FEB. 1972

SPACE SHUTTLE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE FACT SHEET

The space shuttle will be a manned reusable space vehicle which will carry out various space missions in Earth orbit. It will consist of two stages. The first stage booster will be an unmanned liquid-or solid-fueled rocket. The second stage orbiter will look like a delta-winged airplane and will be piloted by two men who will fly it back to Earth for an airplane-like landing.

On the launch pad the orbiter will be mounted to the booster, which will launch the orbiter to an altitude of about 55 to 65 kilometers (approximately 35 to 40 miles). The orbiter with its payload and crew will detach and continue into Earth orbit for missions lasting about seven days, or possibly as long as 30 days.

The man-operated space shuttle orbiter will deploy in Earth orbit all types of scientific and applications satellites weighing up to 29,500 kilograms (65,000 pounds) and thereby replace most of the expendable launch vehicles currently used.

The National Aeronautics and Space Administration plans to develop the space shuttle over the next six years at a total cost of approximately $5.5 billion. Test flights are to begin in 1976, manned orbital test flights in 1978, and the complete space shuttle vehicle is to be operational before 1980.

President Nixon's Endorsement

On Jan. 5, 1972, President Richard M. Nixon stated that "the United States should proceed at once with the development of an entirely new type of space transportation system designed to help transform the space frontier of the 1970s into familiar territory, easily accessible for human endeavor in the 1980s and 90s."

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February 8, 1972

The President stated further that:

...."In the scientific arena, the past decade of experience has taught us that spacecraft are an irreplaceable tool for learning about our near-earth space environment, the moon, and the planets, besides being an important aid to our studies of the sun and stars. In utilizing space to meet needs on earth, we have seen the tremendous potential of satellites for intercontinental communications and world-wide weather forecasting. We are gaining the capability to use satellites as tools in global monitoring and management of natural resources, in agricultural applications, and in pollution control. We can foresee their use in guiding airliners across the oceans and in bringing televised education to wide areas of the world."

President Nixon concluded by saying,

...."The continued pre-eminence of America and American industry in the aerospace field will be an important part of the shuttle's 'payload'.

"Views of the earth from space have shown us how small and fragile our home planet truly is. We are learning the imperatives of universal brotherhood and global ecology -- learning to think and act as guardians of one tiny blue and green island in the trackless oceans of the universe. This new program will give more people more access to the liberating perspectives of space, even as it extends our ability to cope with physical challenges of earth and broadens our opportunities for international cooperation in low-cost, multi-purpose space missions.

"'We must sail sometimes with the wind and sometimes against it,' said Oliver Wendell Holmes, 'but we must sail, and not drift, nor lie at anchor.' So with man's epic voyage into space -- a voyage the United States of America has led and still shall lead."

Importance of the Shuttle

Four main reasons why the space shuttle is the important and the right next step in manned space flight and the U.S. space program were stated by Dr. James C. Fletcher, NASA Administrator.

First, the shuttle is the only meaningful new manned space program which can be accomplished on a modest budget. Man has worked hard to achieve -- and has indeed achieved -- the freedom of mobility on land, the freedom of sailing on his oceans, and the freedom of flying in the atmosphere. And now, within the last dozen years, man has discovered that he can also have the freedom of space. Man has learned to fly in space, and man will continue to fly in space. Given this fact, the United States cannot forego its responsibility -- to itself and to the free world -- to have a part in manned space flight. And the space shuttle is clearly the meaningful and useful new manned space program for the coming decade.

Second, the space shuttle is needed to make space operations less complex and less costly. Today we have to mount an enormous effort every time we launch a manned vehicle, or even a large unmanned mission. The reusable space shuttle gives us a way to avoid this. This airplane-like spacecraft makes a launch into orbit an almost routine event. This is possible by not throwing everything away after we have used it just once -- just as we don't throw away an airplane after its first trip from Washington to Los Angeles.

The shuttle even looks like an airplane, but it has rocket engines instead of jet engines. It is launched vertically, flies into orbit under its own power, stays there as long as it is needed, then glides back into the atmosphere and lands on a runway, ready for its next use. With the shuttle, space operations will indeed become routine.

Third, the space shuttle is needed to do useful things. There are many areas -- in science, in civilian applications, and in military applications -- where we can see now that the shuttle is needed; and there will be many more by the time routine shuttle services are actually available.

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Take, for example, civilian space applications. We have already seen the great value of communications and weather satellites. The space shuttle will make it possible, in the future, to routinely launch communications and weather satellites with vastly improved capabilities -- to bring education via television to remote areas, and to improve our ability to predict the weather. Soon, also, we will have satellites that will allow us to monitor, and help us husband, our natural resources -- water, minerals, and our agriculture. And perhaps with routine space operations, one could develop a global environmental monitoring system, international in scope, to help control our environment here on earth.

