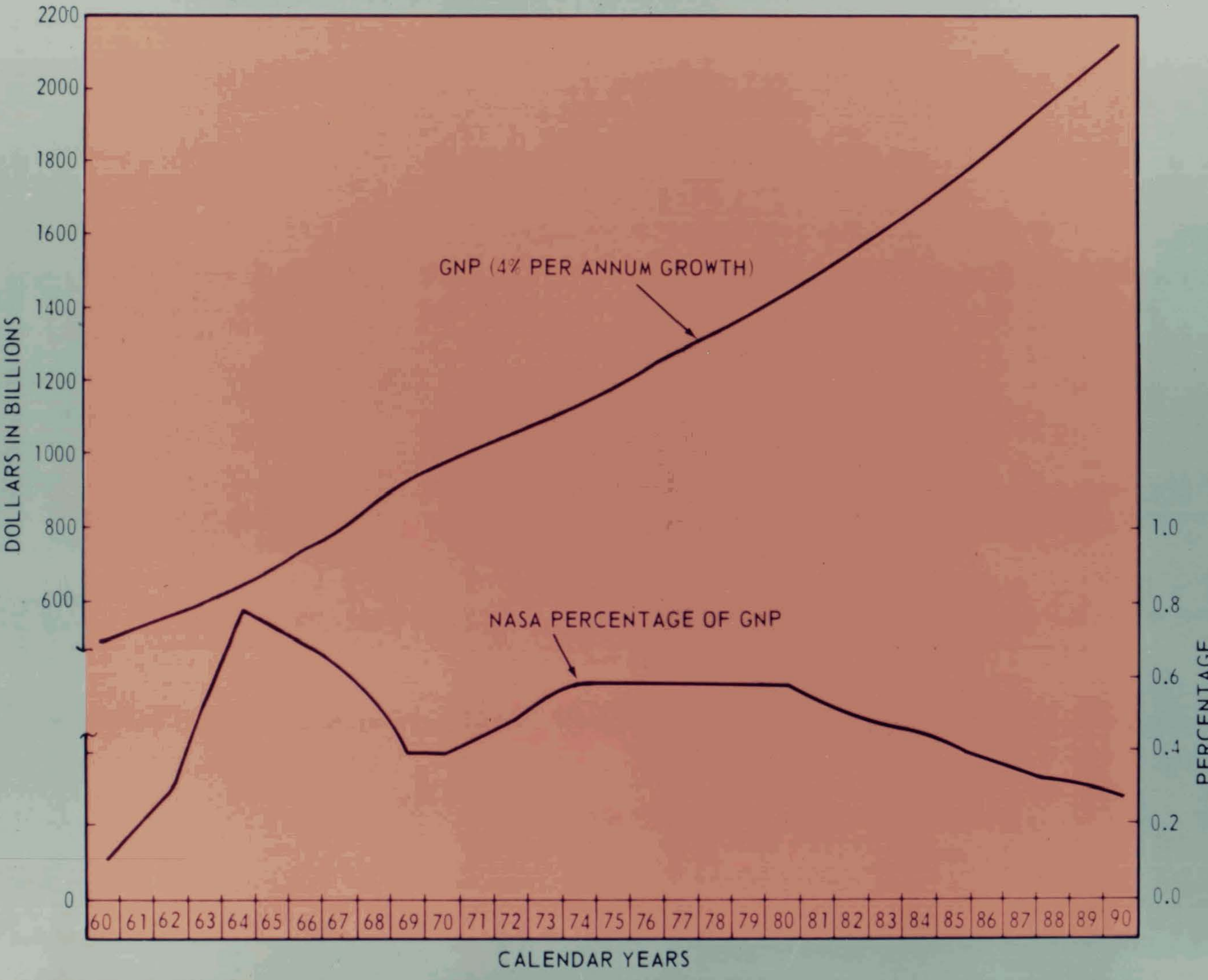
MSFC-69-PD-SA 197

SPACE AND THE GNP

The accompanying curves indicate the Gross National Product and the NASA budget plotted as a percentage of this GNP for a 30-year span from 1960 to 1990. The GNP line reflects actual data through mid-1969 and is increased by 4% per annum thereafter. This is a projected "real" growth rate without inflation.

The NASA percentage of the GNP reached a peak of 4/5 of 1% in 1964. It has dropped steadily since then to approximately 2/5 of 1% at present. The projected space program funding requirements would cause this value to increase to 3/5 of 1% in 1974 and decline slowly throughout the remaining years. By 1990, the NASA budget would only equal 1/5 of 1% of the GNP.

