SHUTTLE PROGRAM STATUS

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FIGURE 1

The Space Transportation System consists of an earth-to-earth orbit Space Shuttle (a concept of the orbiter stage of the two stage system is depicted) and an orbit-to-orbit shuttle (a concept of the space tug is depicted). This status report today will be limited to the earth-to-earth orbit system.

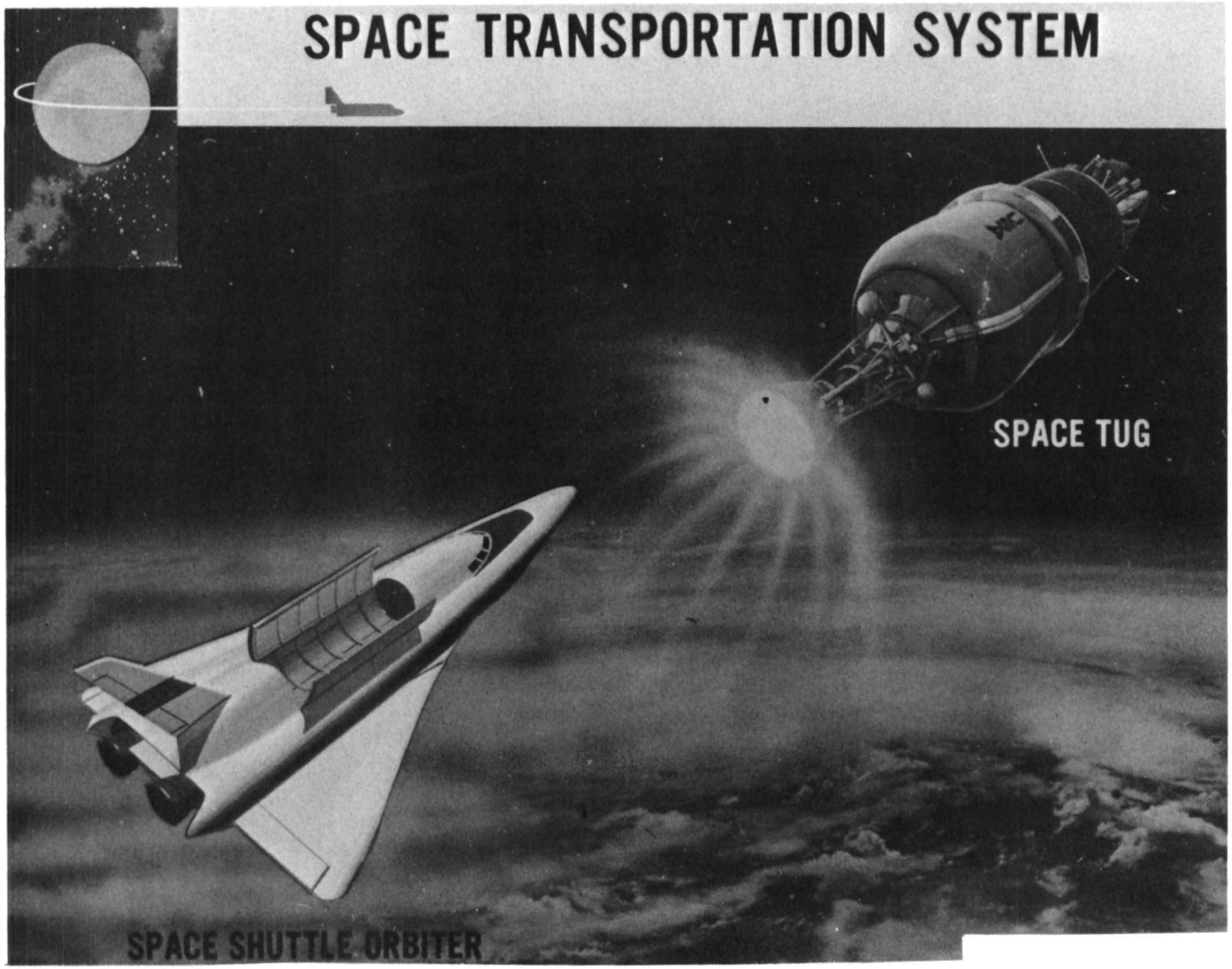
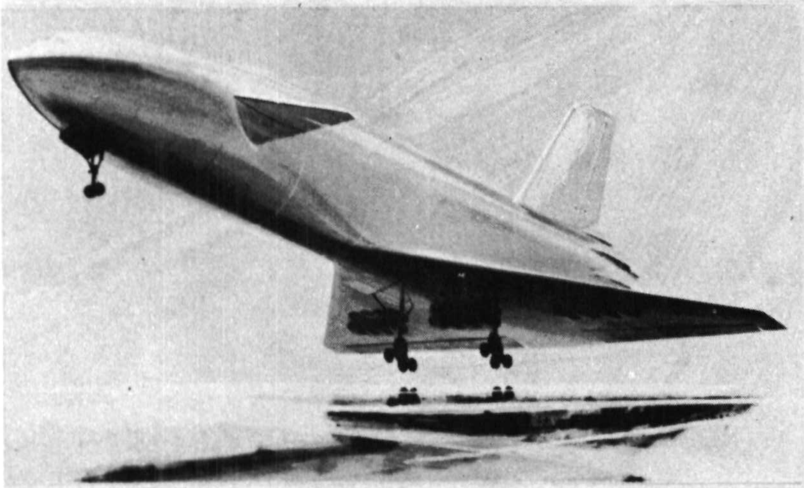

SPACE TRANSPORTATION SYSTEM
SPACE TUG
SPACE SHUTTLE ORBITER

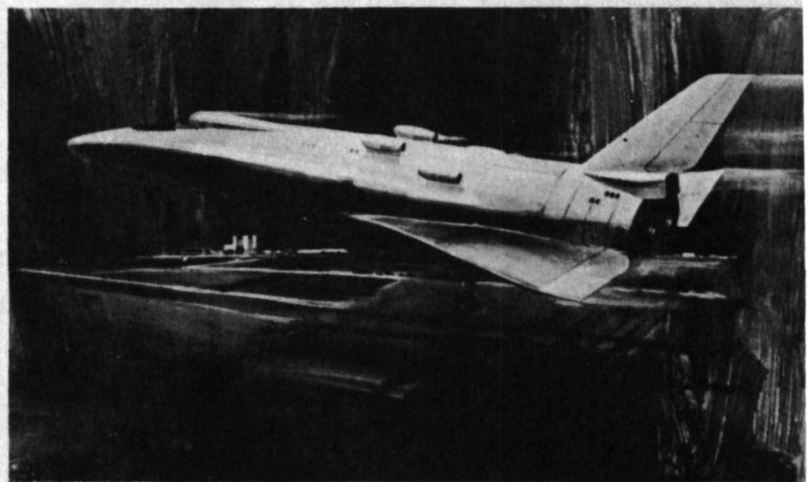
Figure 1

FIGURE 2

The principal objectives of the Space Shuttle Program are listed on this figure.

SPACE SHUTTLE





- REDUCE SUBSTANTIALLY COST OF SPACE OPERATIONS
- PROVIDE FUTURE CAPABILITY DESIGNED TO SUPPORT WIDE RANGE OF SCIENTIFIC, DEFENSE & COMMERCIAL USES

Figure 2

FIGURE 3

The earth-to-earth orbit Space Shuttle capabilities being utilized as a basis for system design are summarized on this figure. Of particular importance to payload designers is the ability to retrieve and to return satellites (or other payloads) from orbit to the earth's surface for refurbishment.

SPACE SHUTTLE CAPABILITIES

- SATELLITE PLACEMENT AND RETURN
- REPAIR AND SERVICE SATELLITES
- DELIVERY OF PROPULSIVE STAGE AND SATELLITE TO LOW EARTH ORBIT FOR TRANSFER TO SYNCHRONOUS ORBIT OR ESCAPE
- SHORT DURATION SCIENCE AND APPLICATION S MISSIONS
- RESEARCH LABORATORY
- SPACE RESCUE
- PROPELLANT DELIVERY
- SPACE STATION SUPPORT

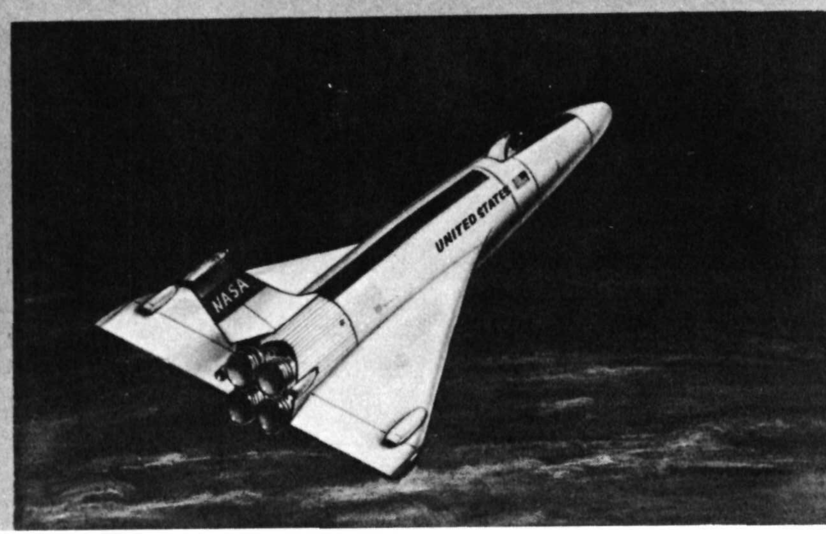


Figure 3

FIGURE 4

The classes of launch vehicles which are envisioned at this time to be replaced by the Space Shuttle are displayed in the shaded portion of this figure. The small Scout and the giant Saturn V are examples of launch vehicle payload and/or operational cost characteristics falling outside the competitive range of the Space Shuttle.