Fourth, the shuttle will encourage far greater international participation in space flight. In his address to the United Nations in September 1969, the President promised that the United States will take positive, concrete steps "toward internationalizing man's epic venture into space -- an adventure that belongs not to one nation but to all mankind." With the shuttle's low cost to orbit and inherent flexibility, the rest of the world -- the free world at least -- can work with us to launch many of their space experiments, and share with us some of the expense of space exploration. With the shuttle's easy and routine access to space, scientists and astronauts of many nations could be taken into orbit -- with their experiments -- to join at first hand in space studies. We are also discussing compatible docking systems with the Soviet Union so that their spacecraft and ours can join in space. Perhaps ultimately men of all nations will work together in space -- in joint experiments, joint environmental monitoring, or perhaps even other joint enterprises -- and through these activities help humanity unite in peace on its planet earth.

The Space Shuttle will be the only manned space program after 1973, Dr. Fletcher said. Without it, space will be occupied by the only other great power with the will and determination to occupy it -- the USSR.

The Shuttle also provides the basis for greater progress in international cooperation, the NASA Administrator pointed out. Working with the Soviet Union and other foreign nations depends on our strength. "Space cooperation could lead to cooperation in other fields and greatly facilitate the President's efforts to achieve an era of lasting peace for the world," Dr. Fletcher said.

Background

Extensive engineering, design, and cost analysis studies of a space shuttle have been the major future planning effort of NASA's Office of Manned Space Flight for the past two years. These included concepts of both a fully reusable manned booster and orbiter and the unmanned booster and manned orbiter. Earlier emphasis was placed on a fully reusable manned system powered by throttleable, high pressure rocket engines using liquid hydrogen and liquid oxygen propellants.

In July 1971, Rocketdyne Division of North American Rockwell Corp., Canoga Park, Calif. was selected to develop the high pressure space shuttle main engine and is proceeding under an interim contract.

During the course of the space shuttle system studies, information developed which led to a decision in June 1971 to extend the study effort to obtain additional data on a system employing an unmanned rocket booster and manned reusable orbiter. It was concluded that this configuration, an unmanned rocket booster and manned reusable orbiter, could be developed for about half the cost of a fully reusable manned system and have equal operational capability in space.

Space Shuttle Configuration

Booster - Two different kinds of boosters are under consideration, a liquid-fueled recoverable and reusable rocket or expendable solid-fueled rockets. One will be selected in March 1972.

Liquid-fueled booster - The liquid-fueled booster would be powered by new pressure fed engines. In a series burn configuration, it would launch the manned orbiter to an altitude of about 55 to 65 kilometers (35 to 40 miles), jettison, descend into the ocean by parachutes, be recovered and reused. The engine's propellants, kerosene and liquid oxygen or propane and liquid oxygen would be fed into the combustion chamber by 300 pounds of pressure in the tanks. Six engines of about 1 million pounds thrust each would be used.

Solid-fueled booster - This booster could be twin solid-fueled rockets, clusters of three meters or 3.9 meters (120 inches) or 156 inches) which would burn in parallel with the orbiter. Both booster and orbiter engines would ignite and burn simultaneously at launch, the booster would jettison at an altitude of about 55 kilometers (35 miles) while the orbiter engines continue burning to carry it into space.

Two other booster configurations under consideration are twin liquid-fueled rockets which would burn in parallel with the orbiter at launch and a series burn solid rocket.

Orbiter - The manned orbiter will be powered by three high pressure engines with 470,000 pounds thrust each in space.

The orbiter will be approximately 36 meters (120 feet) long and have a wing spread of 23 meters (75 feet). The cargo compartment, or payload bay, will be approximately 4.5 meters (15 feet) in diameter and 14 to 18 meters (45 to 60 feet) long. Payload capability will be up to 29,500 kilograms (65,000 pounds). External propellant tanks will be attached to the orbiter and will be jettisoned in orbit. The tanks would be deorbited by retro-rockets and landed in remote ocean areas.

The crew will consist of two pilots and two flight engineers. The engineers' duties will include checking out the unmanned satellite payloads and deploying them in space.

A special pressurized sortie module can be carried in the payload bay to accommodate up to 12 persons, or passengers who are not astronauts. Scientists and engineers will have an opportunity to accompany their experiments into space for the first time.

The shuttle orbiter will have a maximum of 3 G forces during launch and reentry and a cross-range maneuvering capability of 1,760 kilometers (1,100 miles).

Unlike previous manned spacecraft the shuttle orbiter will have reusable external insulation. Each vehicle is to be capable of carrying out 100 space missions.

Space Shuttle Missions - It will be used to carry into space virtually all of the nation's civilian and military payloads, manned and unmanned. It will also accommodate the future need of commercial users and foreign governments.

These will include all the automated scientific space probes, Earth orbiting solar and astronomical observatories. Applications payloads will be Earth resources sensing, communications, meteorological and geodetic satellites.

Normal manned missions will be up to seven days duration in which scientists and engineers will conduct investigations in space aboard a pressurized module in the payload compartment. Man may also repair satellites in space, retrieve them and return them to Earth if necessary.

A smaller powered vehicle, called a space tug, can be deployed from the shuttle for manned or unmanned space operations such as boosting a communication satellite to higher altitudes including synchronous orbit and retrieving payloads from high orbits.

