Arsenal
Assessing the Islamic Republic of Iran’s Ballistic Missile Program

Behnam Ben Taleblu

Foreword by
Vice Admiral (Ret.)
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Dedication

This monograph is dedicated to the memory and scholarship of three giants in the fields of arms control, nonproliferation, and ballistic missiles: Janne Nolan, Emily Landau, and Michael Elleman. Like many others, I have benefitted immensely from their wisdom, support, and good nature, especially when our views differed. As we say in Persian, “May their souls be joyous, and their memory be cherished.”

Author’s Note

This monograph draws on open-source English- and Persian-language reporting on Iran’s ballistic missiles and patches together more than eight years of the author’s public and private assessments of Iranian strategy, capabilities, and intentions. It builds on excellent scholarship from other research institutions by filling gaps, buttressing findings, and challenging policy recommendations. In so doing, it presents additional data and new interpretations to foster debate over how best to understand and address Iran’s ballistic missile threat. This monograph was continuously revised between rounds of peer review and editing from its earliest submission date, April 2021, to provide the most up-to-date information on Iran’s reported ballistic missile launches. Its information cut-off date is December 2022.
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“Let your enemies be afraid of your power.”
Former Iranian Supreme Leader Ayatollah Ruhollah Khomeini
(April 17, 1980)

“The fact that our enemies are upset by our missiles means that missiles are our most effective weapon today. Through the words of our enemies, we have come to know the value of our missiles more than ever before.”
Former Iranian President Hassan Rouhani
(September 22, 2018)

“Possessing missiles doesn’t solve every problem, but it destroys the greedy fantasy of our enemies.”
Iranian Supreme Leader Ayatollah Ali Khamenei
(November 3, 2020)

“That our enemies are focused on our missile program and consistently express concerns about this and speak of limiting it is due to the power which exists and grows stronger day by day.”
Islamic Revolutionary Guard Corps Aerospace Force Commander Brigadier General Amir-Ali Hajizadeh
(January 16, 2021)

“Praise be to God, the missile power of the Islamic Republic of Iran grows more so day by day against the aggressors, oppressors, global arrogance, and murderous Zionists. ... If there is peace and security in our country, it is because of the fear that the enemies have in their hearts of the result of an invasion and assault against our heroic Islamic system.”
Chief of Staff of the Iranian Armed Forces Major General Mohammad-Hossein Bagheri
(February 9, 2022)
Foreword

America’s adversaries are committed to developing and deploying increasingly lethal missile systems that complicate U.S. foreign and defense policy and pose a threat to our partners, our regional interests, and our own national security. In addition to advances in missile technology by Russia, China, and North Korea, which certainly deserve attention, Washington cannot afford to ignore the Islamic Republic of Iran’s growing ballistic missile capabilities.

During my tenure as director of the U.S. Missile Defense Agency from November 2012 to June 2017, we worked with the military services, the combatant commands, other elements of the Department of Defense, and American industry to protect Americans from enemy ballistic missiles. We also worked with a host of regional allies and partners confronting the same missile threats.

Three years ago, Tehran fired ballistic missiles with considerable accuracy at bases housing U.S. troops in Iraq. More than 100 American service members suffered traumatic brain injuries, and the consequences could have been even worse. Last January, Tehran’s proxies in Yemen apparently used similar missiles in an attempted strike against a base in the United Arab Emirates housing American military forces. And at least twice last year, once in March and once in September, Iran launched ballistic missiles at targets in Iraqi Kurdistan, with the latter strike reportedly killing 13 people, including one U.S. citizen. These attacks demonstrate the increasing willingness of Tehran and its terrorist proxies to use these weapons.

The Islamic Republic and its proxies rely on ballistic missiles to punish and deter action against their regional terror networks. Missiles support Iran’s effort to evict America from the Middle East and coerce U.S. partners into accommodating the Islamic Republic. The United States must therefore develop better missile defense capabilities and other tools to degrade Iranian missile power. The establishment of Aegis Ashore sites in Romania and Poland as part of the European Phased Adaptive Approach is an important but insufficient step.