LAUNCH VEHICLE REPLACEMENT

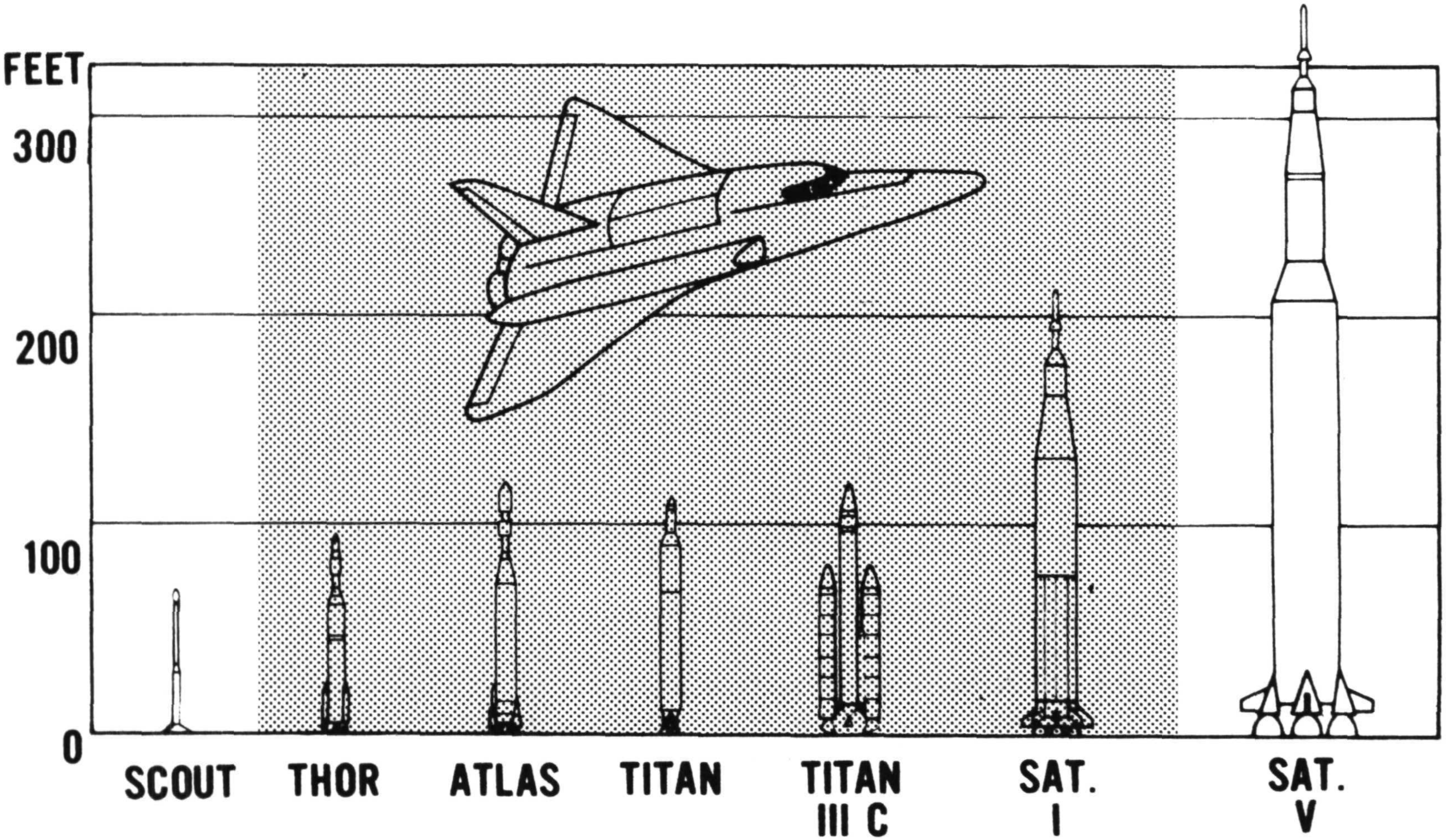


Figure 4

FIGURE 5

Space Shuttle studies have considered a wide variety of system configurations which are represented by the six comparative size outline drawings displayed on this figure. Chronologically, the figure should be read from right to left in that the system studies initiated in 1969 were based on "fully reusable" configurations with liquid oxygen and liquid hydrogen propellant tanks inside the orbiter. Later studies developed the advantage of reduced orbiter and booster size by tanking the hydrogen propellant external to the orbiter (the H_2 tank baseline configuration).

The concept of external tanking of propellants was extended to consider both hydrogen and oxygen (the HO tank concept) outside the orbiter. Concepts illustrating this configuration are shown in the two center drawings. The change in HO tank length (152' to 184') with change in booster configuration from the Reusable F-1 Flyback to Twin Pressure Fed for the same orbiter size is also shown.

Other concepts studied to develop data on smaller expendable systems are illustrated in the two drawings on the left (the Titan III L Glider and the Ballistic/Titan III M). The glider concept has no integral main propulsion system; orbital insertion is obtained through use of expendable booster and insertion stages. On the Titan III L the glider cargo bay would be 12' diameter by 40' long compared to 15' diameter by 60' long for the configurations shown to the right of the glider. The Ballistic/III M is a manned spacecraft of the "big" Gemini concept having limited capability compared to the other concepts illustrated. The Ballistic/T III M was studied to develop its characteristics for comparison with the larger systems.

Four space shuttle system configurations characterized by the two center illustrations (Twin Pressure Fed and Reusable F-1 Flyback) are under active study today. The following illustrations provide more detail on the orbiter and the four system configurations:

(1) Reusable F-1 Flyback Booster (series burn)

(2) Pressure Fed Recoverable Booster (series burn)

(3) Twin Pressure Fed Booster (parallel burn)

(4) Twin Solid Rocket Motors (parallel burn).