It is estimated the shuttle will carry out 30 to 40 space missions per year. Approximately 30 percent of the missions will be for the Department of Defense. About 80 percent of the total flights will be deploying and servicing automated satellite payloads.

Costs - Development costs are estimated at $5.5 billion over the next six years. This includes all research, development and test, and evaluation expenses of two flight test orbiters and two boosters.

In addition, initial operational facilities will cost about $300 million. Each added orbiter is estimated at $250 million, and each added booster $50 million.

Cost of a shuttle launch is estimated to be $7.7 million with a liquid-fueled booster and $10 to $13 million with a solid-fueled booster. However, development of the liquid-fueled booster will be more expensive than a solid-fueled booster development.

The shuttle can be developed over the next six years at the present level of the NASA budget, $3.2 billion and with no reduction of the space science, applications, aeronautics and technology programs.

Savings - When the shuttle becomes operational, the cost savings to the nation over a twelve-year period beginning about 1980 will total $12 to $13 billion. Launch costs savings with the reusable shuttle will be about $5 billion. However, the bigger savings will be $7 to $8 billion in payload costs. With the shuttle, automated satellites can be repaired or serviced by men in space, or returned to Earth for refurbishment and reuse. The size and weight-carrying capacity of the orbiter will free designers from constraints which made design more difficult and costly. This will make it possible to use relatively inexpensive standard laboratory equipment in place of specially constructed, highly miniaturized equipment which is expensive to develop and test.

Appropriations

To date, Congress has appropriated $198.5 million for the space shuttle, $80 million in Fiscal Year 1971 and $118.5 in Fiscal Year 1972. The request this year, Fiscal Year 1973, is $227.9 million, $200 million for research and development and $27.9 million for construction of facilities.

NASA Space Shuttle Program Management

Overall funding responsibilities and principal requirements will be under the Space Shuttle Program Office, Office of Manned Space Flight in Washington, D.C. The Manned Spacecraft Center, Houston,has been designated the lead center with program management responsibility, overall engineering and systems integration, basic performance requirements for the shuttle, and development of the orbiter stage. Marshall Space Flight Center, Huntsville, Alabama, has been given responsibility for development of the booster stage and the space shuttle engines. Kennedy Space Center, Florida,will be responsible for design of launch and recovery facilities. All other NASA centers will contribute by providing technical knowhow and support.

1972 Milestones

NASA Plans to request proposals from the aerospace industry for development of all major flight hardware in March. This includes the booster, orbiter, and pressure fed engine if the liquid-fueled booster concept is chosen. Contractor selection will be made during the summer.

A space shuttle launch and recovery site will be selected by the NASA Administrator.

Major Space Shuttle Study Contracts

Contractor	Scope of Study	Cumulative Funding as of Jan. 1972)	
McDonnell-Douglas/ Martin Marietta	Vehicle design & development	$19.3	million
North American Rockwell/ General Dynamics	" " " "	19.3	"
Grumman Aerospace/ Boeing Co.	" " " "	13.6	"
Lockheed	" " " "	4.5	"
Chrysler	Recoverable launch booster	.750	"
Chrysler	Pressure fed engine booster	.865	"
Mathematica	Economic Benefits	.645	"
Aerojet General	High pressure engine (orbiter)	6.7	"
Pratt & Whitney	" " " "	6.7	"
Rocketdyne	" " " "	6.7	"
Aerojet General	Pressure fed engine (booster)	.450	"
TRW Systems Group	" " " "	.450	"
United Technology Corp.	Solid Rocket Motor (booster)	.150	"
Aerojet	" " " "	.150	"
Lockheed	" " " "	.150	"
Thiokol	" " " "	.150	"
Aerospace Corp.	Operations & Payload analysis	3.6	"
Lockheed	Payload analysis	.599	"
Parsons	Facilities plan	.715	
Loewy/Snaith	Habitability design	.100	
Cornell Aeronautical Laboratory Inc.	Orbiter approach and landing Simulators	.175	

Space Shuttle Development Contract

Rocketdyne (Interim Contract)	High pressure orbiter engine	6.0

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January 7, 1972

STATEMENT BY DR. ROBERT C. SEAMANS
SECRETARY OF THE AIR FORCE

Secretary Seamans said today that the President's decision to proceed with the space shuttle development initiates a program which holds great promise for scientific and technical advances in the interest of the nation and all mankind. We are also interested in its potential as a means for performing our military mission more effectively and economically. The Air Force role in the program is to provide NASA data to help assure that the shuttle will be of maximum utility to the DOD and we are pleased that the proposed vehicle is configured to meet potential DOD needs.

We will continue our close coordination with NASA as their development program proceeds.

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APPENDIX TO SPACE SHUTTLE FACT SHEET

SPACE SHUTTLE ECONOMICS

1. Justification

The justification of the space shuttle is not based on the details of space shuttle economics alone. It is a fact that the shuttle is a good investment and will make possible significant savings in future space operations. But the fundamental reason for developing the space shuttle is the necessity to have a means for routine, quick reaction, and economical access to space and return to earth in order to achieve the benefits of the scientific, civil, and military uses of space that will be important in the decade of the 1980's and beyond. The space shuttle program is also the lowest cost approach for providing a continuing useful capability for manned space flight and for maintaining a clear U.S. presence in space.

