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Iran Takes Next Steps on Rocket Technology

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Brief Analysis

Solid-propellant motors represent the future for the Islamic Republic, promising much longer ranges and orbit reach for its space and ballistic missile programs.

On February 9, just as the nuclear talks in Vienna reached a critical stage, Iran unveiled its "Khaybar Sheikan" (Khaybar Buster) missile, which has a purported range of 1,450 kilometers. This significant development demonstrates, more than anything, the increasing size and range of Iran's slant-firing solid-motor missiles. The Khaybar reference, meanwhile, points to a seventh-century battle between Muhammad's army and Jewish communities near Medina whose members refused to convert to Islam and were defeated after their hardened fortresses were overrun.

The unveiling likewise came just six days after Iran's "National Space Technology Day," which commemorates the 2009 launch into earth orbit of the country's first satellite, Omid, aboard a homegrown liquid-fuel Safir rocket. The Safir emerged from Iran's family of Shahab-3 medium-range surface-to-surface ballistic missiles, which are based on North Korea's Nodong design. According to documents in Iran's "nuclear archives" snatched by Israel in January 2018, Shahab-3 was intended to carry the country's first nuclear weapons. Safir has since been superseded by other designs, including the larger Simorgh, although it has yet to successfully place a satellite into orbit despite at least five attempts since 2016. Iran has clearly not yet been able to "stabilize" its liquid-fuel space launch vehicles (SLVs).

Iran's Unclear Trajectory to Space

The Safir launch in 2009 marked the first achievement of Iran's space program, initiated in complete secrecy earlier in the decade by the Ministry of Defense and Armed Forces Logistics. The goal was to eventually launch heavy telecommunications satellites into 36,000-kilometer geosynchronous earth orbit (GEO). To date, however, such an aspiration has proven too technologically challenging, given that it requires multistage rockets much more powerful than Iran has so far tested or fielded.

But Iran is nevertheless working hard to boost its capabilities and achieve its stated goal. Responsibility for this task lies with the space group of the Defense Ministry's Aerospace Industries Organization (AIO), the developer and producer of most of Iran's missiles and rockets. This group has been working on a series of significantly larger, more powerful rockets to culminate in a heavy rocket with strap-on boosters called Soroush-2. The aim is then to insert a 2.5-ton satellite into GEO, or else multiple smaller satellites into low earth orbit (LEO) to create interlinked clusters. For the sake of comparison, the Space-X Falcon-9 rocket can place an 8.3-ton payload into geostationary transfer orbit, known as GTO, which is at a lower altitude than GEO.

The Iranian effort would arguably require substantial funding and resources, especially for the propulsion component, an outcome that now appears more likely considering Iranian president Ebrahim Raisi's marked interest in the subject. An eventual revival of the Iran nuclear deal and removal of related sanctions could also reduce political hurdles and free up money for the Iranian regime's ambitious rocket projects.

When Raisi became president in 2021, he promised to revive the partially "dormant" Defense Ministry–led space program and, to this end, chaired the first Supreme Space Council meeting in eleven years on November 26. During that meeting, Raisi set the ambitious goal of taking a satellite into GEO within four years, but only after Iran's military proved consistently able to place satellites into LEO, defined as 200–2,000 kilometers. Yet this nearer-term objective has proven elusive, and Iran has struggled to further develop its liquid-fuel engines. After only eight launches, the Safir SLV has already been retired, registering a less than 50 percent success rate. Meanwhile, the larger Simorgh rocket has yet to place a satellite into orbit after at least five tests, and the even larger Sarir and Soroush-1 and 2 designs have not appeared on the launchpad. Iran will also need to test its new Saman orbital bus, or maneuvering stage, which is designed to push payloads to higher orbits, and finish its Chabahar space port on the Gulf of Oman coast, which will allow significantly more efficient space launches.

Despite all the hype surrounding the GEO effort, Iran has been assigned only one GEO "parking" spot by the UN International Telecommunications Union, and it is highly unlikely to enter the commercial satellite launch market any time soon. Therefore, Tehran's "civilian" space program could prove much like its nuclear program: the recipient of disproportionate investment with uneven progress, all toward questionable outcomes.

Solid Propulsion as a Preferable Alternative

Alongside liquid-fuel options, Iran has been pursuing another path mostly through a parallel space program run by the Research and Self-Sufficiency Organization of the IRGC Aerospace Force. As the real beneficiary of any future additional resources, the Guard's space arm has long been developing its own satellite launch capability using powerful solid-propellant rockets, aimed at placing a heavy satellite into sun-synchronous orbit, defined as 1,000 kilometers and best suited to creating imagery for spy reconnaissance. This altitude allows the satellite to fly over the same location every few days at the same time of day, facilitating consistent shadow angles or daytime passes.