REPRESENTATIVE ALTERNATE TRANSPORTATION SYSTEMS

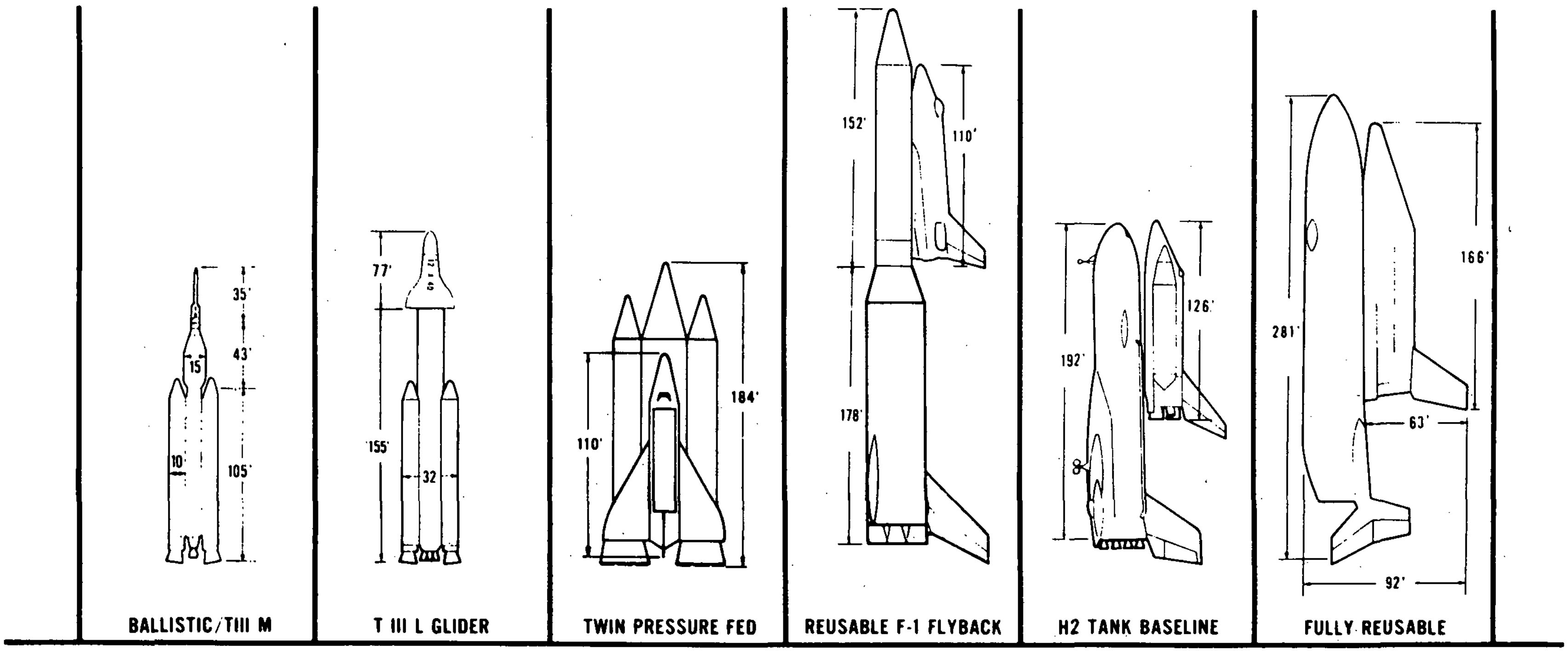
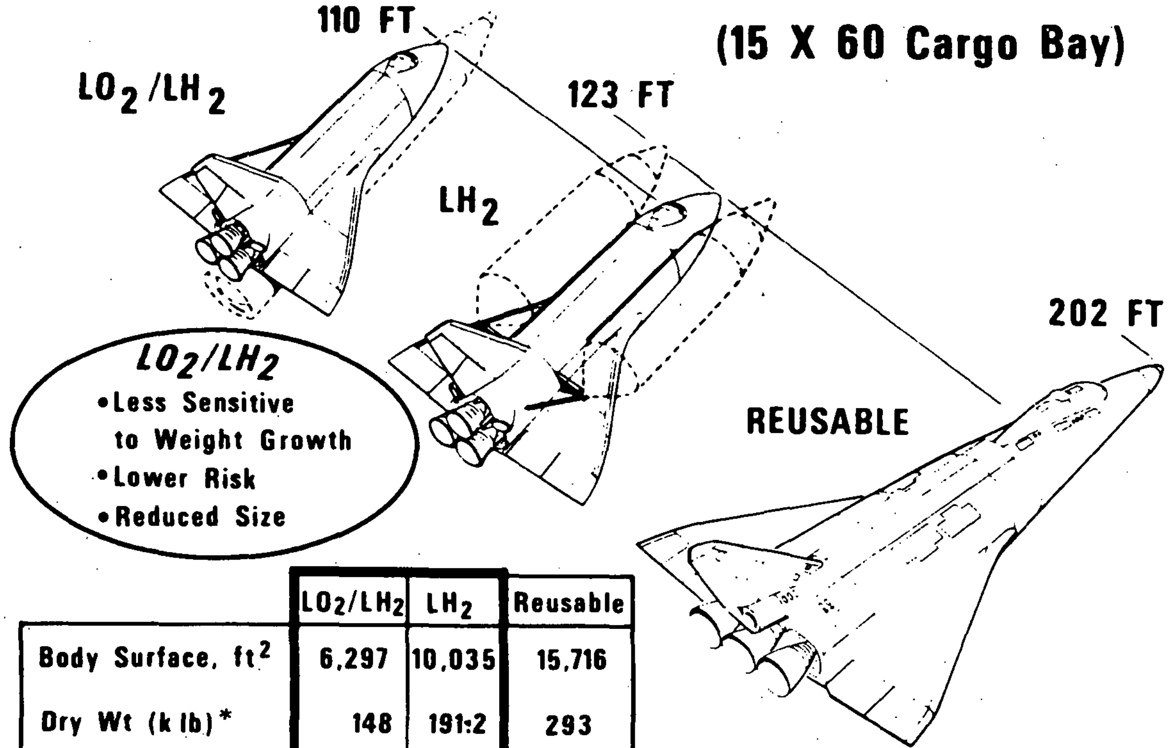


Figure 5

FIGURE 6

Reduction in Space Shuttle orbiter length, body surface area, dry weight, and rocket engine thrust level with change in system configuration from fully reusable to external liquid hydrogen (LH_2) tanks to external liquid oxygen/liquid hydrogen tank (LO_2/LH_2) is shown in this illustration. The advantages of the LO_2/LH_2 configuration compared to the other concepts are summarized in the elliptical box in the left center. It appears at this time that the orbiter configuration is settling on the LO_2/LH_2 concept.

ORBITER COMPARISON



	LO_2/LH_2	LH_2	Reusable
Body Surface, ft^2	6,297	10,035	15,716
Dry Wt (k lb)*	148	191.2	293
3 Hi-Pc-F_{vac} Eng (k lb)	420	447.5	551

*Less Tanks & Payload

Figure 6

FIGURE 7

Features of the LO_2/LH_2 orbiter are illustrated.

SPACE SHUTTLE ORBITER

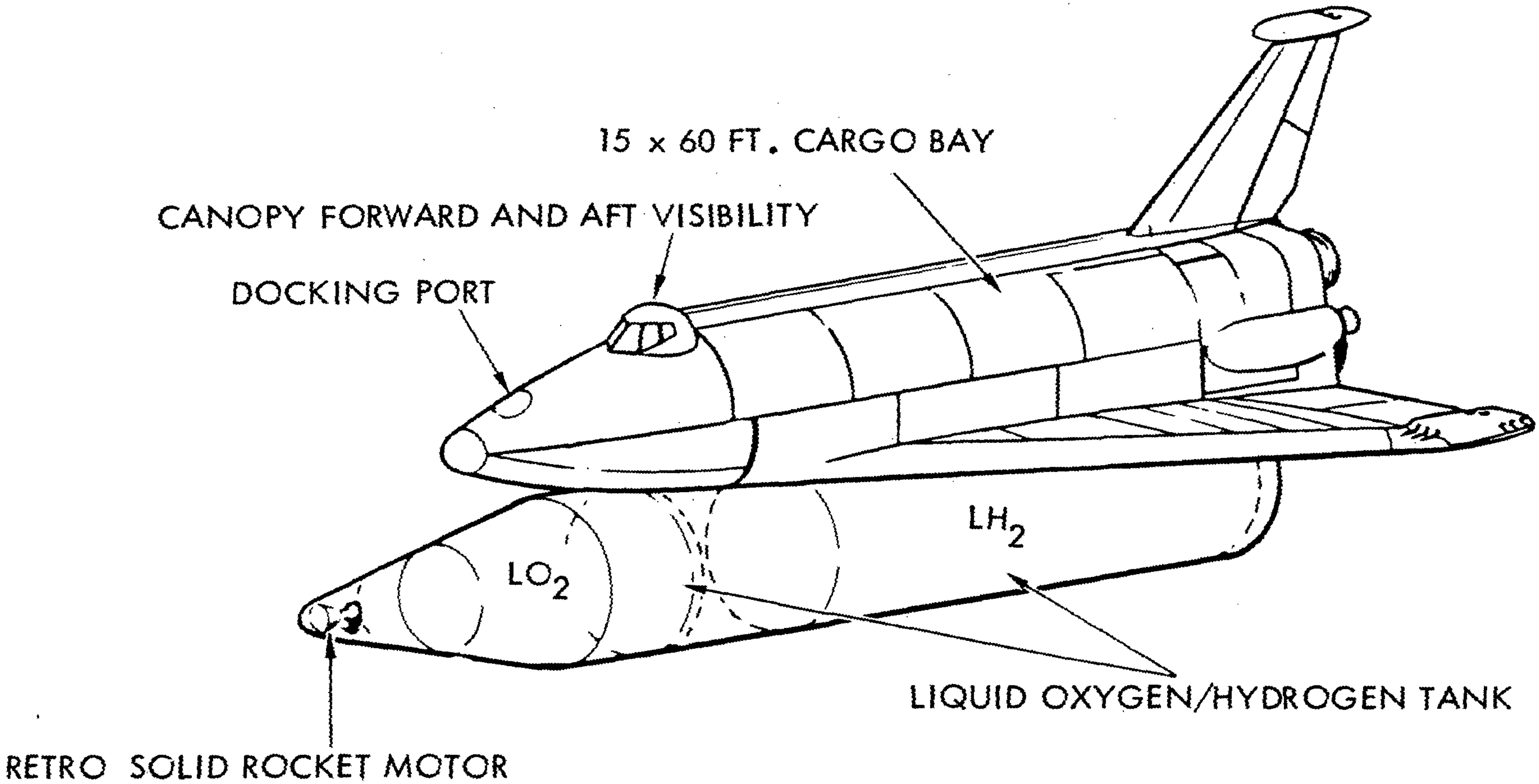


Figure 7

FIGURE 8

Highlights of system configuration of the Reusable F-1 Flyback Booster based on the Saturn V S-IC stage are shown. The crew cabin, canard, and ballast tanks are forward and a "stretched" intertank section accommodates wing attachment and air breathing jet engines for flyback.

