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QUARTERLY LAUNCH REPORT

Special Report:

The U.S. Evolved Expendable Launch Vehicle (EELV) Programs

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The US Evolved Expendable Launch Vehicle (EELV) Programs

The Evolved Expendable Launch Vehicle (EELV) Program is a Department of Defense technology-development program managed by the Air Force. The program is intended to produce an improved launch vehicle family for government use. The EELV will replace the currently used fleet of Atlas, Delta, and Titan launch vehicles and is expected to cut launch vehicle life-cycle costs by 25 to 50 percent. This goal is to be achieved through the use of up-graded (but not "clean slate") technology, improved manufacturing, and decreased launch operations overhead.

The EELV will use existing technology or components in order to reduce cost, time, and development risks. Beyond its immediate goal of reducing the cost and complexity of government launch operations, the EELV program is also intended to increase US commercial market share when EELV manufacturers use the vehicles to compete for international launch contracts. It is hoped that the EELV will increase US market share from the current approximately 35 percent to around 50 percent of the world market.

In 1995, four companies were awarded 15 month, $30 million, concept validation contracts for initial EELV work. These companies were Alliant Techsystems, Boeing, Lockheed Martin, and McDonnell Douglas. On December 20, 1996 the second major selection in the three-part EELV program took place. Lockheed Martin and McDonnell Douglas were selected as the two firms to further develop their EELV designs under two $60 million pre-development engineering and manufacturing contracts. Alliant Techsystems' proposal for a largely solid-fueled launch vehicle and Boeing's proposal for a launch vehicle with a reusable engine pod were passed over for the Lockheed Martin and McDonnell Douglas designs. It is notable that the more unusual technological solutions proposed by Boeing and Alliant Techsystems were turned down in favor of the fine-tuning approach of Lockheed Martin and McDonnell Douglas.

Both the McDonnell Douglas and the Lockheed Martin designs are based on commercial launch vehicles now in development and or in use. The Lockheed Martin design uses technology from both the Atlas and the Titan programs while the McDonnell Douglas entry will build on the current Delta 2 and the Delta 3 (currently in development).

The McDonnell Douglas EELV

Although proven technology is being used in the design of these launch vehicles, new technologies are also being introduced. McDonnell Douglas will use the first new liquid rocket engine developed in the United States since the Space Shuttle Main Engine (SSME), which was designed in the seventies. This engine, the Rockwell-Rocketdyne RS-68, is being developed from the S-II engine used on the second stage of the Saturn 5 moon rocket with the addition of technology from the SSME (also built by Rockwell-Rocketdyne). It will be both larger and simpler than the SSME and is one of the key technologies required to make the McDonnell Douglas EELV a success. The commercial version of McDonnell Douglas' EELV has been referred to as the Delta 4.

Another interesting design feature of the McDonnell Douglas EELV is its use of horizontal integration (Boeing's EELV plans also included horizontal integration). Horizontal integration is when a launch vehicle is assembled, tested, and prepared for launch lying on its side (i.e. horizontally), which is done away from the launch pad. When integration is complete and it is time to launch, the vehicle is moved to the pad, raised, and launched in short order. McDonnell Douglas expects to reduce pad time from the current 24 days to a period of six to eight days. In many ways horizontal integration is easier than the current US standard of vertical integration; horizontal integration has always been the Russian standard.

In addition to making the launch vehicle easier to work on by keeping it closer to the ground, horizontal integration also greatly reduces time spent occupying the launch pad. With the exception of the Saturn family of launch vehicles and the space shuttle (which uses the same pad infrastructure) US vehicles are all assembled or "stacked" on the launch pad in a vertical position. This is done because of historical and technological inertia and has long been recognized as a serious bottleneck in US space operations. This is why the Saturn family's launch infrastructure was designed to allow vehicle assembly and integration to take place in the very tall vehicle assembly building (VAB) with the move to the launch pad delayed to the last minute. Moving vertical rockets is an expensive proposition, however, and the Saturn example has not been imitated. A Titan 4 (for example) may sit on a pad for months while it is prepared for launch. As the availability of launch pads is one of the limiting factors on launch rates, horizontal integration is also a desirable characteristic and contributes to the economic advantages that are a major part of the EELV program's goal.

The Lockheed Martin EELV

Lockheed Martin also plans to use a new rocket engine, the NPO Energomash RD-180, for its EELV. This engine is a derivative of the RD-170 that was used by the Russian Energia heavy lift launch vehicle (no longer in service). The RD-180 is expected to give a five percent performance advantage over current American engines. Because the RD-180 has 70-percent component commonality with the proven RD-170 it should be cheaper and less risky to develop than a totally new design. In order to meet national security requirements this engine will be built by Pratt & Whitney in the United States.

Lockheed Martin is also developing an improved version of its Agena main axial engine for use in a new EELV upper stage. This storable propellant upper stage will be part of Lockheed Martin's EELV entry but it will also be available for other launch vehicles such as Lockheed Martin's Atlas.

