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The New Soviet Medium-Lift Launch Vehicle (s)

A Research Paper

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IA 84-10048
June 1984

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The New Soviet Medium-Lift Launch Vehicle (S)

Summary

Information available as of 1 June 1984 was used in this report.

A new Soviet medium-lift space launch vehicle is expected to be launched from Tyuratam Missile and Space Test Center by the end of 1984. The Intelligence Community estimates that the new launch vehicle will be capable of lifting payloads of about 15,000 to 17,000 kilograms to low earth orbit. This vehicle will fulfill the Soviets' requirement for a launch vehicle to bridge the gap between their SL-4, which can place a 7,000-kilogram payload into orbit, and their existing medium-lift vehicle, the SL-13, which can orbit 20,000 kilograms. The medium-lift vehicle may be used for orbiting payloads such as new, heavier reconnaissance satellites or a small, manned spaceplane that is believed to be under development. In addition, the first stage of the launch vehicle will be used as a thrust-augmentation, strap-on booster for the Soviet heavy-lift launch vehicle that also is under development.

The medium-lift launch vehicle is probably being developed jointly by the Glushko and Utkin space systems design bureaus. The launch vehicle [redacted] and has at least two stages mounted in tandem; both stages use liquid oxygen and probably kerosene propellants. A prototype medium-lift vehicle was seen for the first time [redacted] at Tyuratam, undergoing compatibility checkout with launch pad facilities. The launch vehicle has been seen on subsequent occasions undergoing both compatibility checkout and propellant-tanking tests at its Tyuratam launch site. 25X1

This information is Secret [redacted] 25X1

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The New Soviet Medium-Lift Launch Vehicle (S)

Background

The new Soviet medium-lift launch vehicle (MLLV) is probably being developed jointly by the Glushko and Utkin space systems design bureaus. The MLLV (temporarily designated the SL-Y by the Intelligence Community) is a liquid-propellant booster with at least two stages. The first stage also will be used as a thrust-augmentation, strap-on booster for the new Soviet heavy-lift launch vehicle (HLLV), designed in the mid-1970s by the Glushko organization.[1] Consequently, the design, or at least the design specifications, for the first and possibly second stages of the MLLV probably also was done by the Glushko organization. Actual series production of at least one, and probably both, of the stages occurs at Utkin's Dnepropetrovsk Missile Development Production Center, where a three-car rail train used to transport MLLV components has been identified. (S [redacted]

Facilities for the receipt, assembly, checkout, and launch of the MLLV are located at Tyuratam Missile and Space Test Center. Components of the medium-lift vehicle are delivered by three-car train to Support Facility 3 at Tyuratam, where they are offloaded, assembled, and checked out in a refurbished vehicle assembly and checkout building. Launch of the MLLV will be conducted from Space Launch Site Y, located about three kilometers south of Support Facility 3. Construction of Launch Site Y was begun in 1978, and the first of two launch pads (Pad Y1) was completed by December 1982 and is capable of supporting a launch of the MLLV. Construction of the second pad—Y2—began in 1981, but was suspended for an unknown reason in late 1983 in an early stage of construction. An assembled, prototype MLLV was seen erected at Pad Y1 for the first time [redacted] 25X1

[redacted] where it was undergoing compatibility checkout with pad facilities. The launch vehicle has since been seen on numerous occasions undergoing both compatibility checkout and propellant-tanking tests at Pad Y1. The apparent state of facility and launch vehicle readiness indicates that the first launch of the medium-lift vehicle could occur before the end of 1984. (S [redacted] 25X1 25X1

Based on the observed and estimated characteristics of the launch vehicle, the Intelligence Community believes that the payload-lift capability to low earth orbit for the MLLV will probably range from 15,000 to 17,000 kilograms. This vehicle will fulfill the Soviets' requirement for a launch vehicle to bridge the gap between their SL-4, which can place a 7,000-kilogram payload into orbit, and their existing medium-lift vehicle, the SL-13, which can orbit 20,000 kilograms. The medium-lift vehicle may be used for orbiting payloads such as new, heavier reconnaissance satellites or a small, manned spaceplane that the Intelligence Community believes is under development. (S [redacted] 25X1 25X1