In addition, every time a sun-synchronous satellite completes its orbit in approximately ninety minutes to two hours, it shifts slightly, allowing its sensors to capture scenes slightly off path. This helps in acquiring more interesting data or images unobscured by shadows or cloud cover. Technically, the proficiency of securing successive images is known as "temporal resolution," with higher such resolution equating to greater speed in returning to the same spot, as measured in days.

One way to enhance this resolution is through interlinked small imaging satellite clusters at lower orbits, bringing the revisit times to hours rather than days. Iran is known to be showing increased interest in creating clusters of cheap imaging, navigation, or communication micro- or nanosatellites. When interlinked, these can offer significant military capabilities to support the Iranian regime's harmful activities in the region, such as tracking international shipping or assisting in suicide drone navigation/targeting, as well as those of its proxies.

The April 2020 SLV Launch

The military's dominant role in developing Iran's SLVs, accompanied by Iran's typical lack of transparency, offers reason enough to worry. But on April 22, 2020, the evidence grew more concrete when the IRGC announced the launch of its own satellite using its own Qased SLV (https://www.washingtoninstitute.org/policy-analysis/irgc-lifts-implications-irans-satellite-launch). Even today, this model is absent from the official developmental charts of Iran's space rocketry, which until recently were based on "less efficient" liquid-fuel first and second stages. The situation is changing, however, and as of early 2021 even the AIO had tested a surprise new rocket, called the Zoljanah, on a suborbital mission. For its first and second stages, the Zoljanah used a 1.5-meter solid-fuel motor reportedly producing seventy-four tons of thrust, and it is expected to place a 210-kilogram satellite into 500-kilometer orbit.

Also, in January 2022, the IRGC released footage of a successful ground test of a larger and more powerful solid-propellant motor with swiveling thrust-vector nozzles at its Shahrud-based test range. Called Raafe (Lifter), the powerful composite encased rocket is earmarked to power the first stage of both intermediate-range ballistic missiles and SLVs. On a historical note, in a recently declassified letter dated December 12, 2005, to the Islamic Republic's Supreme Leader Ali Khamenei, the former director of the IRGC's missile and space launch program Gen. Hassan Tehrani Moghaddam—who was killed in November 2011 in a massive explosion while working on a missile propulsion project—spoke in a single sentence of completing both a "rapid-reaction hypersonic" missile with enough range to reach Israel and an SLV. While the former may or may not refer to the Sejjil solid-propellant missile unveiled in 2008, the latter could be referencing either the Safir, Qased, or a more powerful design.

In sum, alongside Iran's publicly known military-led space launch program, the IRGC has its own program that is showing increasing capability to produce large rockets made of solid-fuel motor stages, with diameters reaching 3.5 meters. This potential development should be traced back to the all-solid-fuel-motor, four-stage Qaem SLV (https://www.washingtoninstitute.org/policy-analysis/irans-missile-arsenal-and-nuclear-negotiations) project, also linked to Tehrani Moghaddam. Indeed, on February 3, Iran announced a plan to launch two experimental satellites into orbit using the Zoljanah and Qaem SLVs.

Conclusion

Whatever the status of the current nuclear talks, the United States should keep close tabs on Iran's space program, and especially its solid-fuel space launch program. This is because the IRGC and affiliated entities play a central role in supervising such activity and because it directly benefits Iran's long-range missile projects, including any future intermediate-range ballistic missiles capable of reaching as far as Diego Garcia, in the Indian Ocean. To be sure, the Islamic Republic is unlikely to disavow its regional aspirations, which are premised on forcing the United States out of the Middle East and eliminating Israel altogether.

While the peaceful use of space should be the right of any nation—with the Iranian people and scientific community no exception—the ideological Islamist regime in Tehran should not be trusted with a hedging strategy to hide its true intentions, reinforced by sensitive technologies that could benefit its worrisome missile and drone programs, with further destabilizing effects on the Middle East and beyond.

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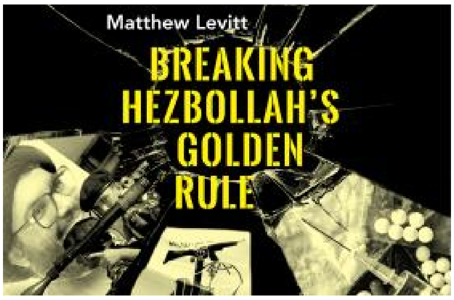

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