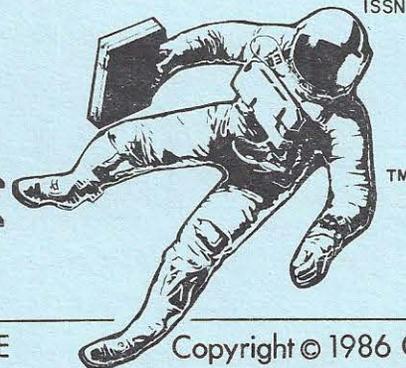


# THE COMMERCIAL SPACE REPORT

ISSN 0735-9314



A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

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Volume 10, No. 9

September, 1986

## U.S. Launch Vehicles Coming Up Off The Mat

After a devastating series of failures, The United States' stable of existing launch vehicles is beginning to show signs of recovery. The expendable launch vehicles (ELVs), such as the Delta, Atlas and Titan, are recovering from their setbacks more quickly than NASA's Space Shuttle. Recent launches of the Delta and Atlas went well, and the Titan is expected to fly again in 1987. Still, the Shuttle is not far behind. Current plans call for a Shuttle to fly as early as February of 1988.

Following is a quick update on the status of the ELVs (the status of the Space Shuttle program, including the technical solutions to the vehicle's problems, will be discussed in greater depth in a later issue).

### Delta:

Delta No. 178 failed in flight on May 3 of this year when its main engine and vernier engines shut down prematurely. The vehicle broke up in the atmosphere and a GOES weather satellite was lost (details on the Delta's problems, and those of the Atlas and Titan, are in the May, 1986 C.S.R.).

The Delta accident has been traced to an electrical short, which reduced voltage to solenoids controlling engine propellant valves. The valves closed, and the engines shut down. The short circuit was caused by mechanical vibrations during flight that apparently abraded some wiring harnesses.

A number of changes were made in the design which corrected the problem, and on Sept. 5, Delta No. 180 successfully flew to orbit. The 3920 Delta was carrying a Strategic Defense Initiative payload which performed a number of detection and tracking tests.

The flight was a long-awaited success for NASA, which has been suffering a severe, agency-wide loss of morale since the Challenger disaster in January.

### Atlas:

On Sept. 17, an Air Force/General Dynamics Atlas E booster successfully launched the NOAA-G weather satellite into polar orbit from Vandenberg Air Force Base in California.

The Atlas launcher had not suffered any recent accidents. Nevertheless, it was grounded for a time due to the similarity of its control systems with those of the Delta. The launch of the NOAA weather satellite was then scheduled for late summer of 1985, but was plagued by numerous delays until the vehicle finally got off the pad.

Titan:

Martin Marietta's Titan remains grounded after the explosion on April 18. However, investigators have established that the problem was due to poor quality control rather than any fundamental design error. The actual loss was traced to thermal insulation in one of the Titan's solid rocket boosters. The insulation came loose from the booster's metal casing, which allowed hot combustion gases to burn through.

The Titan failure was not caused by the same problems that caused the failure of a Shuttle Solid Rocket Booster (SRB). The Titan booster, built by United Technologies, is segmented in the much the same way as the SRB, and also uses rubber O-rings to seal its joints. Naturally, when the Titan explosion was first traced to a solid booster, suspicion fell on the joints and their seals. However, the seal configuration of the Titan booster, although similar, was not identical to the seal configuration on the SRB, and the Titan's joint design in the end proved to be innocent. So, without a fundamental design problem to fix, resolution of the Titan's problems is well under way.

The Titan pad at Vandenberg was severely damaged (\$70 million worth) by the Titan explosion, and launches into polar orbits (military reconnaissance satellites) must wait until repairs are completed--probably sometime in 1987. Launches out of Cape Canaveral (communications and missile warning satellites) could begin earlier.

Martin Marietta is enthusiastically moving ahead with commercialization of the Titan. The company is taking advantage of the fact that its production line is being held open by heavy Air Force contracts, including one for \$2.1 billion for ten Titan 4 ELVs. Martin will emphasize the Titan 3 launcher, which can carry 32,000 lbs. into low earth orbit or 12,500 into geosynchronous.