SPACE AND THE GNP



MSFC-69-PD-SA 195

MAJOR SCHEDULE MILESTONES

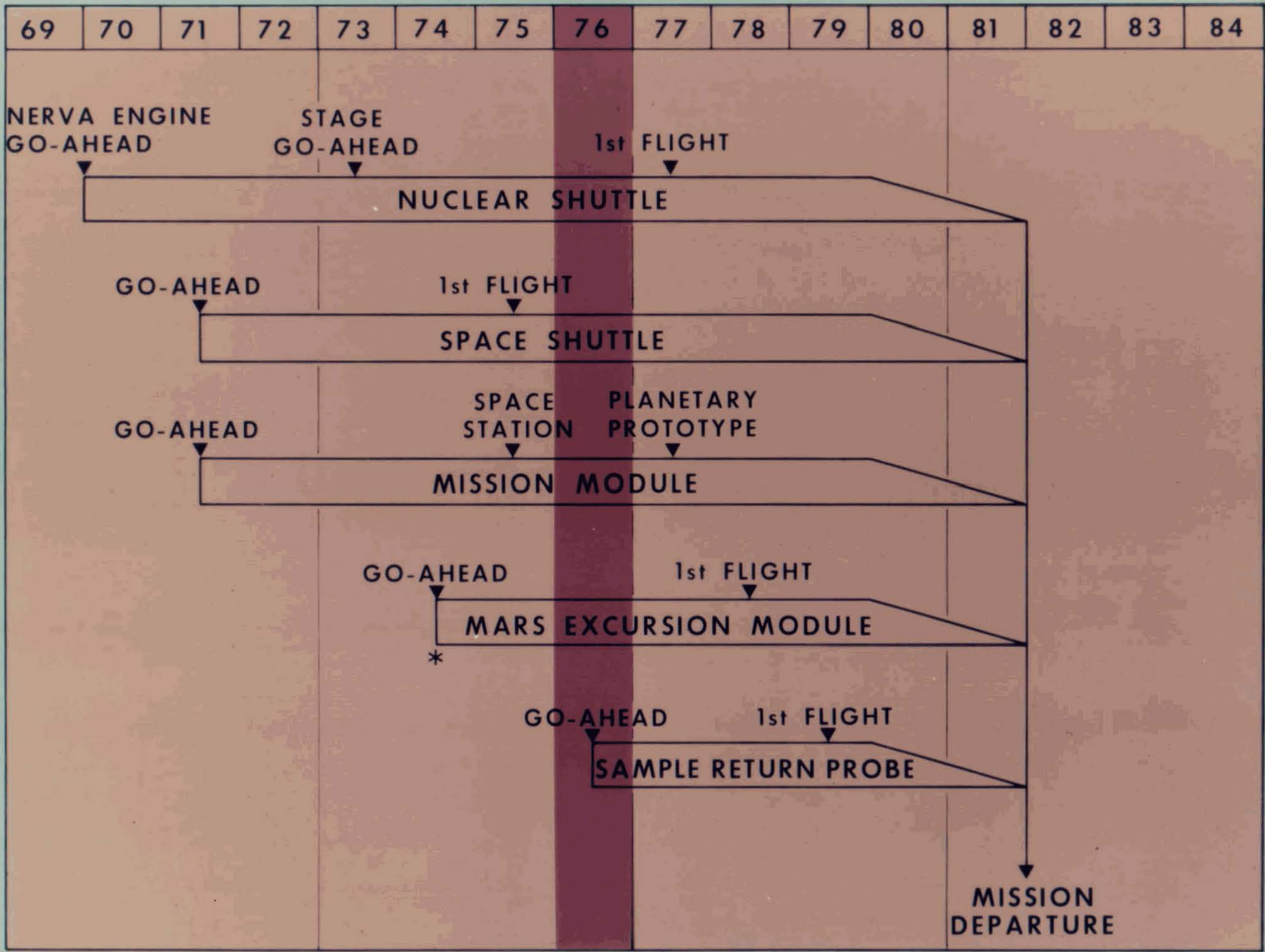
1982 MANNED MARS LANDING

The development schedule for the 1982 Manned Mars Landing culminates with the December 1981 Earth departure. The five major hardware elements required are shown. The Nuclear Shuttle, Space Shuttle and the mission module are required to carry out the planned program for the 1970's. The Mars Excursion Module and the Mars Surface Sample Return Probe are needed exclusively for this landing mission.