SHUTTLE WITH REUSABLE F-1 FLYBACK BOOSTER

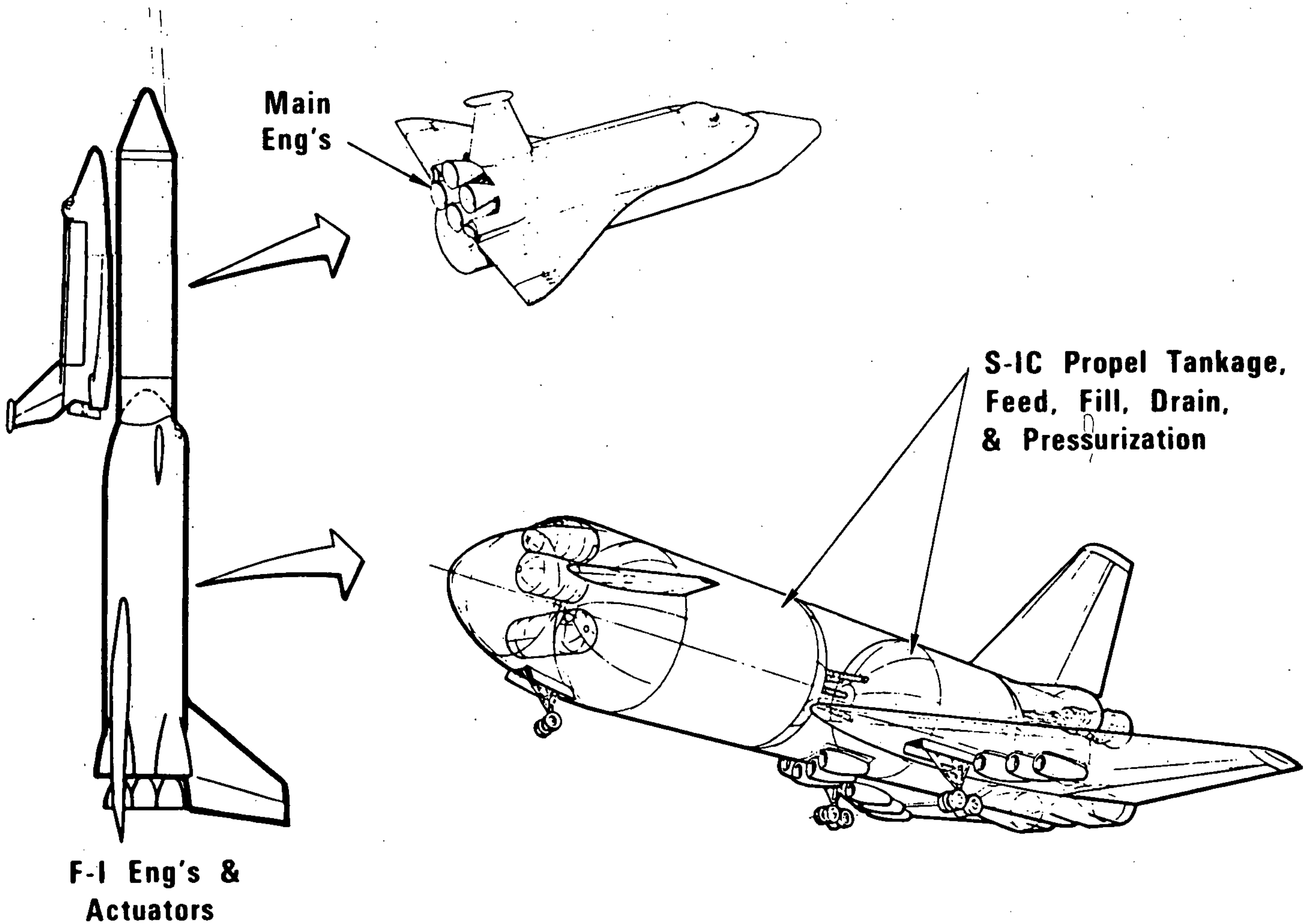


Figure 8

FIGURE 9

A summary mission profile of the F-1 Flyback Space Shuttle indicates LO_2/LH_2 tank disposal following orbital insertion. Deorbit of the tank is planned for all missions for the middle of the Indian Ocean.

SPACE SHUTTLE MISSION PROFILE

(F-1 FLYBACK)

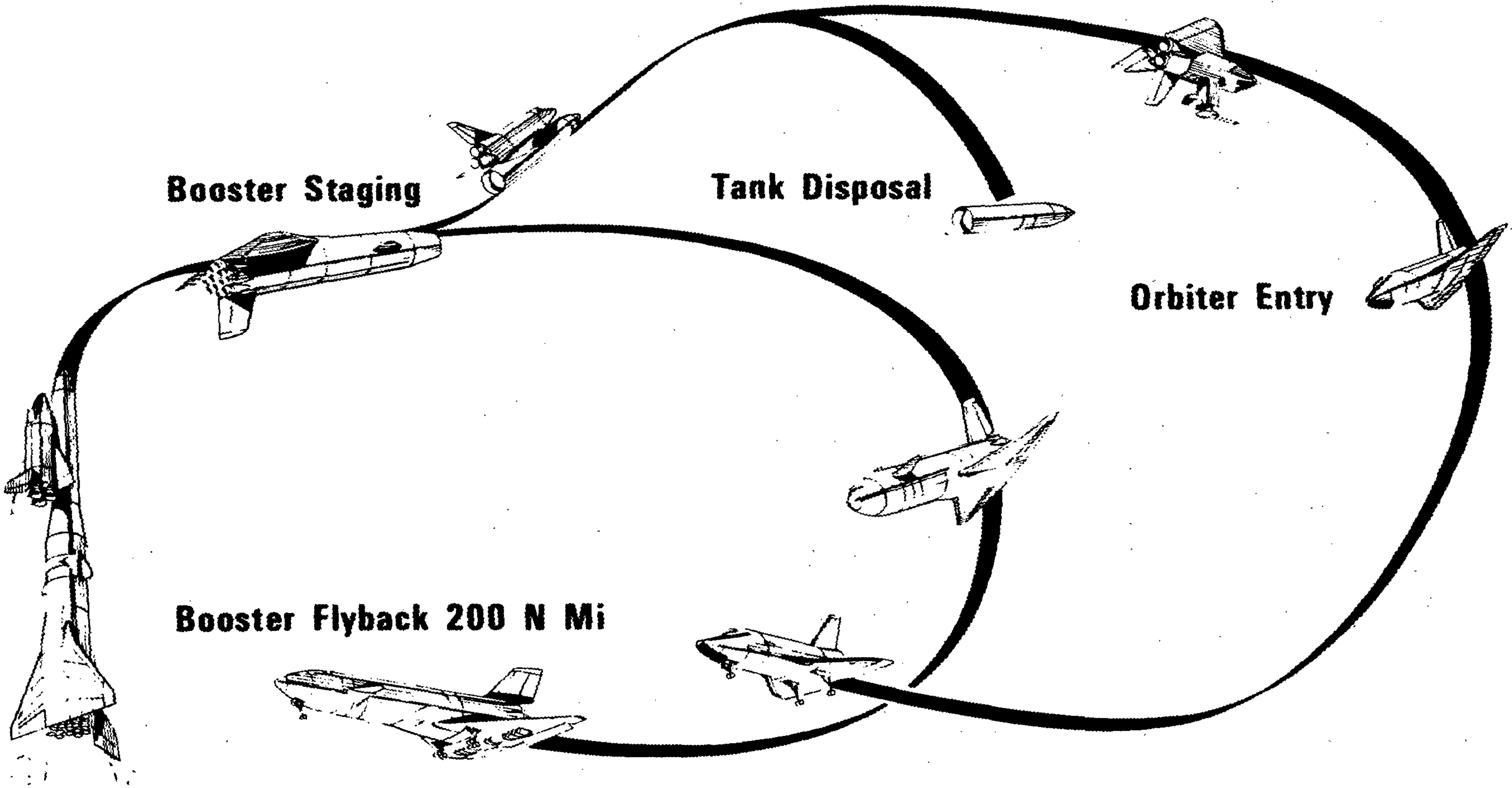


Figure 9

FIGURE 10

Highlights of systems configuration of the Pressure Fed Recoverable Booster based on use of Inconel 718 for corrosion resistance is shown. Aluminium is also being considered as the main structural material. This concept, like the Reusable F-1 Flyback, is burned in a series manner, i.e., only the booster engines are started at liftoff and burned to shutdown and staging when the orbiter engines are started.