Many satellite customers were stranded by the loss of the Space Shuttle, and have been left holding not only their satellites, but the expensive orbital transfer motors that the Shuttle required to place these satellites into geosynchronous orbit. Martin Marietta is going out of its way to accommodate these customers, adapting its Titan mission profiles to place these satellites and their motors into the same low earth orbit that the Shuttle would have (the company is designing payload adaptors which would permit the Titan 3 to carry two such satellite/motor combinations at once). Of course, the Titan can fly payloads directly into geosynchronous orbit (like the Ariane) should the customer require it. A number of potential customers have approached Martin, including Intelsat, Europe's Inmarsat, and others. Martin hopes to begin commercial flights in 1989.

Early in September, the Federal Express Company put a deposit of \$100,000 down with Martin to reserve a 1989 flight for their ExpressStar satellite. Martin is touting this as the first such firm reservation to be made by a U.S. commercial ELV company. The two companies must now negotiate a full launch services contract.

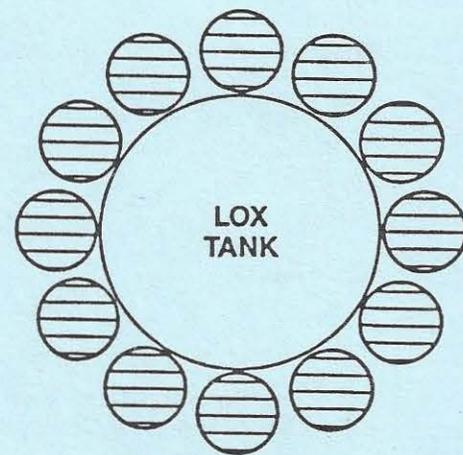
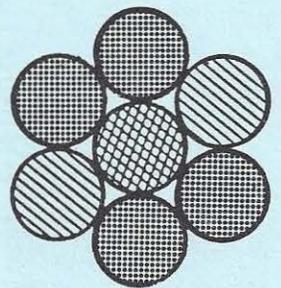
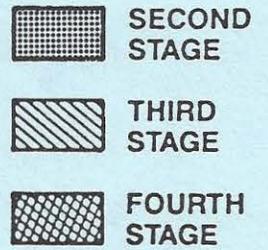
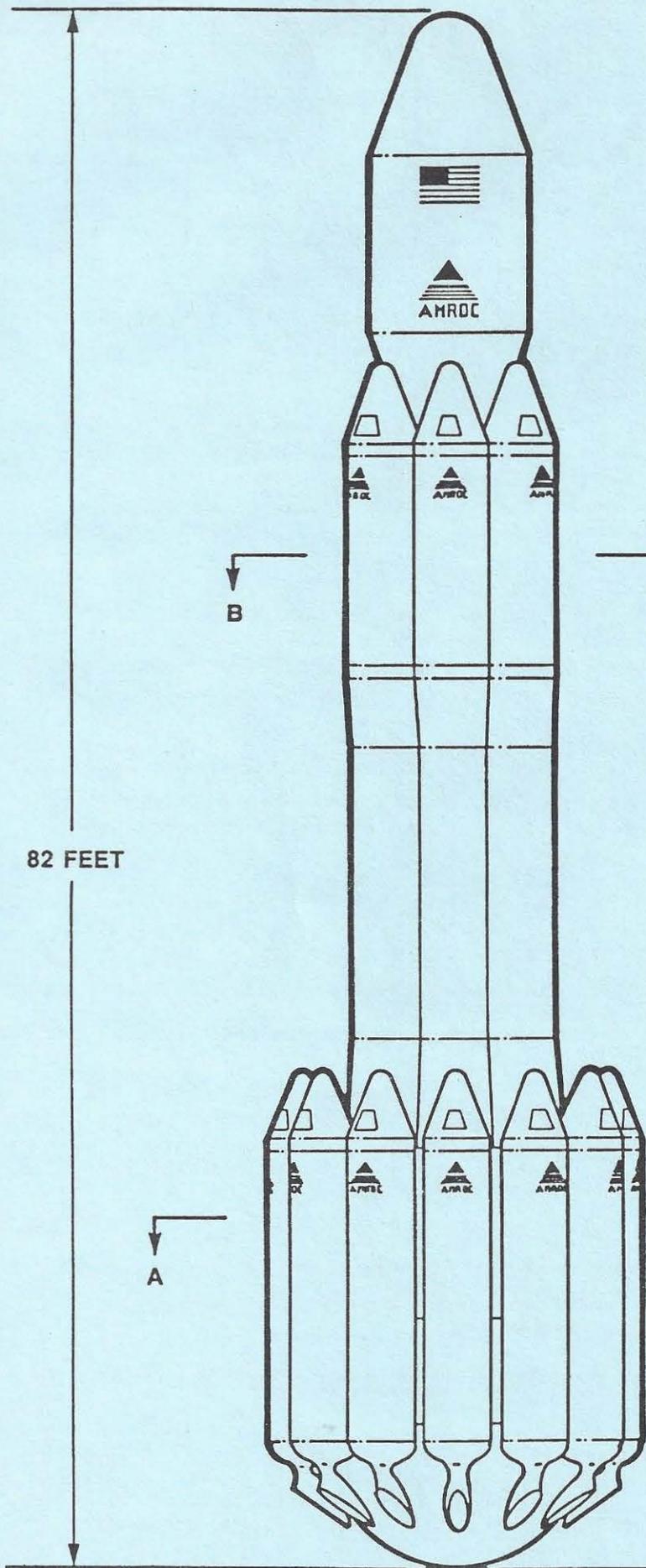
#### AMROC Releases New Launch Vehicle Design