Understanding the nature and drivers of the Iranian missile threat is a vital prerequisite for developing a comprehensive and effective response.

In “Arsenal: Assessing the Islamic Republic of Iran’s Ballistic Missile Program,” Behnam Ben Taleblu describes in impressive detail the origins, evolution, and future of a weapon that has become synonymous with the Iranian threat. Taleblu leverages an impressive array of English- and Persian-language sources to produce one of the most comprehensive publicly available assessments to date of Iranian ballistic missile capabilities and intentions. In addition to showing how and why Iran’s ballistic missiles will improve over time, Taleblu explains how Tehran’s technical progress on missiles will drive it to employ these weapons more often. Expect more missile attacks and transfers from Iran, not fewer, he argues.

Taleblu walks readers through the wartime origins of Iran’s ballistic missile program in the 1980s and the web of individuals and companies that helped Tehran build the Middle East’s largest missile arsenal. He then sheds light on the reasons Tehran has invested so heavily in ballistic missiles over the past 40 years and how the arsenal affects Iran’s nuclear quest and security strategy. The report covers missile tests in Iran and transfers to proxies abroad, while providing a systematic overview of every known Iranian ballistic missile as well as how Iran is using its space program as a potential pathway to develop longer-range missiles that could one day target the U.S. homeland.

Despite its detail, this timely report is accessible to non-technical readers and to those who are not subject-matter experts on Iran. At the same time, the report offers technical experts several avenues for further research and analysis. Taleblu’s findings and recommendations will stimulate a productive policy discussion regarding the steps Washington must take to counter the rising Iranian ballistic missile threat.
# Glossary

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<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>AIO</td>
<td>Aerospace Industries Organization</td>
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<td>ARI</td>
<td>Aerospace Research Institute</td>
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<td>ASBM</td>
<td>Anti-Ship Ballistic Missile</td>
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<td>ASCM</td>
<td>Anti-Ship Cruise Missile</td>
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<td>BMD</td>
<td>Ballistic Missile Defense</td>
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<td>CAATSA</td>
<td>Countering America’s Adversaries Through Sanctions Act</td>
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<td>CEP</td>
<td>Circular Error Probable</td>
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<td>CRBM</td>
<td>Close-Range Ballistic Missile</td>
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<td>DIO</td>
<td>Defense Industries Organization</td>
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<td>EPAA</td>
<td>European Phased Adaptive Approach</td>
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<td>GCC</td>
<td>Gulf Cooperation Council</td>
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<td>HCOC</td>
<td>Hague Code of Conduct</td>
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<td>IAEA</td>
<td>International Atomic Energy Agency</td>
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<td>ICBM</td>
<td>Intercontinental Ballistic Missile</td>
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<td>IDF</td>
<td>Israel Defense Forces</td>
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<td>IFPC</td>
<td>Indirect Fire Protection Capability</td>
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<td>INF</td>
<td>Intermediate-Range Nuclear Forces</td>
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<td>INKSNA</td>
<td>Iran, North Korea, and Syria Nonproliferation Act</td>
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<td>IRIB</td>
<td>Islamic Republic of Iran Broadcasting</td>
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<td>IRBM</td>
<td>Intermediate-Range Ballistic Missile</td>
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<td>IRGC</td>
<td>Islamic Revolutionary Guard Corps</td>
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<td>IRGC-AF</td>
<td>Islamic Revolutionary Guard Corps Aerospace Force</td>
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<td>IRGC-RSSJO</td>
<td>Islamic Revolutionary Guard Corps Research and Self-Sufficiency Jihad Organization</td>
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<td>IRGC-AF-SSJO</td>
<td>Islamic Revolutionary Guard Corps Aerospace Force Self-Sufficiency Jihad Organization</td>
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<td>IRGC-GF</td>
<td>Islamic Revolutionary Guard Corps Ground Force</td>
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<td>IRGC-QF</td>
<td>Islamic Revolutionary Guard Corps Quds Force</td>
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<td>ISA</td>
<td>Iranian Space Agency</td>
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<td>ISRC</td>
<td>Iran Space Research Center</td>
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<td>JCPOA</td>
<td>Joint Comprehensive Plan of Action</td>
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<td>LACM</td>
<td>Land-Attack Cruise Missile</td>
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<td>LEO</td>
<td>Low Earth Orbit</td>
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<td>LoL</td>
<td>Left of Launch</td>
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<td>MaRV</td>
<td>Maneuverable Re-entry Vehicle</td>
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<td>MRBM</td>
<td>Medium-Range Ballistic Missile</td>
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<td>MODAFL</td>
<td>Ministry of Defense and Armed Forces Logistics</td>
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<td>MTCR</td>
<td>Missile Technology Control Regime</td>
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<td>PGM</td>
<td>Precision-Guided Munition</td>
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<td>PMD</td>
<td>Possible Military Dimensions</td>
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<td>PSI</td>
<td>Proliferation Security Initiative</td>
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<td>RV</td>
<td>Re-entry Vehicle</td>
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<td>SBIG</td>
<td>Shahid Bagheri Industrial Group</td>
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<td>SHIG</td>
<td>Shahid Hemmat Industrial Group</td>
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<td>SLV</td>
<td>Space/Satellite Launch Vehicle</td>
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<td>SMG</td>
<td>Shiite Militia Group</td>
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<td>SRBM</td>
<td>Short-Range Ballistic Missile</td>
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<td>SSM</td>
<td>Surface-to-Surface Missile</td>
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<tr>
<td>UCAV</td>
<td>Unmanned Combat Aerial Vehicle</td>
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<td>UNSCR</td>
<td>United Nations Security Council Resolution</td>
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<tr>
<td>WMD</td>
<td>Weapon of Mass Destruction</td>
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Executive Summary