2. Funding Requirements

a. The development cost for the space shuttle is estimated to be $5.5 billion.

b. The additional investment cost for procurement of production flight hardware and facilities is estimated at $1.5 billion, on the reasonable assumption that the initial inventory will include: 3 production orbiters, 2 refurbished orbiters, and 4 production boosters (plus 2 development boosters if not expended during development).

c. The total investment, therefore, required to develop the shuttle and procure flight hardware and provide facilities will be approximately $7 billion.

3. Implied Future Commitments

a. The full development of the shuttle, the initial investment required, and its subsequent operation, together with a continuing well-balanced program in science, applications, and aeronautics, can be supported at an essentially constant total NASA budget level, i.e., about $3.4 billion in 1971 dollars.

b. The peak annual total funding level required for the shuttle during the development period is estimated at $1.3 billion. As stated above, this will not require an increase over the current total NASA budget level.

4. Relation of Shuttle Funding to Other Space Program Funding

a. There has been some confusion on funding levels required for the shuttle because some people have incorrectly counted the cost of future satellites and other payloads and mission support in future years as a part of the development or investment costs of the space shuttle system. In this way, figures of $10 billion or more have been arrived at as the "true" cost of the shuttle system. This line of reasoning seems to assume that future satellites and payloads would be put in space only because we will have a shuttle, or would be put in space at a rate which is unreasonably high because we have the shuttle, thereby leading to annual budget levels far greater than current levels.

b. The facts are:

(1) The decision to develop the shuttle does not entail an increased level of future expenditures for the satellites and payloads it will carry or for conducting shuttle missions.

(2) The scientific and civil and military applications missions the shuttle will perform will be the same ones that would otherwise be launched by expendable boosters, although the additional capabilities of the shuttle will mean that many missions will be performed differently and more effectively.

(3) After development, the cost of performing these missions will be less with the shuttle than without, because the shuttle will be a more economical launch vehicle and because payload costs can be reduced by reuse and redesign.

(4) Economical use of the shuttle including mission costs is achievable with total annual budgets for space at substantially the current levels. Numbers of the order of $10 billion or more, if correct at all, relate to expenditures that would be spread over a long period of time and which need not exceed the present annual levels.

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5. Illustration of Expected Economies through Use of the Shuttle

a. A conservative combined mission model for NASA, DOD, and other users that has been studied calls for some 500 missions over a 12-year period (1979-1990), a rate of less than 50 missions per year. This model is not a plan, but provides a realistic set of assumptions used to test the reasonableness of developing the space shuttle from an economic standpoint.

b. In this model, launch costs using existing conventional vehicles would be some $11.0 billion over those 12 years. Using the shuttle, the total launch costs, including procurement of replacement boosters, drop to about $5.8 billion, an economy of some $5.2 billion.

c. The payload development and procurement costs for the 500 missions would, for conventional launches, run about $29.8 billion over these 12 years divided between NASA, DOD, and other agencies. Because of payload reusability, design simplification, and lower risk factors, those same 500 missions using the shuttle would have payload costs of about $22.6 billion. This is an economy of another $7.2 billion.

d. Therefore, the assumed 12-year flight program can be carried out with the shuttle $12.4 billion cheaper than without, an average saving of over $1 billion per year.

e. The average total annual cost for launch and payloads in the assumed mission model is $3.4 billion without the shuttle and slightly below $2.4 billion with the shuttle. These levels are compatible with the current levels of the total space budgets for NASA, DOD, and other agencies.

6. Shuttle Amortization over 500 Missions in 12 Years

a. Investment in space shuttle, based on pressure-fed reusable booster, including initial inventory, as in Item 2 above (details shown below):		$7.0 billion
(1) Development, test, and procurement of 2 orbiters and 2 boosters	(5.5)	
(2) Refurbish 2 orbiters and procure 3 more, including engines	(.9)	
(3) Procurement of 4 boosters, including engines	(.3)	

(4) Facilities for development, test, and launch capability (.3)

b. Additional investments required to fly mission model assumed in Item 5 above: 1.3 billion

c. Total development and investment 1972-1990 (sum of Items 6a and 6b): 8.3 billion

d. Net reduction in cost of 500 missions because of shuttle operations, as in Item 5d above: 12.4 billion

e. Twelve-year benefit saving realized from shuttle investment (Item 6d minus 6c): 4.1 billion

f. Thus, even if the space programs of NASA, DOD, and other agencies terminated in 1990, the shuttle would have more than paid for itself by then.

7. Additional Points

a. The specific missions that justify the shuttle are those that could and would otherwise be justified on their own merits with conventional launch vehicles; the shuttle makes them more effective and less expensive.