Following the second phase of the EELV competition, which is scheduled to end in May 1998, one of the two vehicles will be selected for the final $1.6 billion engineering and manufacturing development phase. This phase will result in a medium-size EELV launch in the year

2000 followed by a heavy-lift version of the vehicle in 2003.

With the announcement that Boeing and McDonnell Douglas intend to merge, Boeing reentered the EELV program. In fact with its acquisition of Rockwell-Rocketdyne, Boeing will control both halves of the McDonnell Douglas EELV proposal.

The intended merger of Boeing and McDonnell Douglas means that the EELV competitors are the two largest US aerospace companies. Boeing is also heavily involved in the space station program and Lockheed Martin is a major satellite builder. The table below shows the strength of the two firms' launch vehicle divisions. Other aspects of these companies are discussed below.

Boeing / McDonnell Douglas

The Boeing Company is headquartered in Seattle, Washington and is organized into three groups. These are the commercial Airplane Group, the Defense and Space Group, and the Information and Support Services Group. Boeing's 1995 sales were $19.5 billion with 1994 sales for the Defense and Space Group at $5.63 billion. Boeing's major space contracts are:

- International Space Station (prime contractor, $6.3 billion)
- Boeing Sea Launch (partnership to launch Zenit launch vehicles at sea)
- Inertial Upper Stage (upper stage used on DoD and planetary probe missions)

In August of 1996 Boeing agreed to purchase Rockwell International's space assets which will be renamed Boeing North American. This sale included the Rockwell Space Systems Division, Rocketdyne, and Rockwell's Autonetics and Missile Systems. Rockwell's space related sales were $2.044 billion in 1994. Current contracts include:

- United Space Alliance (partnership with Lockheed Martin to operate the shuttle)
- Cyclone launch vehicle (marketing partnership)
- SSME (space shuttle main engine)
- RS-68 (new engine for McDonnell Douglas EELV)
- Navstar Block 2F (GPS satellites to follow Block 2R now coming on line)
- Space Shuttle Upgrades.

As of December 1996, it had been agreed that, pending regulatory approval, McDonnell Douglas would merge with Boeing under the Boeing name. McDonnell Douglas is headquartered in St. Louis, Missouri with revenues of $14.332 billion in 1995.

Boeing/McDonnell Douglas Launch Vehicles	Lockheed Martin Launch Vehicles
· Cyclone (international partnership acquired with Rockwell) · Delta 2 · Delta 3 (in development) · EELV Family/Delta 4 (in development) · Zenit/Sea Launch (Boeing international partnership)	· Atlas 2 A, AS · Atlas 2 AR (in development) · Lockheed Martin Launch Vehicle 1 · Lockheed Martin Launch Vehicle 2 (in development) · Proton (ILS international partnership) · Titan 4

Current Major Launch Vehicle Programs

1995 space, missile, and electronics sales were $1.9 billion. Current McDonnell Douglas space related contracts include:

- Space Station (station truss, $2.1 billion)
- Delta 2 Launch Vehicle
- Delta 3 Launch Vehicle
- EELV/Delta 4 Launch Vehicle

Lockheed Martin

The Lockheed Martin Corporation is headquartered in Bethesda, Maryland and is organized into six sectors: Aeronautics, C3I Systems Integration, Electronics, Energy and Environmental, Information and Services, and Space and Strategic Missiles. Lockheed Martin's 1995 sales were $22.397 billion with 1993 (the latest year available) space sales of $6.7 billion. Lockheed Martin's major space contracts are:

- Atlas 2 Launch Vehicle
- Titan 4 Launch Vehicle
- EELV Launch Vehicle
- Lockheed Martin Launch Vehicle
- United Space Alliance (partnership with McDonnell Douglas to operate the shuttle)
- Iridium LEO Communication Constellation
- BMDO/SDI (major contractor)
- Agena Upper Stage
- Milstar (Lockheed has built more military satellites than any other western aerospace company)
- Reusable Launch Vehicle Testbed
- SBIRS

Lockheed Martin is also a major commercial satellite manufacturer.

In April of 1996, Lockheed Martin purchased Loral Corporation's space assets which are initially grouped in the Tactical Systems Sector. This portion of Loral had 1995 sales of $6.2 billion. Current contracts include Space Station systems integration for propulsion, communications, tracking, and information.

Loral is also a major commercial satellite builder and will continue to exist as a separate entity from Lockheed Martin's satellite manufacturing operations for anti-trust reasons.

Lockheed Martin markets both its own Atlas launch vehicle and the Russian made Proton launcher through its subsidiary International Launch Services (ILS). ILS was established in 1995 from Lockheed Martin's Commercial Launch Services Company and Lockheed Khrunichev Energia International (LKEI), a joint venture to market Proton. ILS is working to offer the flexibility and added reliability of two proven launch systems and two launch sites, allowing its customers' payloads to be launched on either vehicle. All commercial Proton launches are arranged through ILS, and the Russian government conducts all Russian national launches on Proton.