Iran’s ballistic missile arsenal is growing in size and quality. It is a threat to U.S. interests and the security of America’s allies in the greater Middle East. Improvements in ballistic missile precision, range, mobility, warhead design, and survivability (including the creation of underground missile depots) imply an increasingly lethal long-range strike capability in the hands of the world’s foremost state sponsor of terrorism.

Iran’s diverse ballistic missile program is an outgrowth of Tehran’s experiences during the Iran-Iraq War, which taught the nascent revolutionary regime the imperatives of deterrence and self-reliance. Status and security considerations also spur Iran’s ballistic missile drive, as they do its nuclear program.

Iran’s ballistic missile program benefits from sustained elite backing. The program was established by the Islamic Revolutionary Guard Corps (IRGC), the ideological military that exists alongside Iran’s conventional forces. The missile program is now underwritten by a broad swath of government-connected defense contractors, enabling the procurement, production, and proliferation of missile systems and associated technologies or materials.

Ballistic missiles offer Tehran the means to deter, punish, and coerce adversaries. They compensate for Iran’s conventional warfighting deficiencies and keep the door open for nuclear weapons. According to the 2019 U.S. Missile Defense Review, missiles constitute “one of Tehran’s primary tools of coercion and force projection.”

Iran’s ballistic missile arsenal also provides Tehran with the confidence and security to pursue its revisionist foreign policy with less fear of military reprisal. This may lead to increased risk-taking, including battlefield use of its arsenal. This was apparent in over half a dozen ballistic missile operations launched from Iranian territory between 2017 and 2022, one of which, in 2020, included strikes on bases in Iraq housing American soldiers. Failure to deter Iran will likely guarantee more missile use. In 2022, for example, Iran launched almost three times as many ballistic missiles as it did in 2021. A missile’s ability to reach its target in minutes amplifies existing challenges in an already troubled region.

Since agreeing to the 2015 nuclear deal, formally known as the Joint Comprehensive Plan of Action (JCPOA), Iran has launched at least 228 ballistic missiles, including failed and successful flight tests of surface-to-surface systems in drills and military operations as well as space/satellite launch vehicles (SLV) from its own territory. In addition, Iranian proxies in Iraq, Syria, Lebanon, and Yemen have received ballistic missiles or associated technology from their patron. This weaponry bolsters Iran’s forward-deployed deterrent and threatens U.S. forces in the Central Command (CENTCOM) area of responsibility as well as partners such as Israel and the Arab states of the Persian Gulf.