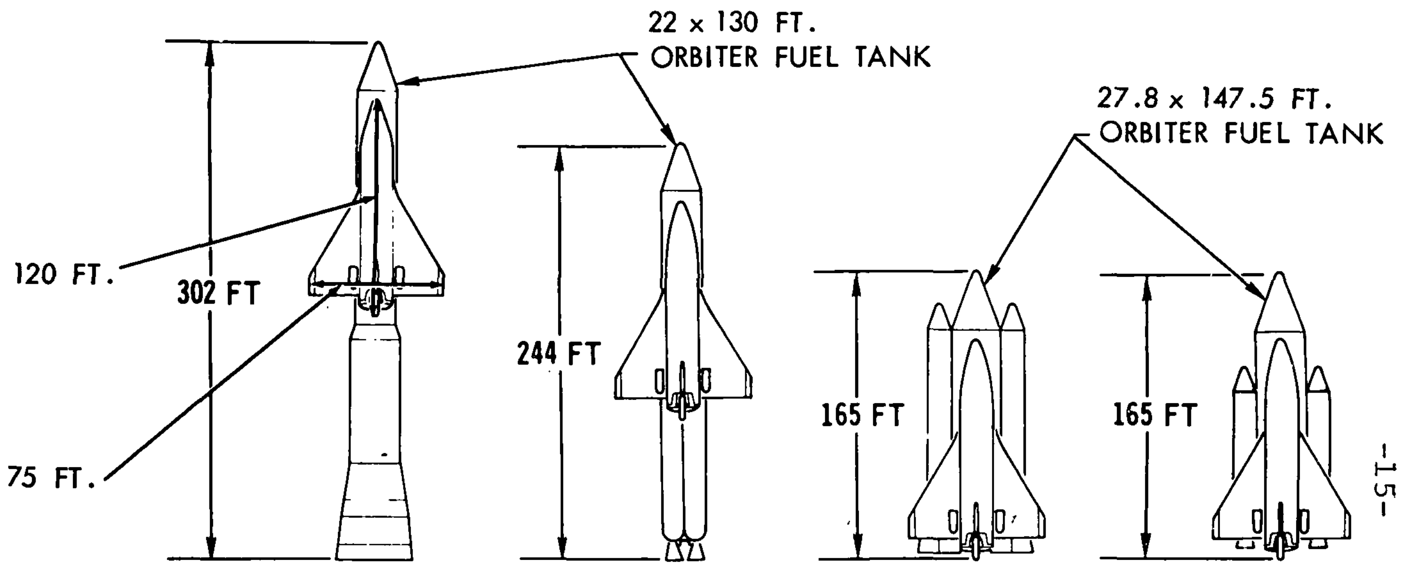
b. The shuttle is self-sufficient; it does not require a space station in order to meet the good investment criterion, or to conduct useful manned missions in Earth orbit.

c. Without the shuttle, the U.S. will have no program of manned space flight after 1973.

8. Conclusion

Even though the primary justification for the space shuttle is not economics, for mission models similar to those now in effect the shuttle investment will be returned with billions to spare. If, as is likely, new useful and economically beneficial mission possibilities open up during the 1980's because of the routine and quick access to space the shuttle provides, the investment will be returned many times over.

SHUTTLE CONFIGURATIONS UNDER STUDY



BOOSTER	SINGLE LIQUID PRESSURE FED	SINGLE SOLID	TWIN LIQUID PRESSURE FED	TWIN SOLID
BURN MODE	SERIES	SERIES	PARALLEL	PARALLEL
STAGING VELOCITY FT/SEC.	5000	5055	4000	4211
FUELED WEIGHT (1,000 LBS.)	5196	4823	4126	3924
UNFUELED WEIGHT (1,000 LBS.)	722	632	512	430
BOOSTER/ORBITER UNFUELED (1,000 LBS.)	538/137	488/137	317/137	236/137