"Go-ahead" dates refer to the start of a hardware development program and "1st flight" indicates the first test flight of the system. Sufficient test time has been included to allow an earth orbital practice mission because of the long mission duration and the infrequency of Mars mission opportunities.

The option to make the 1982 Mars Landing can be kept open until 1974 (Mars Excursion Module go-ahead) provided the Nuclear Shuttle, the Space Shuttle, and the Common Mission Module are designed to be responsive to the ultimate requirements of the Mars Landing Mission.

MAJOR SCHEDULE MILESTONES
1982 MANNED MARS LANDING



* FIRST DECISION THAT IS MARS PECULIAR

MSFC-69-PD-SA 181

INTEGRATED PROGRAM LOGIC

In order to accomplish the Integrated Space Program for the funding shown, it was necessary to develop an integrated program logic. This logic required maximum use of Apollo systems, multi-mission application of common modules, and the introduction of reusable transportation systems. The application of the logic in formulating this Integrated Program made it economically feasible.

The long duration manned planetary missions will be made possible by the operational experience gained and the systems developed for the Integrated Program in the 1970's. The Earth orbital program will qualify both man and systems for long duration while the lunar program will provide techniques and experience for surface operations. The automated precursor missions provide Mars atmospheric and surface characteristics necessary to design and develop mission peculiar systems. In order to accomplish this high energy mission, it will be necessary to augment the chemical propulsion systems with a more efficient nuclear system.

With the systems developed and the experience gained from the early Mars mission, it will be possible to evolve to a temporary base by the end of the decade of the eighties if early explorations prove interesting.

INTEGRATED PROGRAM LOGIC

- MAXIMUM USE OF APOLLO SYSTEMS
- APPLICATION OF COMMON MISSION MODULES
- DEVELOPMENT OF REUSABLE TRANSPORTATION SYSTEMS
- EARTH ORBIT DEMONSTRATION OF MANNED LONG LIFE SYSTEMS
- LUNAR SURFACE ACTIVITY AS PREPARATION FOR MARS SURFACE OPERATIONS
- UTILIZATION OF AUTOMATED PRECURSORS
- ADD NUCLEAR PROPULSION TO CHEMICAL PROPULSION FOR DEEP SPACE OPERATIONS

EVOLUTION TO MARS BASE

INTEGRATED PROGRAM 1970-1990

The application of the described logic results in the program shown on the next 2 charts. This chart depicts the integrated program for the 1970's already submitted to the Space Task Group. The next chart represents the logical extension of this program including the Manned Mars Landing Mission.