SHUTTLE WITH PRESSURE FED RECOVERABLE BOOSTER

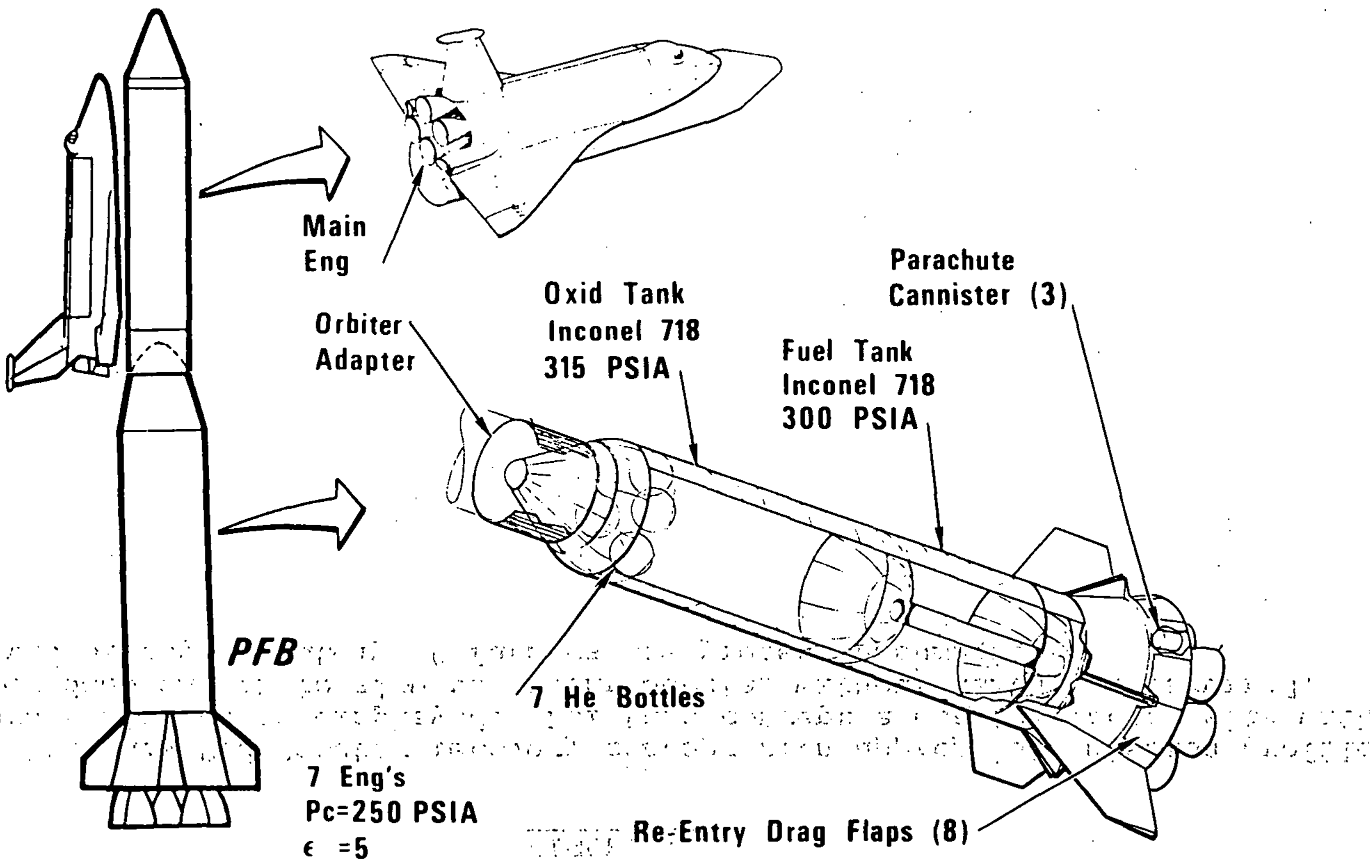


Figure 10

FIGURE 11

The Pressure Fed Booster recovery concept with appropriate mission profile characteristics is displayed. For this concept a coastal launch site with water deep enough to slow the spent booster without damage is required. Depths of approximately 20 fathoms are present assumptions.

PRESSURE FED BOOSTER RECOVERY CONCEPT

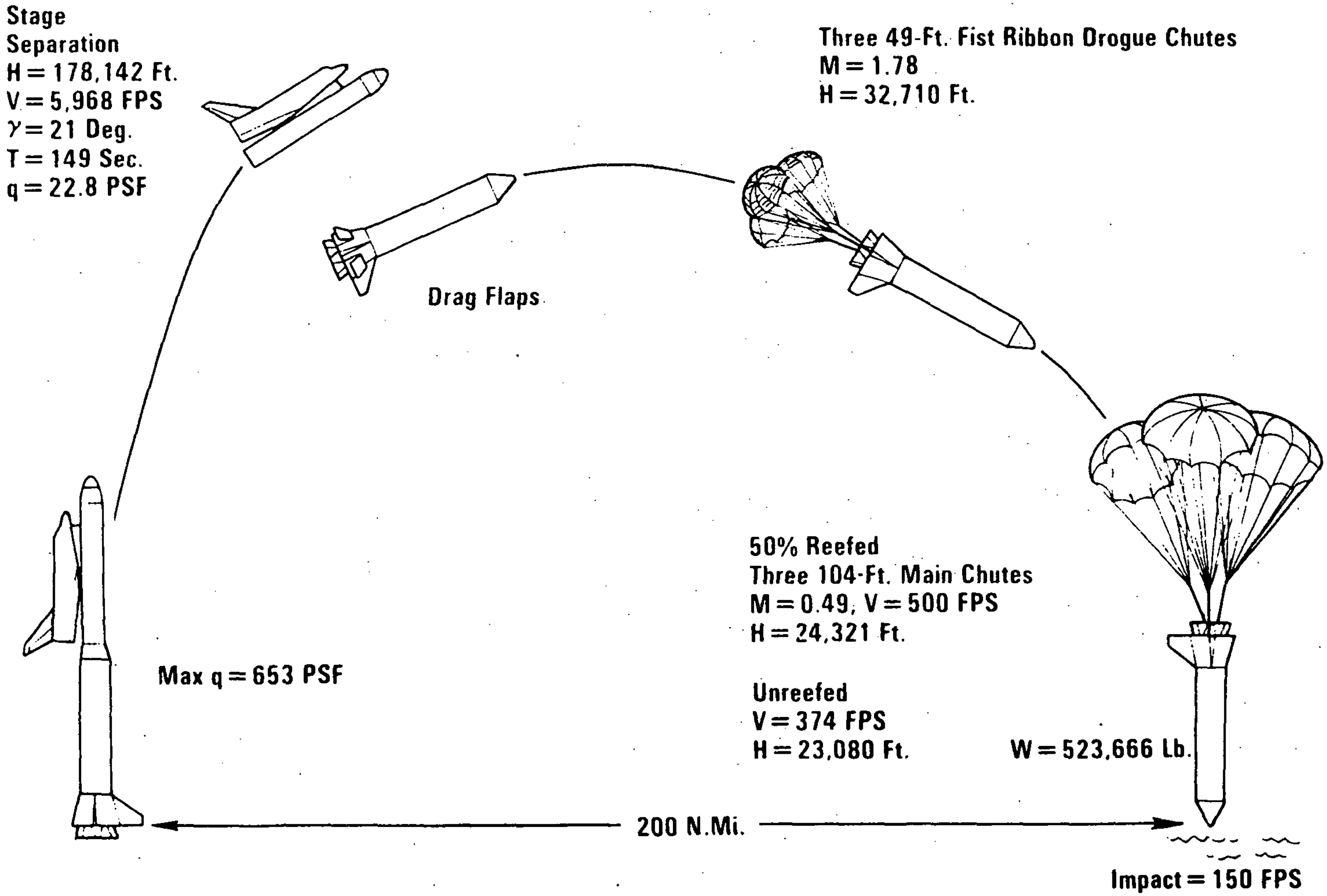


Figure 11

FIGURE 12

The third configuration presently being studied, Shuttle with Twin Pressure Fed Booster, is shown in an artist's concept. The orbiter and booster engines are started for liftoff for a parallel burn to approximately 6000 feet per second staging velocity. Each twin booster element would be recovered in a manner similar to that of the single pressure-fed booster stage.

