SPACELY'S ROCKETS—PERSONNEL LAUNCH SYSTEM/FAMILY OF HEAVY LIFT LAUNCH VEHICLES

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THE UNIVERSITY OF TEXAS, AUSTIN

INTRODUCTION

During 1990, numerous questions were raised regarding the ability of the current shuttle orbiter to provide reliable, on-demand support of the planned space station. Besides being plagued by reliability problems, the shuttle lacks the ability to launch some of the heavy payloads required for future space exploration, and is too expensive to operate as a mere passenger ferry to orbit. Therefore, additional launch systems are required to complement the shuttle in a more robust and capable Space Transportation System.

In December 1990, the Report of the Advisory Committee on the Future of the U.S. Space Program, headed by Norm Augustine, advised NASA of the risks of becoming too dependant on the space shuttle as an all-purpose vehicle. Furthermore, the committee felt that reducing the number of shuttle missions would prolong the life of the existing fleet. In their suggestions, the board members strongly advocated the establishment of a fleet of unmanned, heavy lift launch vehicles (HLLVs) to support the space station and other payload-intensive enterprises.

Another committee recommendation was that a space station crew rotation/rescue vehicle be developed as an alternative to the shuttle, or as a contingency if the shuttle is not available. The committee emphasized that this vehicle be designed for use as a personnel carrier, not a cargo carrier. This recommendation was made to avoid building another version of the existing shuttle, which is not ideally suited as a passenger vehicle only.

The objective of this project was to design both a Personnel Launch System (PLS) and a family of HLLVs that provide low-cost and efficient operation in missions not suited for the shuttle.

PERSONNEL LAUNCH SYSTEM DESIGN

The PLS vehicle is designed primarily for space station crew rotation and emergency crew return. Therefore, a nominal complement of eight passengers is provided for. Studies have indicated that a small, reusable, lifting-body spacecraft can operate at greater cost effectiveness, reliability, and safety than the shuttle. The personnel vehicle is carried into low Earth orbit by a partially reusable, man-rated version of the heavy lift vehicles codesigned in this project.

The final design of the PLS vehicle is depicted in Fig. 1. It has an overall length of 36 ft and an overall width of 27 ft. The weight of this vehicle is 30,000 lb. The vehicle has provisions for eight passengers and a flight crew of two for a maximum mission duration of three days.

The interior of the craft is shown in Fig. 2. Although it is meant to be a payload-intensive vehicle, the PLS is designed to carry a minimum of space station resupply with specific cargo area designed into the craft. More cargo area can be gained by removing the passenger seats when the PLS vehicle does not have a full crew complement.

The PLS vehicle is designed to be boosted into orbit by launching it serially from a man-rated rocket. To ensure crew safety during ascent, the final design provides for an on-pad abort, as well as an abort during ascent if an emergency situation arises.

HEAVY LIFT LAUNCH VEHICLE DESIGN

The mission of the family of HLLVs is to place large, massive payloads into Earth orbit with payload flexibility being considered foremost in the design. Because of this concern, the final design of three launch vehicles was found to yield a payload capacity range from 20 Mt to 200 Mt. These designs include the use of multistaged, high-thrust liquid engines mounted on the core stages of the rocket. Payload flexibility is provided by the use of multiple strap-on solid rocket boosters. The final design of the FHLLV project consists of three basic configurations: the SR-1, the SR-2, and the SR-3. These vehicles are shown in comparison in Fig. 3.

The SR-1 is the smallest vehicle in the launch vehicle family. It has a payload capacity of 20–95 Mt depending on the number of SRBs used, and whether or not a second stage is employed. Figure 4 illustrates the basic dimensions of the SR-1 in the 72-Mt configuration. This configuration employs two SRBs and the second stage. The SR-1 can mount two or four SRBs as required to increase the payload capacity.

The first stage of the all-liquid-propelled core utilizes three SSME-35s for propulsion, and is a cylindrical structure that houses the oxidizer and fuel for the first stage in separate tanks. The first stage is 31 ft in diameter and 149 ft tall. The second stage of the SR-1 relies on two unmodified SSMEs for thrust. It has a diameter of 24 ft and a length of 82 ft without the payload shroud. Overall, the SR-1 stands 357 ft tall, and has a width of nearly 70 ft. The gross lift-off weight and stage dimensions for the SR-1 are shown in Fig. 4.