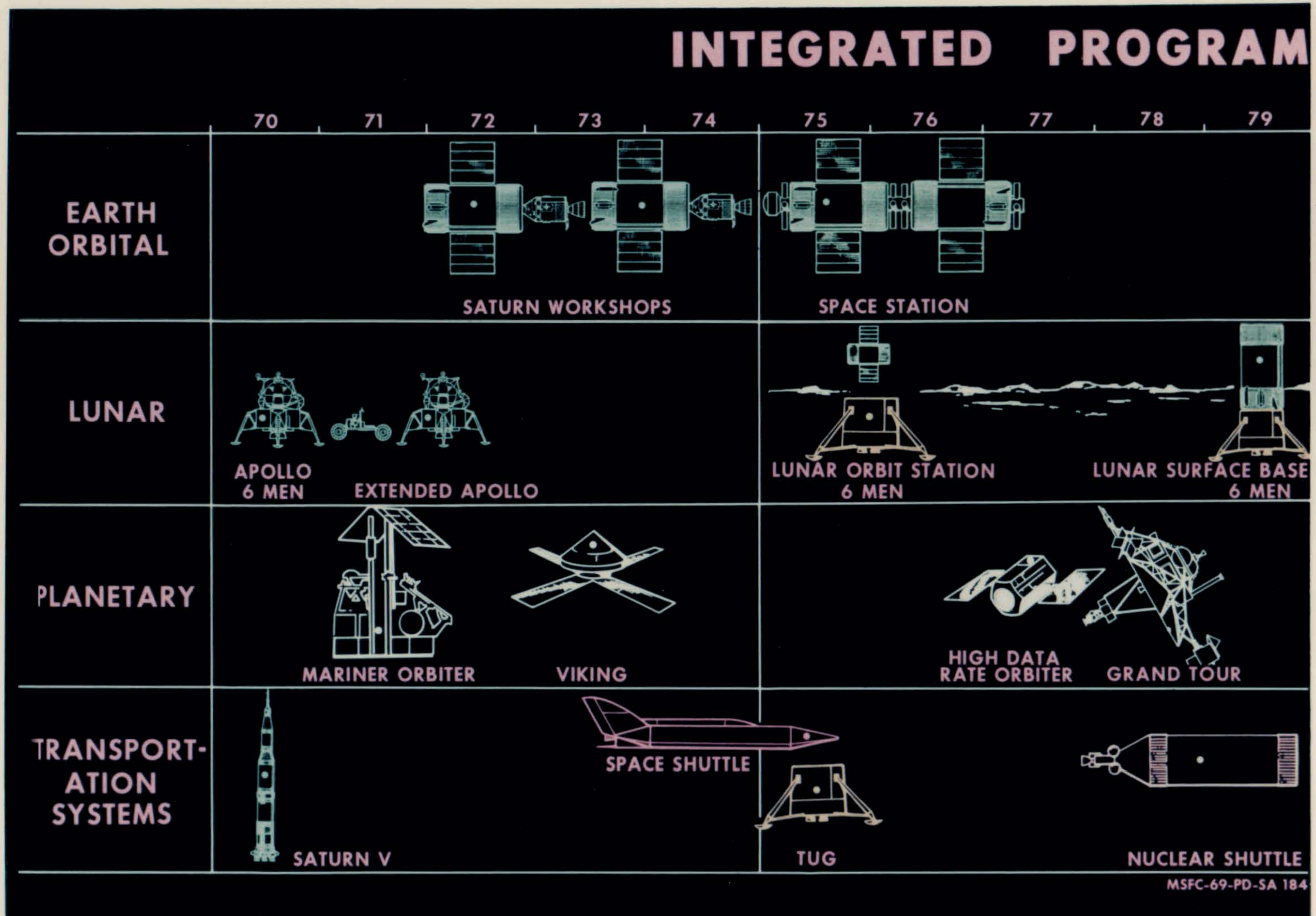
Maximum utilization of Apollo systems in the early 1970's is demonstrated by the use of two Saturn V Workshops in Earth orbit and additional Apollo type missions for further lunar exploration. The Saturn V vehicle is used to launch these missions. The Apollo systems are shown in blue.

Three new systems are required during the 1970's to provide the commonality and reuseability necessary to increase the capabilities in the last half of the decade. The systems are a new mission module (green), a space shuttle (red) and the tug (yellow). Two mission modules are integrated to serve as a space station in Earth orbit until the end of the decade. This same basic mission module is used in lunar orbit and as a lunar surface base.

The space shuttle is the key element to future space operations. It is used to transport people, equipment, and supplies to Earth orbit in support of all subsequent missions.

The space tug is required to support lunar missions and will also be used as a maneuvering unit at the Earth orbital space station. Reuse of these two systems will greatly reduce operational costs over that of the present Apollo-type throw-away systems.

In the late 1970's, the reusable nuclear shuttle (orange) is introduced as the primary space propulsion system. Its initial use is to support increased lunar activity.