The American Rocket Company (AMROC) of Menlo Park, Calif., has released the configuration of its proposed hybrid expendable launch vehicle.

Called "Industrial Launch Vehicle One" (ILV-1), AMROC's design consists of a cluster of nineteen hybrid motors, which use a solid fuel resembling hard rubber, and liquid oxygen (LOX) as the oxidizer.

The vehicle has four stages (see illustration at right). The first stage is a single large tank of LOX with 12 hybrid motors mounted around its circumference. Use of a common oxidizer tank for all first stage motors is intended to simplify

AMERICAN ROCKET COMPANY  
INDUSTRIAL LAUNCH VEHICLE ONE  
CONFIGURATION



assembly, inspection, pre-launch servicing, and range safety requirements. In addition, this engine arrangement forms a plug nozzle, or aerospike, at the base of the LOX tank (an aerospike-type engine, used on advanced concepts for single-stage-to-orbit vehicles, has the desirable characteristic of automatically adjusting itself for optimum performance as the vehicle rises and the surrounding atmospheric pressure decreases.)

The second, third and fourth stages consist of a cluster of seven motors, six arranged around a single motor in the center. Each motor has its own LOX tank mounted on its forward end, and a large expansion bell on its nozzle for vacuum operation (not visible in the illustration). Four of the outer motors fire during second stage operation, then drop away. The two remaining outer motors fire during third stage operation, then the center motor fires as the fourth stage.

The payload fairing, mounted atop the upper stage cluster, is 90 inches in diameter, and is jettisoned during second stage boost, when the vehicle is beyond the atmosphere.

Directional control is provided on the first stage by differential throttling of the twelve engines. The upper stages are controlled by monopropellant thrusters mounted on their forward ends. This differs from the design of early hybrid engines produced by Starstruck, Inc. (AMROC's predecessor company), where steering was provided by injection of fluid into the exhaust stream at the engine nozzle to deflect the thrust.

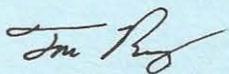
AMROC has not released other technical details, such as engine dimensions or performance statistics. However, by scaling AMROC's drawings, making some assumptions on structural details, and applying standard rocket design procedures, some educated guesses can be made (I will not drag you through the math).

The total vehicle weight at liftoff (including payload) is probably around 375,000 lbs. The average thrust level of the engines, which appear to be about 42 inches in diameter, could be anywhere between 35,000 and 50,000 lbs., with the higher levels being more likely. Average specific impulse of the hybrid engines, to produce the required performance, would need to be about 270 seconds, a figure which should be attainable.

The ILV-1 is designed to deliver 3,000 lbs. to a circular polar orbit at an altitude of 135 nautical miles, or 4,000 lbs. to a similar equatorial orbit. Polar launches will take place from Vandenberg, while other launches will take place at Cape Canaveral. Cost per launch will be between \$5 and 8 million.

The company plans to inaugurate its launch service with three launches in 1988, two being Defense Department payloads (which will be flown for free). The third payload will be a test flight for a small space recovery vehicle (SRV) which is being marketed by General Electric to return small payloads from earth orbit.

Until next time,



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Subscription rates are: U.S., Mexico, Canada: 1 year-\$15.00, 2 years-\$28.00, 3 years-\$39.00. Foreign Air Mail: 1 year-\$20.00, 2 years-\$38.00, 3 years-\$54.00. Back issues are available at \$1.50 each from September, 1977. Xerographic copies may be substituted as stocks are depleted.

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