[1] When used as an HLLV strap-on booster, the first stage is modified by the addition of an asymmetric nosecone and at least two probable airframe stiffener rings. Two pairs of strap-on boosters are mated to opposite sides of a 59.0-meter-long [redacted] core booster to constitute the heavy-lift launch vehicle. (S [redacted] 25X1 25X1 25X1

The Launch Vehicle

The new MLLV consists of at least two stages mounted in tandem and a payload shroud. [redacted] During a series of on-pad propellant-tanking tests conducted with an MLLV in the second half of 1983, icing was evident on the outside of sections of the first and second stages, indicating the presence of cold liquid oxygen (LOX). The non-iced sections on both stages indicated that an ambient-temperature fuel, probably kerosene, was being used (figure 2). Based on the calculated volumes represented by the iced and non-iced sections, a volume ratio of oxidizer to fuel of about 1.94:1 and 1.77:1 was derived for the first and second stages, respectively. These ratios are similar to those of US space boosters using LOX and kerosene propellants, indicating that the MLLV also uses such propellants, or ones very similar in composition. No icing was evident above the second stage, suggesting either that this portion of the launch vehicle was not involved in propellant-tanking tests or that a third stage, if one was present, used ambient-temperature propellants. (S [redacted]

First Stage

The first stage of the launch vehicle is about 32.0 meters long [redacted] and consists of an engine section, a fuel tank (probably for kerosene), and an oxidizer tank for LOX (figure 1). What appear to be instrumentation cable trays and/or pressurization lines run from the engine area to the top of the oxidizer tank. In addition, four structural hard points are positioned at 90-degree intervals around the circumference of an airframe stiffener ring, which is located at or near the junction of the fuel tank and engine section. These hard points are used to physically support the launch vehicle while erected on the launch pad. An open [redacted] trusswork interstage is atop the first stage and is attached to the base of the second stage. The interstage provides structural continuity between the first stage and the rest of the launch vehicle and is used as a bridge between the first and second stages for instrumentation cables. (S [redacted]

The first-stage engine sectio[redacted]houses the stage's propulsion system. Analysis of the base of the engine section has not yet revealed whether the first stage uses a large single engine or smaller multiple engines. The lower portion of the engine section is flared and has a 4.0-meter-diameter exhaust opening. The flared section either is a nozzle for a single-engine system or is a tail skirt for multiple engine nozzles, which would be recessed. Four [redacted] protuberances are positioned around the middle of the engine section at 90-degree intervals and are probably associated with either a thrust vector control (TVC) system or a first-stage, soft-landing system. Each of the four protuberances appears to be affixed at its forward end to a probable airframe stiffener ring and at its aft end to points located 0.6 meter forward of the exhaust opening. (S [redacted] 25X1 25X1 25X1 25X1 25X1 25X1 25X1

A first-stage TVC system is required for attitude and directional control of the booster during launch. Such control usually is accomplished by moving the engine nozzle(s) or deflecting the exhaust gases. If the protuberances near the base of the first stage are associated with a TVC system, they could be either hydraulic actuators or housings for fluid injectors. If the protuberances are actuators, then apparently the las[redacted]section of the nozzle/skirt will be swiveled or gimballed in order to deflect the exhaust gases from the engine(s) and thereby control vehicle attitude and direction. Alternatively, the protuberances could be part of a fluid injection system. In such a system, fluid is injected into the exhaust flow by injectors located uniformly around the circumference of the nozzle openings, thereby slightly diverting the exhaust from a normal direction and providing control over the motion of the booster. (S [redacted] 25X1 25X1 25X1 25X1 25X1