COMMON ORBITER

PAYLOAD: 15 x 60 FT. 65,000 LBS. ENGINES: THREE HIGH PRESSURE LIQUID HYDROGEN/OXYGEN FUEL, 470,000 LB. THRUST

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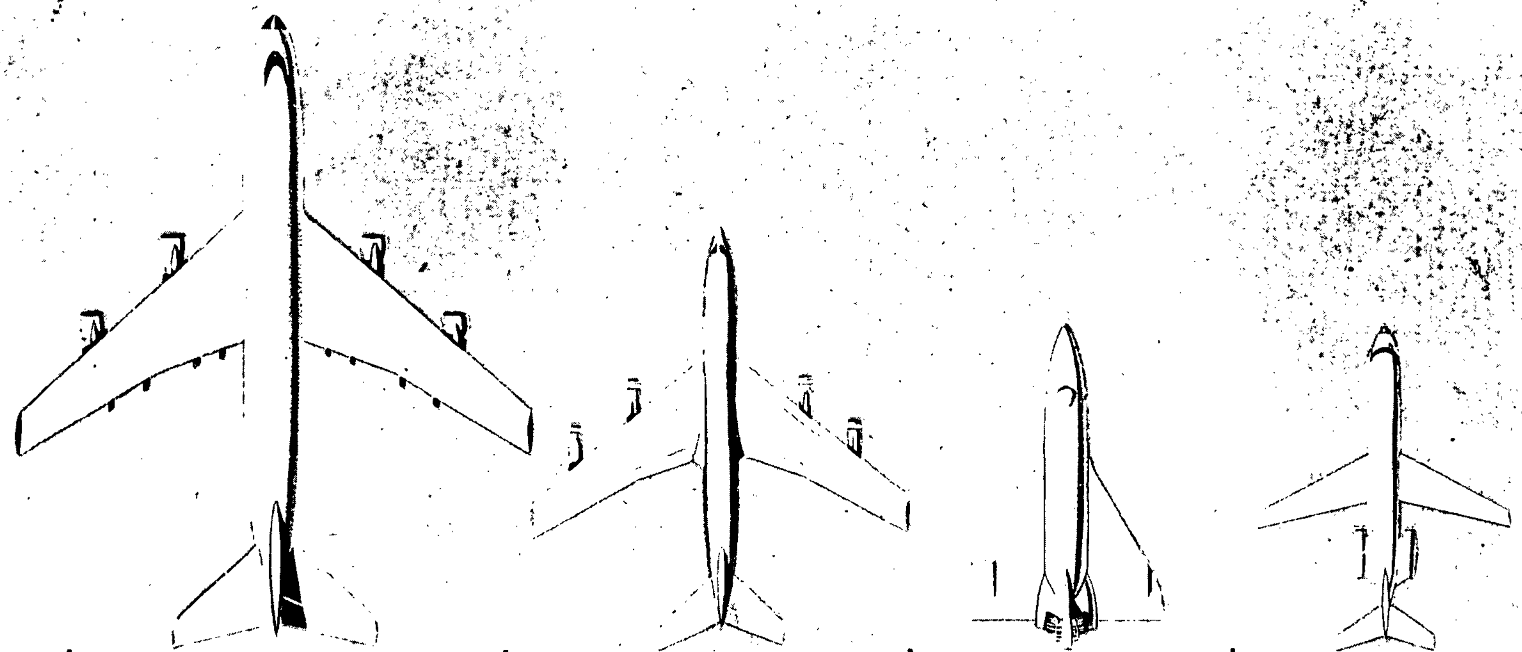
ORBITER COMPARISON WITH EXISTING AIRCRAFT



	747	707	SHUTTLE ORBITER	DC-9
WINGSPAN	59.6 M (196 FT)	43.4 M (142 FT)	22.8 M (75 FT)	28.7 M (94.3 FT)
LENGTH	70.5 M (231 FT)	46.6 M (153 FT)	36.6 M (120 FT)	36.4 M (119.3 FT)
OPER. WT. EMPTY	165,920 KG (365,800 LBS)	61,236 KG (135,000 LBS)	63,400 KG (140,000 LBS)	26,000 KG (57,210 LBS)
LANDING SPEED	160 MI/HR	160 MI/HR	185 MI/HR	130 MI/HR

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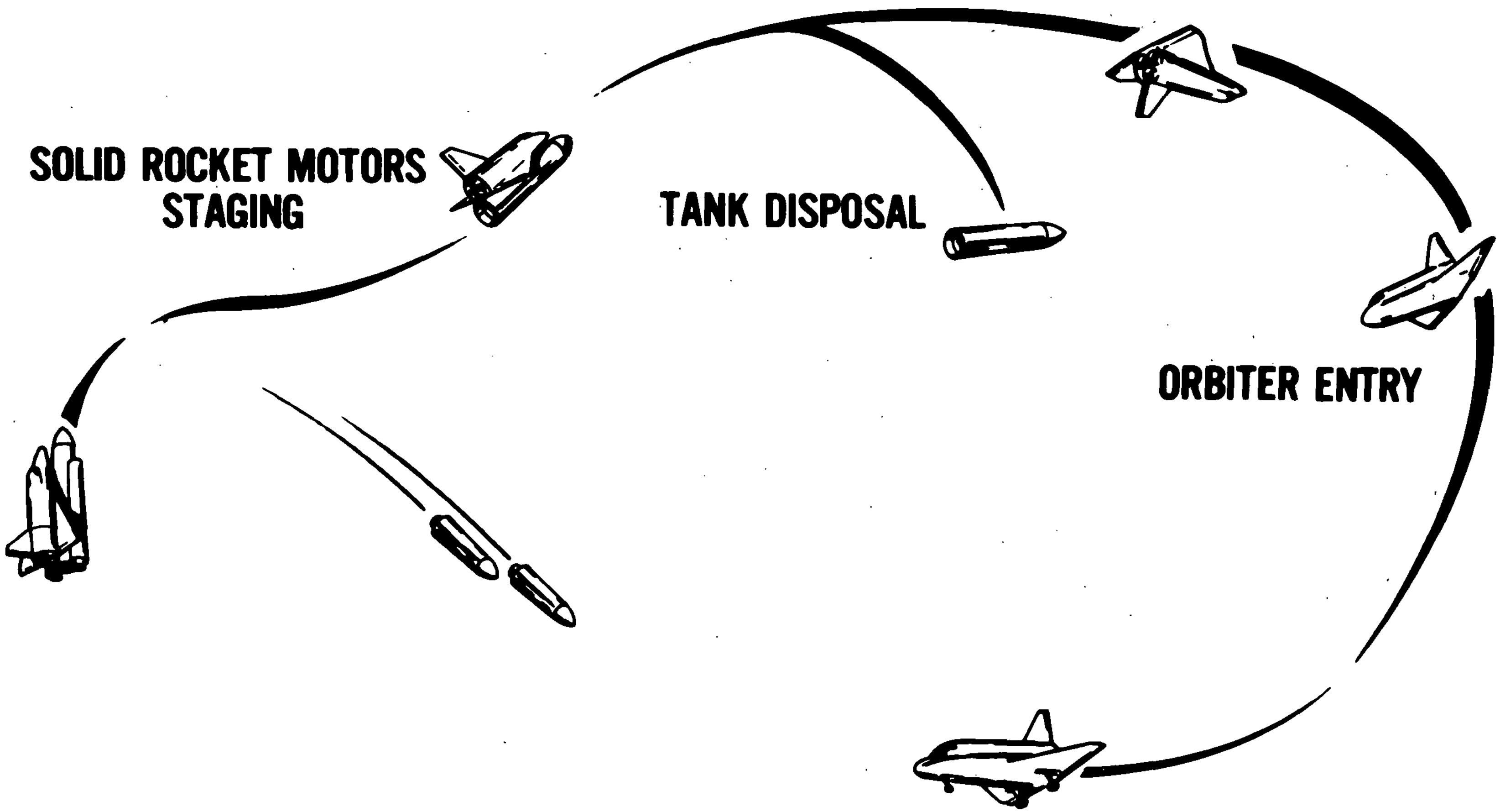
SPACE SHUTTLE

