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A RETROSPECTIVE VIEW OF SOVIET [redacted] SPACE DEVELOPMENT

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SUMMARY AND CONCLUSIONS

Over the past 25 years, the Soviets have demonstrated that they are capable of good work in designing [redacted] space launch vehicles. In toto, this effort represents a huge investment—both in terms of the budget and the allocation of scientific and technical resources—and the Soviet are continuing to introduce new hardware. They are now developing a large new space booster [redacted]

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Through the mid-1960's, the Soviet space program used launch vehicles adapted from proven ballistic missiles, and it still relies heavily on that family of space boosters. More recently, the USSR has begun to design and build more powerful launch vehicles solely for that purpose, but developmental problems have been encountered with those newer systems.

DISCUSSION

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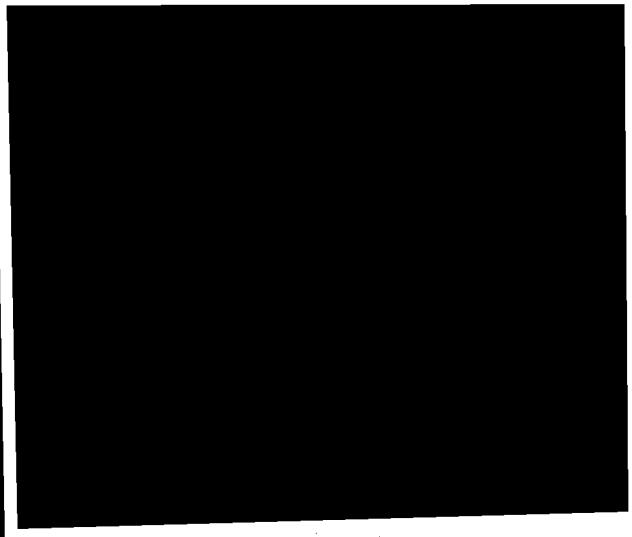

Space Launch Vehicles

Over the years, the mushrooming Soviet space program has demanded an ever-broadening array of launch vehicles. Thus far, the USSR has developed eight distinct space boosters with various capabilities adapted to specific space missions.

The space boosters introduced by the Soviets through the mid-1960's were based on proven ballistic missiles- [redacted] The use of ballistic missile designs simplified space booster development, but problems were encountered with some of the upper stages which were newly designed for the space program. The majority of the Soviet space effort still relies on these ballistic missile-based launch vehicles, which by now have established a reputation for high reliability.

In 1967 the Soviets introduced the SL-12, the first booster designed solely for their space

program. During its first four years, the SL-12 was plagued with design problems. There were 13 failures in the first 19 launch attempts (one first-stage, four second-stage, three third-stage, and five fourth-stage failures). Despite this dismal record, the Soviets continued to fire the SL-12 at a relaxed pace, and it now appears to be showing an acceptable reliability record.

While the Soviets were working the "bugs" out of the SL-12, a huge new space booster—the TT-05—was being readied for flight testing. That vehicle, like the SL-12, was designed from the ground up for the Soviet space program. It, too, appears to be encountering design problems—the two launch attempts thus far both have resulted in first stage failures.

Once it becomes operational, the TT-05 will have a payload capability some 5 to 6 times that of the SL-12. The height of the gantry at the TT-05's launch facility—Complex J at Tyuratam—is about 100 feet higher than the vehicle as it is now configured. Therefore, it seems likely that the facility ultimately is intended for a still larger vehicle. One possibility is that the Soviets are planning to equip the TT-05 with new upper stages using liquid hydrogen fuel. Such a vehicle could more than double the TT-05's payload capability. However, it is very unlikely that the Soviets will add high energy upper stages to the TT-05 in the near future.

With both missiles and space boosters, the Soviets traditionally have treated each research and development launch as a full system test. They generally still do so in the case of missile development, but appear to be gradually turning to a more methodical approach in flight testing space boosters. In the past—when new space launch vehicles were adapted from reliable missile systems by adding one or two new upper stages—the Soviets were willing to risk the loss of a payload by conducting each launch as a test of all stages of the booster together with a live payload. If the launch vehicle or the payload failed, that subsystem would be returned to the drawing board to correct the fault. On the other hand, if the mission were successful, Soviet space exploration would be accelerated, short-cutting the stage-by-stage approach used by the US. However, the increasing complexity and expense of new space boosters and payloads probably is forcing the USSR to adopt a more conservative flight testing technique. In several instances over the past few years, the Soviets have conducted what appear to be purely engineering tests of new space boosters, suggesting that they already have begun to swing away from their traditional "all up" testing philosophy.

In general, the Soviets' new space boosters have tended to be less reliable than their ICBMs. The ICBM research and development effort clearly enjoys a higher priority than the space program and probably has a greater proportion of the USSR's technological resources at its disposal. Still, a large segment of the Soviet space effort is devoted—directly or indirectly—to military objectives, and those programs also would be likely to have a strong voice in the allocation of research and development money and manpower. In most cases, then, the contrasting reliabilities probably do not stem from a deficiency in the technological resources available to the space program. Historically, the fault probably has been due largely to different management and quality control techniques. In the case of the more recent space boosters, these factors probably have accentuated the problems that are inevitable with the introduction of new design concepts. [redacted]