INTEGRATED PROGRAM
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EARTH ORBITAL
SATURN WORKSHOPS
SPACE STATION
LUNAR
APOLLO 6 MEN
EXTENDED APOLLO
LUNAR ORBIT STATION 6 MEN
LUNAR SURFACE BASE 6 MEN
PLANETARY
MARINER ORBITER
VIKING
HIGH DATA RATE ORBITER
GRAND TOUR
TRANSPORT-ATION SYSTEMS
SATURN V
SPACE SHUTTLE
TUG
NUCLEAR SHUTTLE
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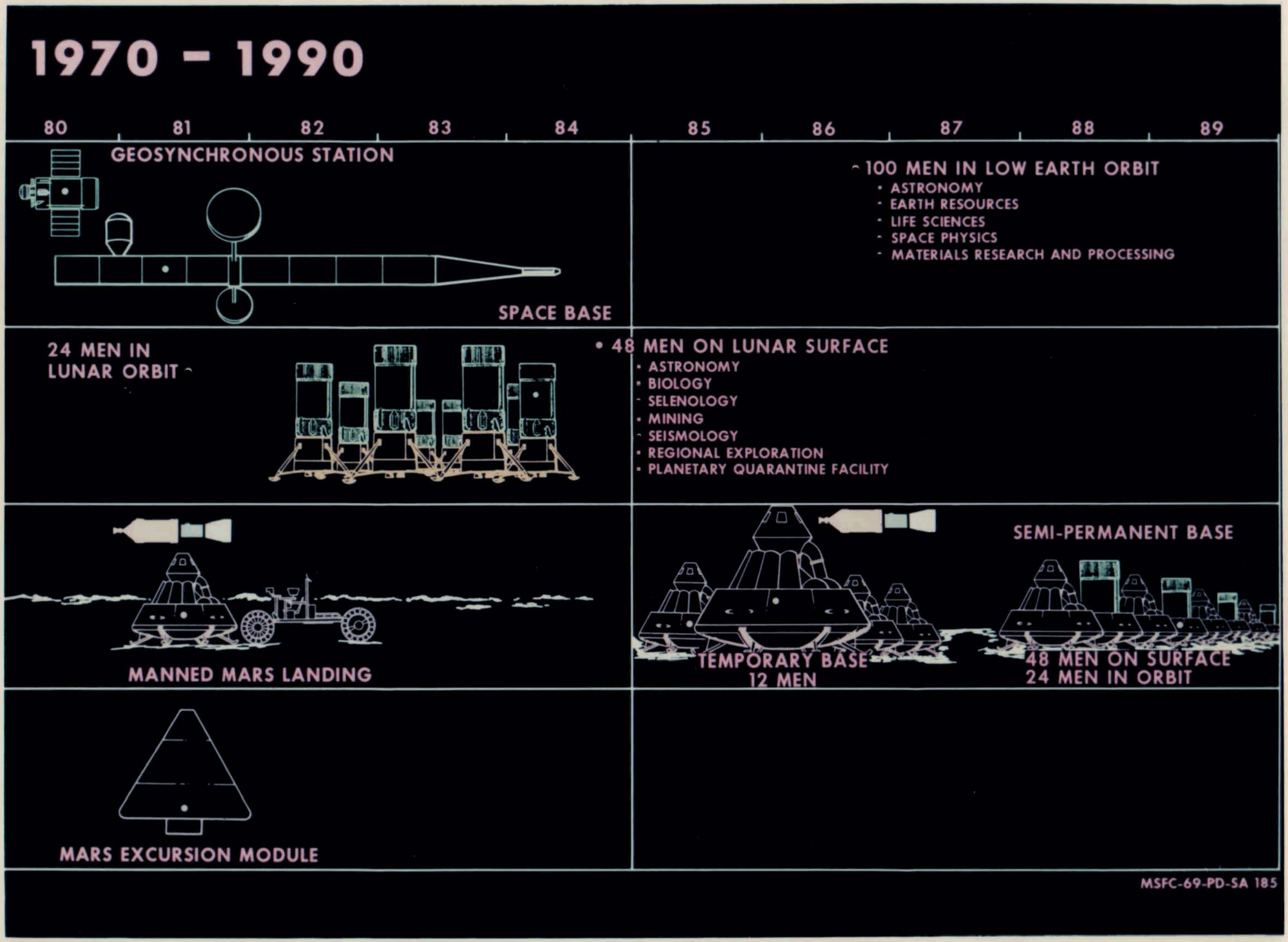
INTEGRATED PLAN 1970-1990

(Cont'd)

The systems of the 1970's are the foundation for building major space facilities in the 1980's. The 1975 space station evolves into a Space Base that can support up to 100 people by the early 1980's. This facility allows extensive multi-disciplinary scientific activities as indicated. A geosynchronous station is practical in this time period with the availability of the nuclear shuttle. Similarly, these new systems permit increased lunar operations.

The logical culmination of the next decade is the 1981 Manned Mars Landing Mission. The systems and experience gained in the 1970's make this a feasible undertaking.

In addition to serving as a focus for the next decade, the 1981 Mars landing is the threshold for manned planetary exploration of the 1980's.



1970 - 1990
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GEOSYNCHRONOUS STATION
SPACE BASE
• 100 MEN IN LOW EARTH ORBIT
• ASTRONOMY
• EARTH RESOURCES
• LIFE SCIENCES
• SPACE PHYSICS
• MATERIALS RESEARCH AND PROCESSING
24 MEN IN LUNAR ORBIT
• 48 MEN ON LUNAR SURFACE
• ASTRONOMY
• BIOLOGY
• SELENOLOGY
• MINING
• SEISMOLOGY
• REGIONAL EXPLORATION
• PLANETARY QUARANTINE FACILITY
MANNED MARS LANDING
TEMPORARY BASE
12 MEN
SEMI-PERMANENT BASE
48 MEN ON SURFACE
24 MEN IN ORBIT
MARS EXCURSION MODULE
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