ROCKET ASSISTED ORBITAL SHUTTLE (RAO)

MISSION PROFILE



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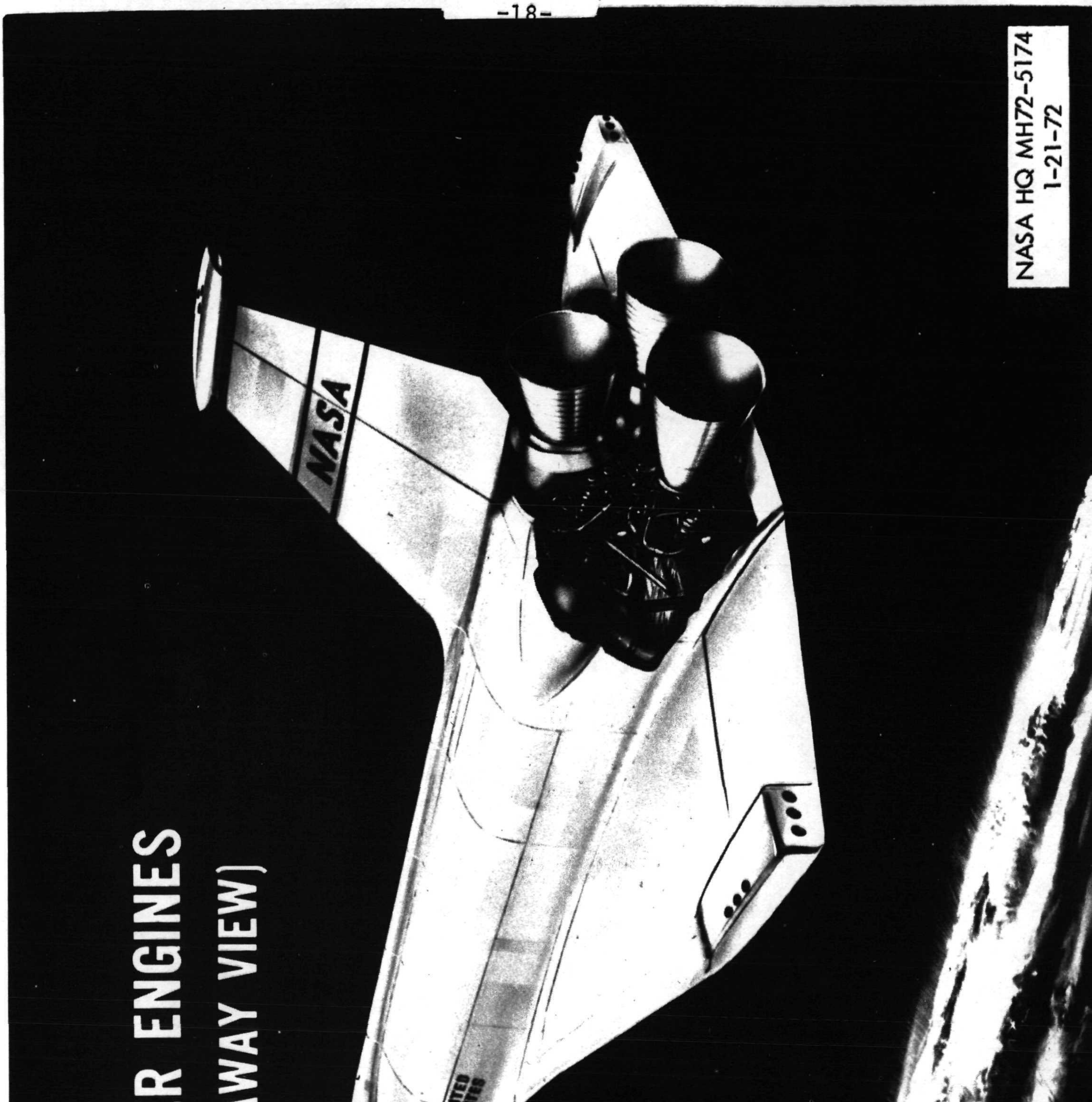
ORBITER ENGINES
(CUTAWAY VIEW)
NASA
UNITED STATES
NASA HQ MH72-5174
1-21-72