The JCPOA does not address ballistic missiles, but the deal is slated to remove EU penalties on Iran’s missile brain trust by October 2023. UN Security Council Resolution (UNSCR) 2231, which accompanied the JCPOA, terminates prohibitions on both Iranian missile testing and transfers by the same date. The deal thereby waters down previous UN penalties on Iran’s missile program and inhibits a more coercive Iran policy by Washington and its European partners.

Iran is unlikely to curb its missile program absent sustained pressure. Even intense pressure may at best impede rather than end Iran’s missile aspirations.

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Trading away sanctions leverage for concessions of little value, such as a range cap or a mere promise not to produce intercontinental ballistic missiles (ICBMs), makes little sense. The resurrection of the JCPOA, or a weakened version of it, will also be unhelpful in this regard. So, too, would attempts to view the missile program purely as an arms control matter, in isolation from Iran's regional policies.

Western policymakers must reach consensus on how to counter the Iranian missile threat, the utility of any potential missile agreement, the degree to which any such deal can be verified, and how much of a ballistic missile capability can be tolerated in the hands of the world’s foremost state sponsor of terrorism. Absent Western unity and resolve, the regime is certain to best the West at the negotiating table.

"Washington should adopt policies that disrupt, deter, devalue, and, when necessary, defang the Iranian missile program through diplomatic, informational, military, and economic means."

Washington should adopt policies that disrupt, deter, devalue, and, when necessary, defang the Iranian missile program through diplomatic, informational, military, and economic means. This report offers several options under each rubric, to include increasing sanctions pressure, the enforcement and broadening of export controls, disrupting procurement and proliferation networks through exposure and interdiction, and increasing regional air and missile defense capabilities.


Like most of the regime’s military capabilities, its ballistic missile program emerged from two foundational events: the late Shah’s military buildup prior to the 1979 Islamic Revolution and the 1980-1988 Iran-Iraq War. Yet the impact of the latter drastically outweights that of the former. In 1977, Tehran reportedly inked an agreement with Israel codenamed “Project Flower” to purchase modified Israeli surface-to-surface missiles (SSMs). While the project stopped due to the onset of the Islamic Revolution, it represented Iran’s first attempt to procure an unmanned long-range strike capability. But it would not be the last.

**Wartime Origins and Post-War Evolution**

At 3:20 a.m. on March 12, 1985, the nascent Islamic Republic of Iran launched its first ballistic missile. Assisted by a team of Libyan missile engineers, Tehran fired a Scud-B at a cement factory near Iraq’s Kirkuk oil refinery. The strike marked the first of an estimated 117 Scud missile launches by Iran during the Iran-Iraq War. After Iranian population centers and other targets absorbed Iraqi Scud-B and FROG-7 attacks aimed at eroding Tehran’s will to fight, the Islamic Republic had finally “responded in kind.”

Iran undertook a deliberate and graduated approach when responding to Iraqi missile and rocket attacks, as the Islamic Republic of Iran Broadcasting (IRIB) detailed in a documentary chronicling the evolution of Iran’s missile program and the life of its founder. The regime new methods of force employment and how to establish deterrence.

There was an urgent need for such capabilities. Before war erupted in September 1980, the Islamic Republic was both grossly unprepared and distracted. Six months after the victory of the Islamic Revolution was declared, the Iranian army and air force encountered significant shortages and personnel issues. Iranian revolutionary authorities, which already distrusted the armed forces, inherited a military in disarray. The government also slashed Iran’s military budget and purged the officer corps of the national military, or Artesh.14