The SR-2 is the medium capacity vehicle in the launch vehicle family. It has a payload capacity of 40–150 Mt depending on the number of SRBs used and whether or not the second stage is employed. Figure 5 illustrates the basic dimensions of the SR-2 in the 100-Mt configuration. This configuration employs

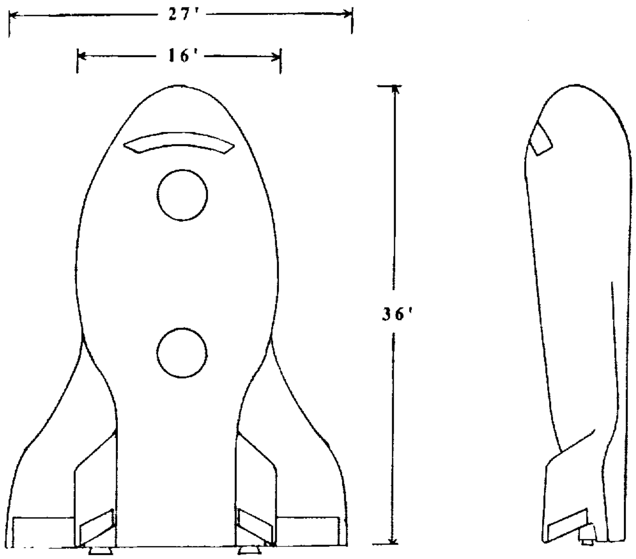

Fig. 1. PLS exterior concept.

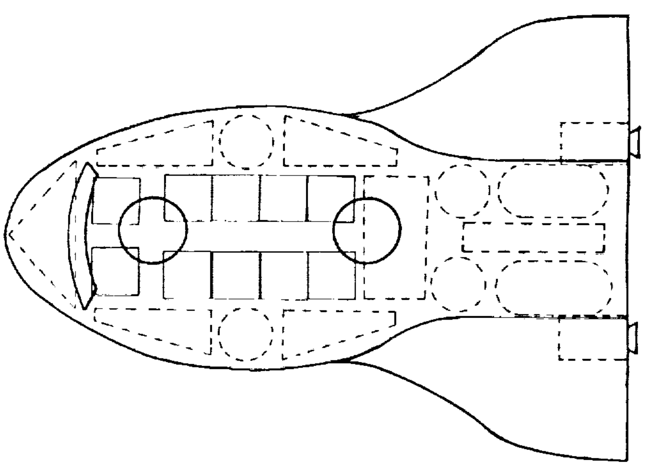

Fig. 2. The interior diagram of the PLS.

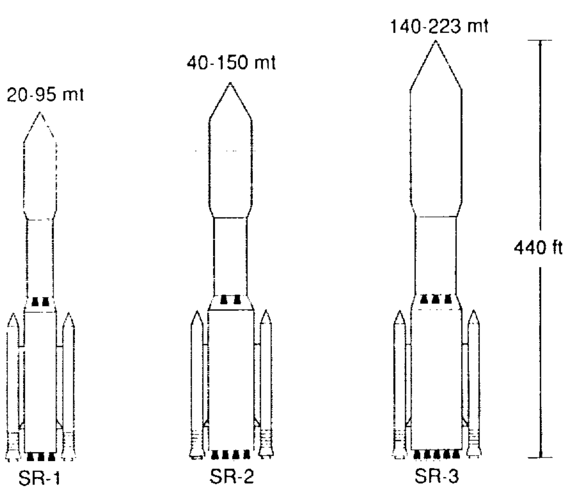

Fig. 3. Launch vehicle family.