If the protuberances are not related to a TVC system, they could be used in conjunction with parachutes as part of a soft-landing system for the first stage. In such a system, parachutes could be deployed after booster separation to slow and stabilize the stage during its descent. Conceivably, the protuberances could be used either to house 25X1 25X1

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[redacted]

landing rockets, which would be ignited near the ground for final deceleration of the stage, or as shock absorbers for cushioning the stage upon impact. Several Soviets have indicated that most of the components of the new HLLV will be recoverable and reusable, probably including the strap-on boosters derived from the MLLV first stage. If so, the MLLV first stage, or a section of it, probably also will be recoverable and reusable. (S [redacted]

The approximate size and location of the first-stage fuel and oxidizer tanks have been determined by a comparative analysis of the airframe during tanking and nontanking operations. The fuel tank is located adjacent to the engine section [redacted] The volume of the fuel tank, assuming that domed endcaps are located at each end, is about 106,600 liters. The oxidizer tank is located between the fuel tank and the interstage structure [redacted] The domed [redacted] upper endcap of the oxidizer tank extends into the trusswork interstage. The volume of the tank, assuming the lower endcap is like the upper, is about 206,400 liters. The propellant volume ratio of the oxidizer to the fuel is about 1.94:1 for the first stage. Because of the presence of gaseous oxygen venting from the stage during tanking tests, we believe a vent valve is located near the top of the oxidizer tank. (S [redacted]

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Second Stage

The second stage of the MLLV is [redacted] consists of an engine section, a fuel tank (probably for kerosene), an oxidizer tank for LOX, and a section that is probably an instrumentation unit/payload adapter. Trays, probably for instrumentation cables and/or pressurization lines, run along the outside of the stage's propellant tankage and between the engine section and the instrumentation unit/payload adapter. (S [redacted]

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The second-stage engine section is about 1.0 meter long and houses the stage's rocket engine(s). At least two, and probably four, protuberances are located on the outside of the engine section and may house second-stage separation motors or small rocket engines for attitude control. (S [redacted]

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The approximate size and location of the second-stage fuel and oxidizer tanks were determined in the same manner as was that for the first stage. The fuel tank is about 3.0 meters long and is located next to the engine section. The volume of the fuel tank, assuming that domed endcaps are present, is about 29,500 liters. The oxidizer tank is about 5.0 meters long and is located between the fuel tank and the instrumentation unit/payload adapter section. The volume of the oxidizer tank, assuming endcaps are present, is about 52,200 liters. The propellant volume ratio of the oxidizer to the fuel is about 1.77:1 for the second stage. Based on the presence of gaseous oxygen venting from the stage during a tanking test, a vent valve is probably located near the top of the oxidizer tank. (S [redacted]

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The probable instrumentation unit/payload adapter section [redacted] and is located atop the stage's LOX tank. At least one cable tray, probably for instrumentation cables, terminates at this section, suggesting that the guidance and navigation control electronics for the first two stages of the launch vehicle are located here. The payload shroud is also attached to this section, suggesting that a support structure or adapter for mounting the payload is present within this section. (S [redacted]

Payload Shroud
The payload shroud [redacted] consists [redacted] cylindrical section and [redacted] conical section. Several parallel striations are apparent along the cylindrical section. It is larger than most known Soviet satellites, which suggests that new, larger satellites are being developed for launch by the medium-lift vehicle. It is possible that the payload shroud could accommodate a smaller payload with its own, integral, third-stage propulsion system. Lastly, if the Soviet manned spaceplane is launched by this booster, it probably would not use a shroud because of its size and shape. Instead, the spaceplane probably would be mated directly to a payload adapter section. (S [redacted]

Ground Support Equipment

Several major pieces of ground support equipment have been designed to handle and service the new launch vehicle. A three-car transport train is used to ship the major components of the launch vehicle from the manufacturing plant to Tyuratam. A rail-mounted transporter/erector is used to transport the fully assembled launch vehicle from its assembly and checkout building to the launch pad, where it is erected into place. Propellant loading and servicing of the launch vehicle and payload is accomplished by means of the transporter/erector, an umbilical mast, and a service structure. In addition, a six-axle transport vehicle has been identified, which probably will be used for recovery of the medium-lift vehicle's first stage. (S [redacted]