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SPACE TRANSPORTATION SYSTEM
SPACE SHUTTLE
SPACE APPLICATIONS
SPACE TUG
- high energy orbits -
EARTH SYNCHRONOUS
SATELLITES
SPACE SHUTTLE ORBITER
- low earth orbits -
NASA HQ MH72-5018
1-14-72

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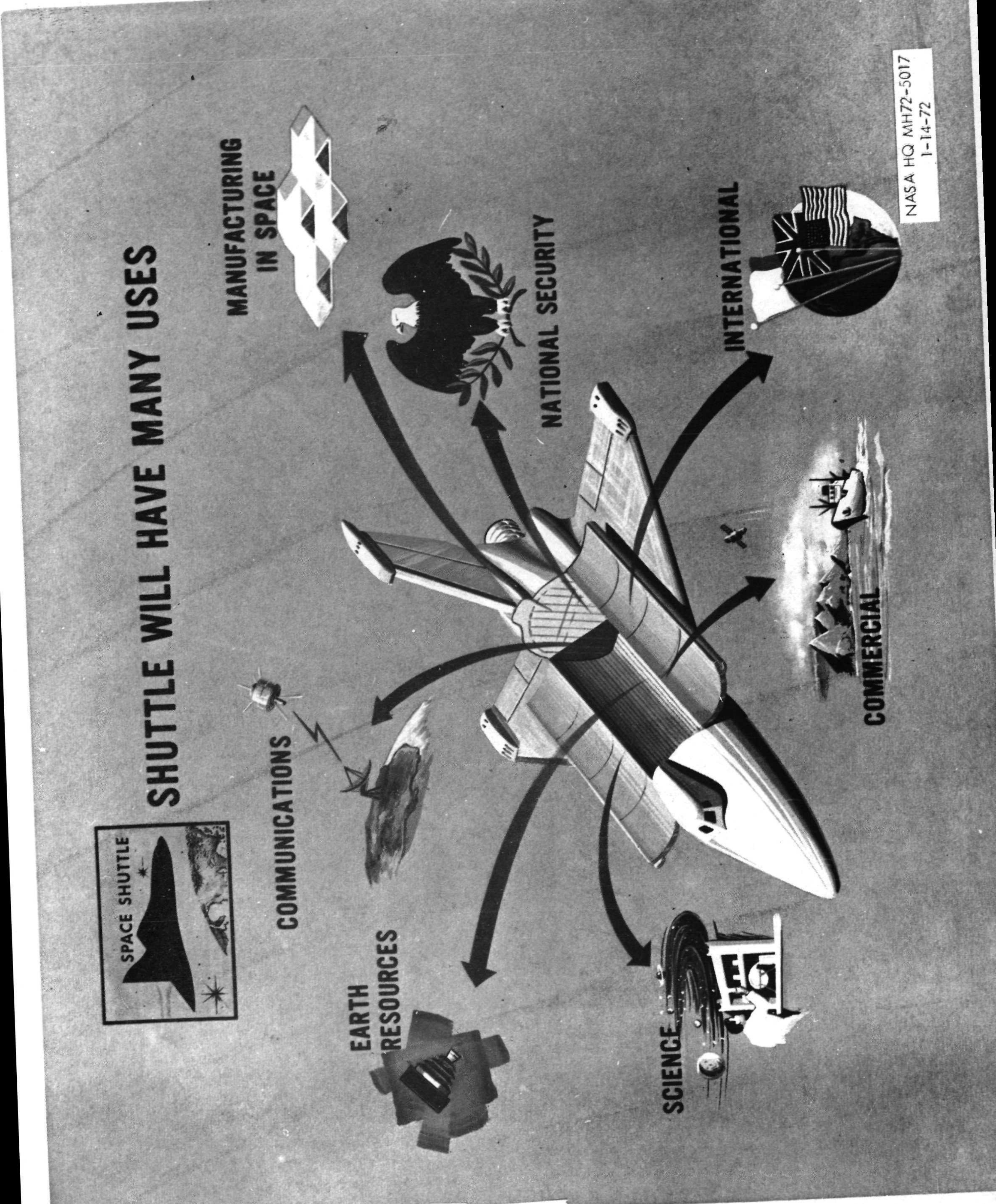
SHUTTLE WILL HAVE MANY USES
SPACE SHUTTLE
MANUFACTURING IN SPACE
NATIONAL SECURITY
INTERNATIONAL
COMMERCIAL
COMMUNICATIONS
EARTH RESOURCES
SCIENCE
NASA HQ MH72-5017
1-14-72

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