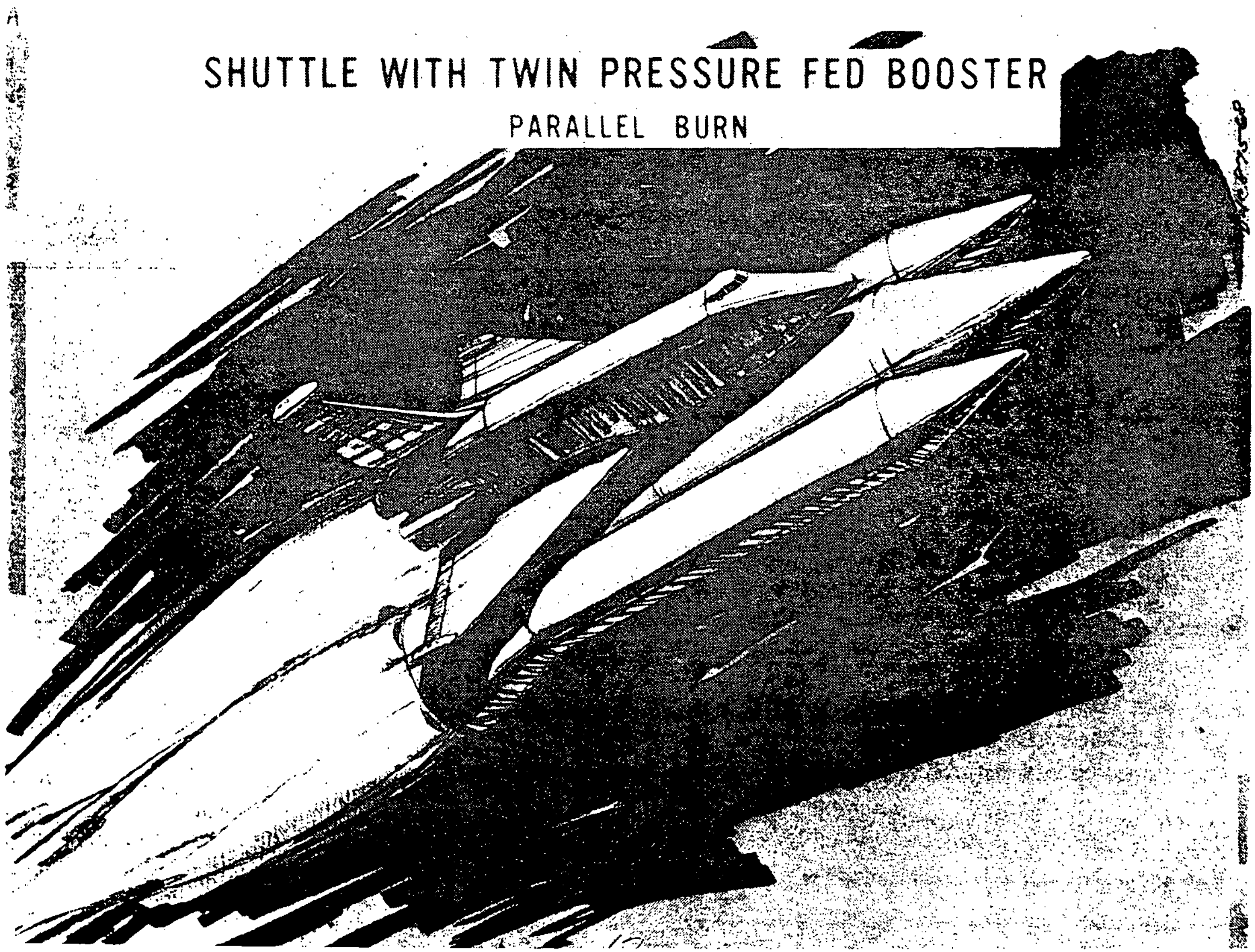


Figure 12

FIGURE 13

The fourth concept is similar to the twin pressure fed concept except the twin booster stages are solid rocket motors (SRM's). In this illustration twin 156 in SRM's are shown.

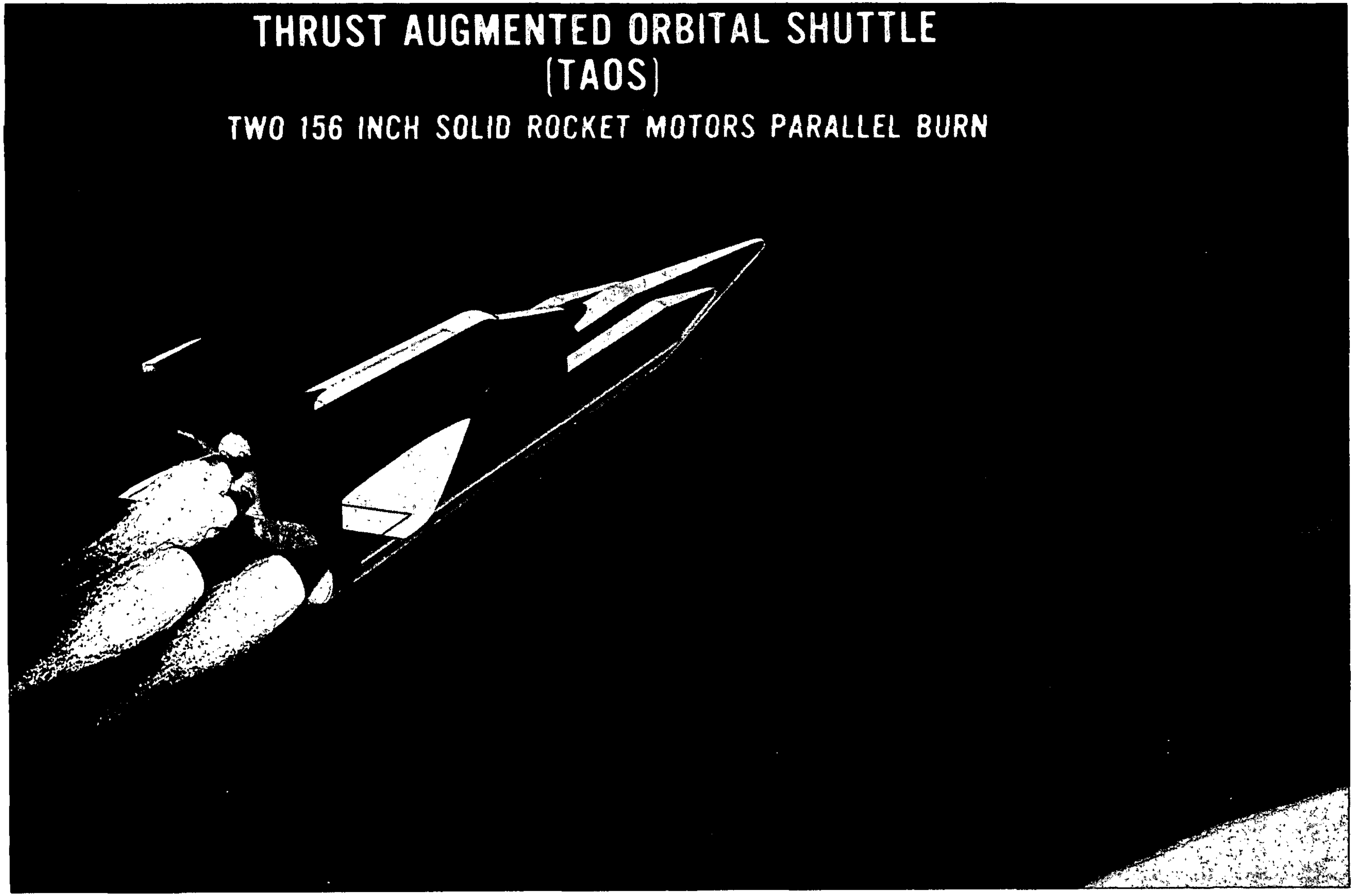

THRUST AUGMENTED ORBITAL SHUTTLE
(TAOS)
TWO 156 INCH SOLID ROCKET MOTORS PARALLEL BURN

Figure 13

<u>FIGURE 14</u>

The mission profile of the twin solid rocket motor (SRM) shuttle indicates that recovery and reuse of the spent SRM's is not contemplated. Water or land impact of the SRM's in areas where injury or property damage is highly unlikely would be acceptable. LO_2/LH_2 tank disposal in the Indian Ocean is the same as in other concepts.