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10. The title of the documentary *Khätt-e Moghadam* is a play on words, as it can be translated as “Frontline” but also the line or path of Moghadam, a reference to the purported “father” of Iran’s missile program, Hassan Tehrani-Moghadam. See: A. Ekramian, “[عکس‌بندی کردن ایرانیان که ایران را در عراق به سمت عراق شلیک کرده/ چگونه این موشک به دست ایرانی‌ها آمد دارد؟]” (Bazroxvani Nokhsitin Teshieh Mojeshki Sipa Dar Ooran Edfah Mads), *“Frontline” Documentary*, YouTube, September 30, 2015. (https://www.youtube.com/watch?v=s-LkkVw5O4)


After Iranian students overran the U.S. embassy in Tehran and took American diplomats hostage in November 1979, Washington froze Iranian government assets, thereby impeding Tehran's procurement of military systems. In 1983, the United States initiated Operation Staunch, which aimed to deny the Islamic Republic technology for its war effort. By 1984, Tehran had earned a U.S. designation as a State Sponsor of Terrorism, instituting a complete ban on U.S. arms sales and exports of controlled dual-use goods to Iran.

Having won few friends abroad since 1979, Iran turned to rogue regimes in Syria and Libya for missiles. Hafez al-Assad's Syria offered training on Scud systems but refused to transfer weapons. More permissive was Muammar al-Qaddafi's Libya, which provided Iran with a contract for Scuds, transporter-erector launchers (TELs), and a missile engineering team for training. The Libyan-supplied Scuds quickly demonstrated the deterrent value of ballistic missiles. After only a few Iranian retaliatory strikes, Iraq's attacks on Iranian cities stopped. However, reportedly due to Tehran's refusal to fire Scuds at Saudi Arabia — a condition to which Iranian officials had allegedly agreed when negotiating with Libya — the Libyans cut off assistance and attempted to sabotage Iran's remaining stockpile. This left the Iranians defenseless against resumed strikes by Iraq. Yet by reverse engineering the Libyan Scuds and procuring components from North Korea, a small team led by newly minted IRGC missile force commander Hassan Tehrani-Moghadam enabled the continued firing of Iran's limited Scud arsenal. Tehrani-Moghadam's efforts would earn him the moniker, "father of Iran's missiles."

Iran fired its first Scud without any foreign assistance on January 11, 1987. Later that year, Tehran received

18. From Secret Disassembly and Reverse Engineering to Building Precision-Strike Missiles/The Efforts of Iran's Man Behind the Missile Curtain to Domestically Produce Missiles,” Khabar Online (Iran), November 12, 2019. (https://www.khabaronline.ir/news/1320450)
20. Ibid.
22. Other accounts contend that Libya was pressured by Arab states to cease supporting Iran.
Many of these Scuds struck population centers during the “war of the cities,” as the conflict came to a close in 1988.

For Tehran, the Iran-Iraq War heightened the imperative of domestic arms production. Iran produced several rocket systems in the 1980s, including an unguided artillery rocket known as Oghab. Iran later developed another rocket, named the Nazeat, variants of which remain in service today. In the post-war period, experimentation with various forms of rocket propellant gave Tehran the capability to build larger, longer-range, and increasingly more capable solid-propellant systems. Iran's progress on solid-propellant systems has yielded an increasingly precise conventional strike weapon employed in public military operations over the past half decade. Iran has also developed at least two solid-propellant SLV motors, raising questions about its ICBM aspirations.

Foreign military support also continued into the post-war period. China provided at least one whole SSM system, dubbed the Tondar-69, as well as gyroscopes and other missile-related technologies. Russia also provided technical assistance and raw materials for the

an estimated 100 Scud missiles from North Korea. Many of these Scuds struck population centers during the “war of the cities,” as the conflict came to a close in 1988.

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Iranian missile program in the 1990s. China remains a key jurisdiction for procuring dual-use goods for the regime’s missile program.