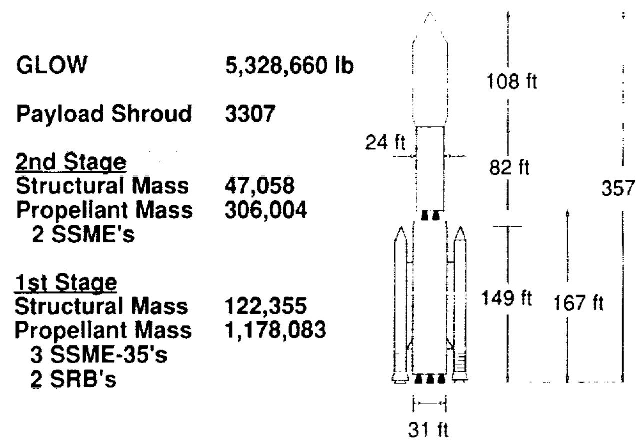

Fig. 4. The SR-1 launch vehicle.

two SRBs and the second stage. The SR-2 can employ two, four, or six SRBs as required to increase the payload capacity.

The first stage of the all-liquid-propelled core utilizes five SSME-35s for propulsion and is 40 ft in diameter and 149 ft tall. The second stage of the SR-2 relies on two or three unmodified SSMEs as needed for thrust. The second stage has a diameter of 31 ft and a length of 82 ft without the payload shroud. Overall, the SR-2 stands 384 ft tall, and has a width of nearly 76 ft. The gross lift-off weight and stage weights for the SR-2 are shown in Fig. 5.

The SR-3 is the largest vehicle in the launch vehicle family. It has a payload capacity of 140–200 Mt depending on the number of SRBs used. Figure 6 illustrates the basic dimensions of the SR-3 in the 200-Mt configuration. This configuration employs six SRBs. The SR-3 can mount two, four, six, or eight SRBs as required to increase the payload capacity.

The first stage of the all-liquid-propelled core utilizes eight SSME-35s for propulsion. It is 50 ft in diameter and 149 ft tall. The second stage relies on two or three unmodified SSMEs as needed for thrust; it has a diameter of 40 ft and a length of 82 ft without the payload shroud. Overall, the SR-3 stands 440 ft tall, and has a width of nearly 86 ft. The gross lift-off weight and stage weights for the SR-3 are shown in Fig. 6.

Both the PLS and family of HLLV systems designed by Spacely's Rockets fit neatly into the planned evolution of the U.S. space program. The PLS, if actually constructed, would provide more efficient manned access to space on a routine schedule of flights. This in turn, alleviates fears that the Space Station *Freedom* will be built without a guaranteed crew return vehicle. The construction of the family of heavy lift launch vehicles would give the U.S. unprecedented launch capacity for any program being pursued, and potentially provide the inexpensive commercial access to space. Thus, the hopes of the Space Exploration Initiative and other projects can be realized by finally having a heavy lift system available.

GLOW	5,496,064 lb
Payload Shroud	6,614
<u>2nd Stage</u>	
Structural Mass	78,446
Propellant Mass	509,915
2 SSME's	
<u>1st Stage</u>	
Structural Mass	203,925
Propellant Mass	1,963,472
5 SSME-35's	
2 SRB's	

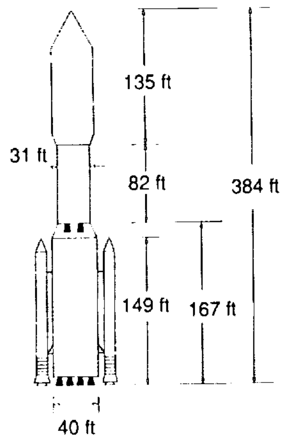

Fig. 5. SR-2 launch vehicle.

GLOW	12,399,460 lb
Payload Shroud	11,023
<u>2nd Stage</u>	
Structural Mass	125,662
Propellant Mass	817,702
3 SSME's	
<u>1st Stage</u>	
Structural Mass	326,281
Propellant Mass	3,141,555
8 SSME-35's	
6 SRB's	

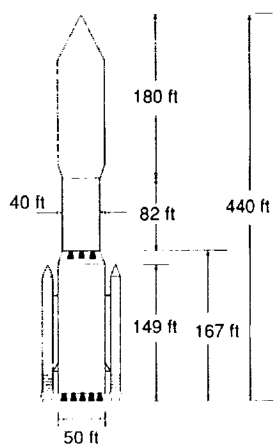

Fig. 6. The SR-3 launch vehicle.