THRUST AUGMENTED ORBITAL SHUTTLE (TAOS) MISSION PROFILE

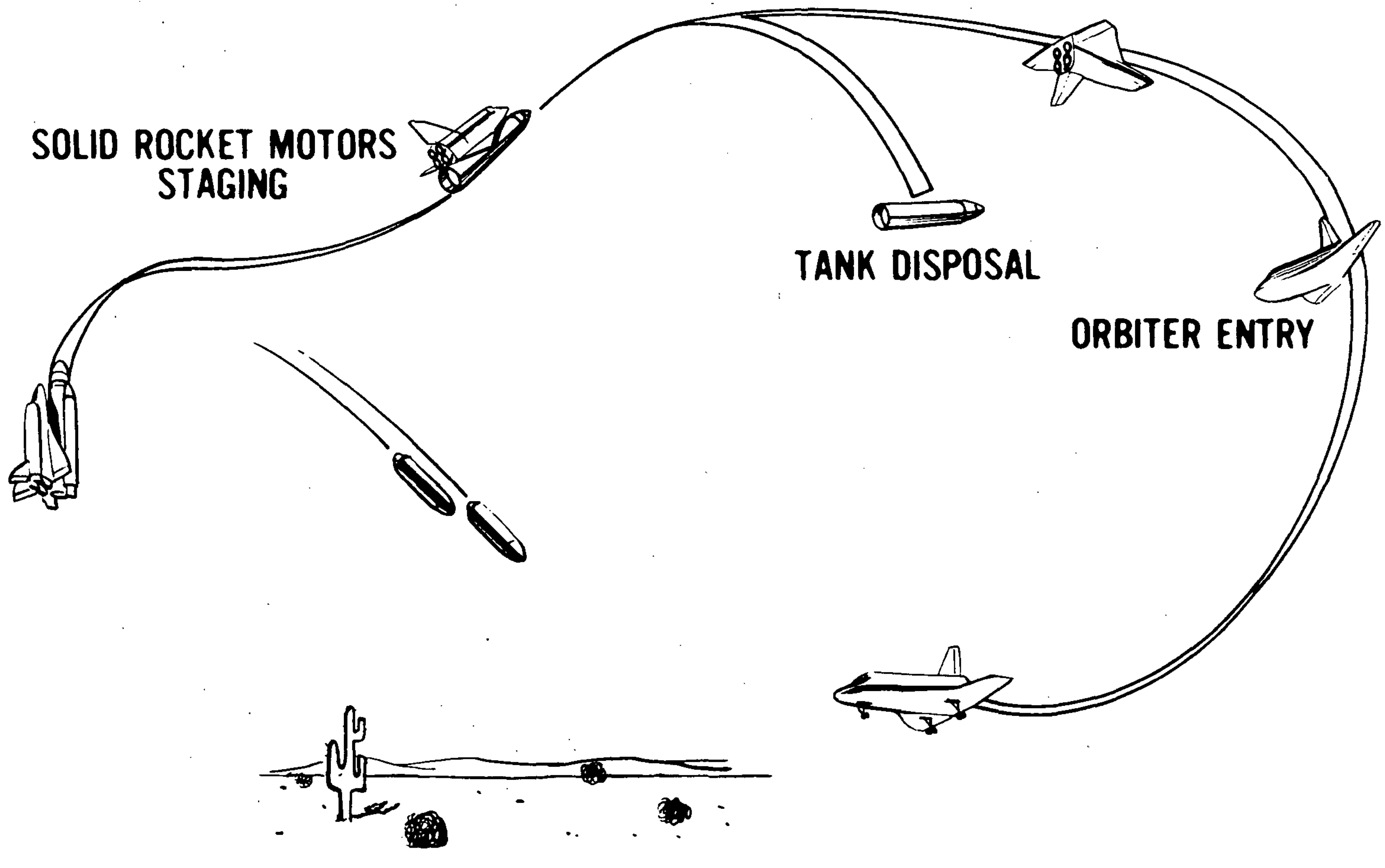
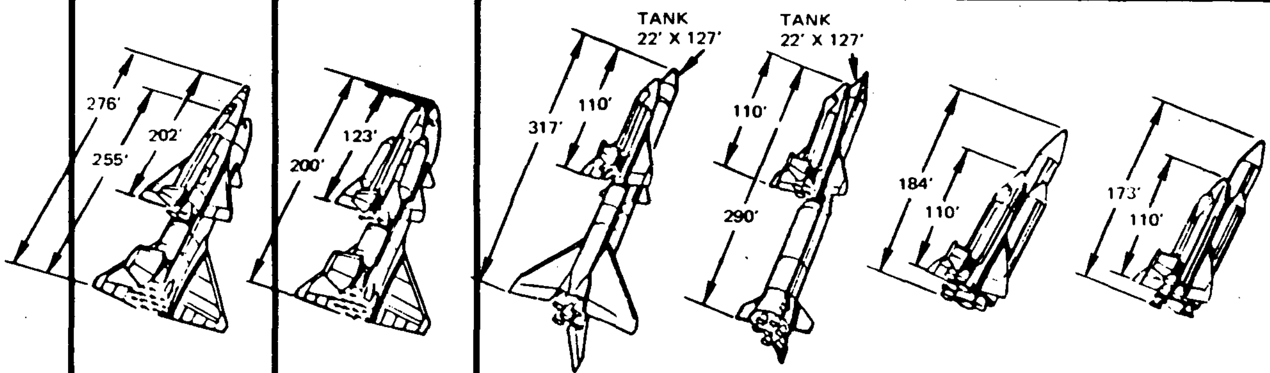


Figure 14

FIGURE 15

Comparison of the current design study concepts with the fully reusable and the H_2 tank baseline designs is made for equal payload into a 100 X 100 nautical mile polar orbit.

SPACE SHUTTLE COMPARISON



	FULLY REUSABLE	H_2 TANK BASELINE	CURRENT DESIGN STUDIES			
BOOSTER	REUSABLE	REUSABLE	F-1 REUSABLE	PF RECOVERABLE	TWIN PRESS.FED	156 IN. DIA SRM (AUGM)
BURN MODE	SERIES	SERIES	SERIES	SERIES	PARALLEL	PARALLEL
STAGING VELOCITY (FPS)	10,832	6838	6000	5968	6,216	4,369
SYSTEM GLOW (KLB)	5,047	3593	5090	5253	5,830	4,560
SYSTEM DRY WT (KLB)	850	604	790	691	686	607
ORBITER/BOOSTER DRY (KLB)	223/627	191/393	148/584	148/487	130/482	127/372
TANK DRY WT (KLB)	-	20	58	56	74	108
POLAR PAYLOAD (KLB)	40.0	40.0	40.8	40.0	40.0	40.0

Figure 15

FIGURE 16

A comparison of Space Shuttle estimated development costs in billions of 1970 dollars with the estimated cost per flight in millions of 1970 dollars is shown, except for the Ballistic/T III M, for the concepts illustrated in Figure 5 and the four current design studies.

SPACE SHUTTLE COST COMPARISON

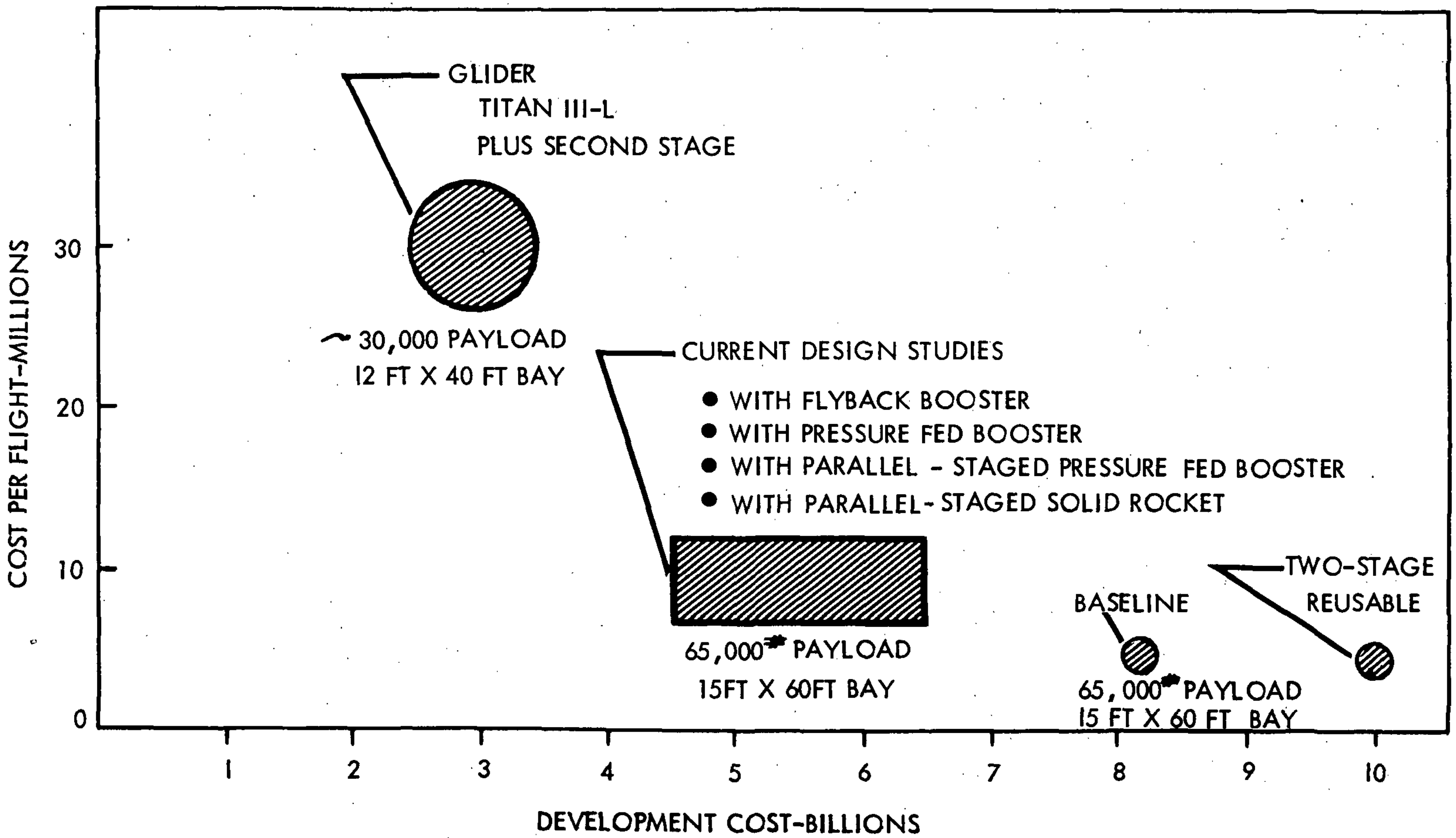


Figure 16

<u>FIGURE 17</u>

The Space Shuttle Program study schedule depicts the activities leading to the data reviews being held in Washington, D.C. today and tomorrow. Based on decisions made in late December 1971 and January 1972, the RFP for systems preliminary design and development (Phases C/D) could be released as early as March 1, 1972, with design/development to start as early as July 1, 1972.