**“Over the past four decades, Iran has procured at least three whole ballistic missile systems from North Korea.”**

Of all of Iran’s outreach, engagement with North Korea proved the most fruitful. In the early 1990s, North Korea transferred Scud-Cs to Iran, as well as more TELs. Over the past four decades, Iran has procured at least three whole ballistic missile systems from North Korea. Pyongyang reportedly developed Iran’s first nuclear-capable medium-range ballistic missile (MRBM), known as the Nodong-A, which Tehran produced under the name Shahab-3 and first tested in the late 1990s. Today, the Shahab-3 is the bedrock of several Iranian liquid-propellant MRBMs and SLVs. In the early 2000s, Pyongyang provided Iran yet another liquid-propellant nuclear-capable ballistic missile that may be the foundation for a potential intermediate-range ballistic missile (IRBM) capability.

The IRGC, which developed Iran’s ballistic missile program, believes that had Tehran abandoned its missile and long-range strike ambitions when the war ended in 1988, another devastating conflict would have taken place. This unwavering belief in the deterrent power of missiles has driven Iran’s procurement and production of missiles into the current era.

America’s response to Tehran’s missile advancements has largely been a policy of denial and containment: a mix of sanctions, export controls, diplomatic pressure, and missile defense initiatives. Furthermore, Washington has narrowly regarded ballistic missiles as nuclear delivery vehicles rather than as conventional-strike assets. To keep pace with the evolving Iranian ballistic missile threat, the United States must refine and enhance these policies.

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The Role of Ballistic Missiles in Iran's National Security Strategy

The pursuit of status and security drive Iran's ballistic missile program just as they do its nuclear program. Ballistic missiles feature prominently in Iranian national security strategy, offering a political, military, and even psychological tool to deter, punish, and coerce Iran's adversaries, as well as to support Tehran's interconnected foreign, security, and defense policies. While the overarching goal of Iran's national security strategy is the perpetuation of the regime, other aims include regional primacy and self-reliance.

Status and Security: Two Sides of the Same Coin

In 2018, the Office of Iran's Supreme Leader produced a video featuring wreckage from Iraqi missile attacks on Iranian cities during the Iran-Iraq War. “Do you remember?” Khamenei asked. “We had no missiles, we had nothing to defend with, we were forced to put our hands together and watch.” The video ended with a montage of Iranian ballistic missile launches. The message was clear: Iran's ballistic missile arsenal and capabilities are among the Islamic Republic's most identifiable achievements.

The regime deems these weapons to be crucial to its existence, its revolutionary foreign policy, and increasingly, the capabilities of its proxies. According to former IRGC Commander Mohsen Rezaie, “Our missiles were planted like a sapling in the war. We harvested its first fruits during the war. But the main fruits of this tree took place after the war, in a manner that Iran's missile capabilities in the region are unique.”

Today, Iran's ballistic missile arsenal contains an array of short- and medium-range systems. Iranian officials are proud of their newfound status as the region's preeminent missile power and use that status to press for hegemony. Iranian officials and media outlets tout...
foreign coverage of Iran’s missile developments as a measure of the regime’s prowess.46

As much as it shuns the current global order, Tehran covets international recognition of its scientific, technical, and military advances. In fact, Iranian officials boast of the regime’s missile and military progress while under sanctions and believe it is a model for other states to employ.47 They also frame opposition to Iran’s missile and military advances as hostility to the regime. IRGC Aerospace Force (IRGC-AF) Commander Amir-Ali Hajizadeh neatly captured this view when he said, “Now they have made the missile issue an excuse… They seek to do something so that we are disarmed and so that we cannot respond in kind.”48 Similarly, Gholamhossein Gheibparvar, former commander of the Basij paramilitary force, said, “The issue of Westerners is not over missiles; rather, their issue is about Islam and the Revolution.”49

Strategies and Capabilities Enabled by Iran’s Ballistic Missiles

Iranian strategy prioritizes above all else the ability to deter or punish attacks on the homeland and, when possible, on regime interests abroad. Some Iranian officials believe that Western hostility toward Tehran’s ballistic missile program stems from the high deterrent value of Iran’s domestically produced missiles, which — in their view — severely complicate military plans targeting Iran.50 As Michael Eisenstadt notes, ballistic missiles have become “central to Iran’s ‘way of war’” and are one leg of “Iran’s deterrence triad,” which also includes asymmetric maritime capabilities and employment of terrorist groups as proxies.51

During the Iran-Iraq War, Iran sought to deter Iraq by “responding in kind.” Early in the “War of the Cities,”52 Iran’s ballistic missiles permitted the regime to punish its Iraqi adversary and to obtain pauses in...
warfighting. They also believe the war was the source of the regime's deterrent and defensive capabilities. As Kenneth Pollack notes, after the war, Iranians armed themselves not against renewed Iraqi aggression, but against a far more powerful adversary: America. Tehran has focused on how best to contest American military dominance and deter a U.S. attack while advancing its revolutionary foreign policy.