Transport Train
The medium-lift vehicle's three-car transport train has an overall length of about 74 meters and is used for the shipment of the vehicle's major components—first stage, second stage, and payload shroud. It also carries a small, fourth component, possibly the instrumentation unit/payload adapter, interstage, or a nozzle gimbal ring. The train consists [redacted] railcar and two [redacted] railcars and has been observed at Support Facility 3 carrying four canvas-covered components (figure 3). The largest of the components, [redacted] is the first stage. Two other components, [redacted] probably are the payload shroud and second stage, respectively. The three-car train also has been seen at the Tyuratam heavy-lift launch vehicle assembly and checkout building, carrying the first stage for use as a strap-on booster, and has been seen empty at Dnepropetrovsk Missile Development Production Center. (S [redacted]

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Transporter/Erector and Umbilical Mast
The MLLV and attached payload are transported in a horizontal position from the vehicle assembly and checkout building at Support Facility 3 to the launch site, using a [redacted] rail transporter/erector (TE) (figure 4). Upon arrival at the launch pad area, [redacted] horizontally positioned umbilical mast is installed between the booster and the TE's booster support cradle. The booster, cradle, and mast are then erected as a single unit over the pad aperture by four hydraulic actuators on the ladderlike TE chassis. The support cradle functions as both a strong back and servicing structure for the booster and payload. Lines for propellant loading and/or payload temperature-conditioning are located along the support cradle. The umbilical mast probably also is used for booster prelaunch servicing activities, such as propellant tanking and pressurization operations, and for connection of launch vehicle monitoring umbilicals. (S [redacted]

Service Structure
A launch vehicle/payload service structure is under construction at Launch Site Y (figure 5). In late 1981, components for the rail-mounted service structure were delivered to the launch site, and construction of reinforced rail lines for the structure began. Possible technical problems, however, may have delayed the actual assembly of the service structure, which did not begin until March 1984 and may not be completed until early 1985. The delay in construction of the service structure indicates that it will not be required for the initial MLLV launch. The structure is in an early stage of assembly and consists of a rectangular chassis, [redacted] When completed, the structure will travel to the launch pad on an 18.0-meter-gauge rail line. The rectangular framework design suggests that the service structure will have limited access to the booster because of the obstructions caused by the erected TE and umbilical mast. The service structure, therefore, primarily may be used for payload access/servicing activities. (S [redacted]

First-Stage Recovery Vehicle
A large transport vehicle, probably designed to recover the first stage of the MLLV, has been identified at Support Facility 3. The vehicle is [redacted] and has a split cab, six axles with tires [redacted] and a ladderlike ramp possibly used for loading (figure 6). The vehicle was first observed on [redacted] and was carrying what appeared to be a load simulator, [redacted] Wheel tracks from this vehicle and gate-widening activity outside the building in which the vehicle is garaged were observed in the first half of March 1984, indicating that the vehicle probably was initially driven at Tyuratam during early March. Numerous offroad tracks from the vehicle were seen later in the month and suggest that it underwent testing/driver training. The tracks show that the vehicle has a turning radius of about 22 meters, indicating that multiple axles may be used for steering. (S [redacted]

The arrival of this vehicle at Support Facility 3 during the final preparations for the first launch of the MLLV, the size of its cargo bed, and its apparent offroad capability indicate that it would be well suited for recovery of a spent medium-lift vehicle first stage. Such recovery operations probably would take place between two and three hundred kilometers from the launch site, and most of this distance would require driving over unimproved roads or rough terrain. If used for recovery of the first stage, the vehicle, or others like it, would almost certainly be used for recovery of the HLLV's strap-on boosters, since they are derived from the MLLV first stage. (S [redacted]

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