SPACE SHUTTLE PROGRAM
(1970–1972)

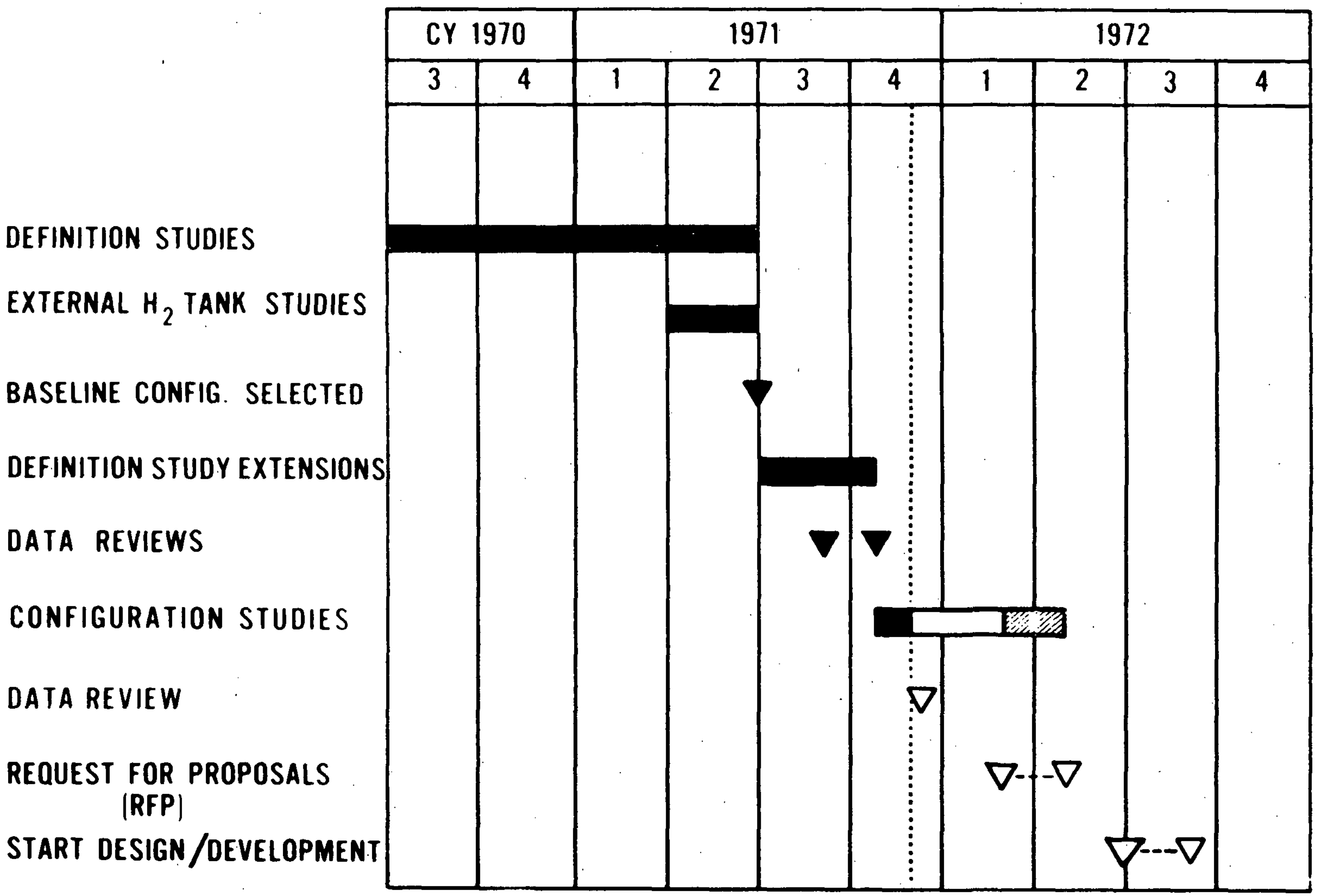


Figure 17

FIGURE 18

The major Space Shuttle development milestones indicate that start of design and development in 1972 will support beginning of the horizontal flight test program in 1976 and the first manned orbital flight in 1978.

SPACE SHUTTLE DEVELOPMENT SCHEDULE

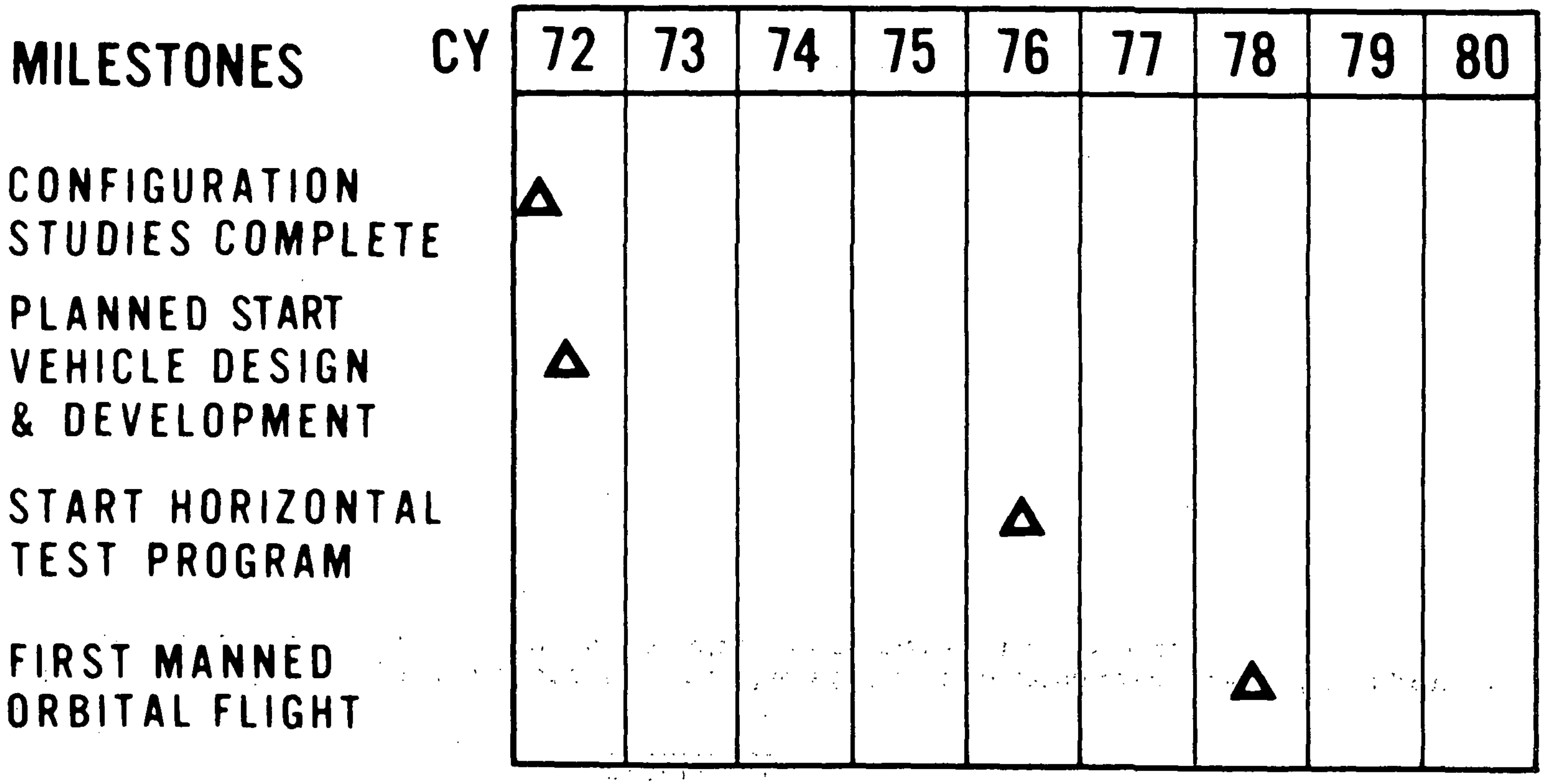


Figure 18

FIGURE 19

As a summation of present status, the benefits of a reusable space transportation system which the current design studies encompass are listed.

BENEFITS OF REUSABLE SPACE TRANSPORTATION

- DIRECT COST REDUCTIONS
- EASY ACCESS TO SPACE
- SCIENTIFIC PROGRESS
- NATIONAL SECURITY
- TECHNOLOGICAL PROGRESS
- INDUSTRY CAPABILITY
- MERGER OF MANNED AND UNMANNED SPACE FLIGHT
- CONTINUATION OF MANNED SPACE FLIGHT
- FOREIGN SALES -- IMPACT ON BALANCE OF OF PAYMENTS
- RAPID INTRODUCTION OF NEW SPACE USES
- STIMULATION OF SPACE USES NOW UNFORESEEN
- CAPABILITY TO RESPOND TO INTERNATIONAL COMPETITION
- POTENTIAL FOR INTERNATIONAL COOPERATION

Figure 19