Today, Iranian officials use the example of the eight-year war to illustrate the cost aggressors would pay in a conflict and believe several wars have already been prevented as a result. They also believe the war was the source of the regime's deterrent and defensive capabilities. As Kenneth Pollack notes, after the war, Iranians armed themselves not against renewed Iraqi aggression, but against a far more powerful adversary: America. Tehran has focused on how best to contest American military dominance and deter a U.S. attack while advancing its revolutionary foreign policy.

Such thinking assumes that as the regime conducts its regional policy — exporting its ideology and creating, co-opting, and supporting local armed groups — Iran will need tools to offset conventionally superior adversaries who have a vested interest in maintaining the regional order that Iran seeks to overturn. To adapt an analogy developed by Karim Sadjadpour, ballistic missiles provide Tehran with a shield with which to deter attacks, while Iran-backed proxies and militia groups function like a sword that thrusts ahead, operating mostly below the threshold that would prompt Tehran's adversaries to use military force.

Thus, Iran’s ballistic missiles devalue its adversaries’ most powerful tool: conventional military force.

To bolster deterrence, Tehran wields a mix of incendiary rhetoric, parades, and media to trumpet its ballistic missile capabilities. Flight tests, transfers, and battlefield-use of missiles also help reinforce deterrence, based on Tehran’s understanding of its adversaries’ “image of war” and risk tolerance. By signaling that a potential conflict with Iran will involve ballistic missiles, making it protracted, costly, and bloody, the Islamic Republic seeks to force adversaries into a policy of begrudging accommodation.

Ballistic missiles offer the regime both a conventional and an unconventional long-range strike capability that fits into a broader spectrum of unmanned aerial threats. This spectrum includes mortars, conventional artillery, rockets, drones, and both cruise and ballistic missiles. Tehran treats ballistic missiles as its strongest vehicle to deliver punishment and thus a replacement for an effective air force, which the regime lacks because of sanctions that block access to spare parts and (until recently) conventional arms markets.

Compared to advanced fighter aircraft, ballistic missiles require significantly less infrastructure to launch and cost considerably less to develop and maintain. While fighter aircraft may offer more diverse striking options given the array of weapons they can carry (not to mention their reusability), ballistic missiles offer speed and surprise. Moreover, the comparatively high velocity of a ballistic missile makes it harder to intercept than a fighter jet.

The lapse of the UN arms embargo on Iran in October 2020 removed a significant barrier inhibiting Iran’s missile programs. Although UNSCR 2231 continues to ban exports to Iran of Category I and II missiles and other items controlled under the Missile Technology Control Regime (MTCR) until October 2023, the arms embargo’s lapse marked the beginning of an unencumbered advance toward modernizing Iranian forces. This will not lead Tehran to replace its ballistic missiles with fighter aircraft, nor will Tehran build formidable conventional forces.

Iran’s ballistic missile arsenal continues to improve in terms of both quantity (the size and diversity of the force) and quality (missile precision and ability to carry submunition payloads or maneuvering warheads). Enhanced arsenal may lead to a lower threshold for the use of ballistic missiles.

Ballistic missiles offer the regime both a conventional and an unconventional long-range strike capability that fits into a broader spectrum of unmanned aerial threats. This spectrum includes mortars, conventional artillery, rockets, drones, and both cruise and ballistic missiles. Tehran treats ballistic missiles as its strongest vehicle to deliver punishment and thus a replacement for an effective air force, which the regime lacks because of sanctions that block access to spare parts and (until recently) conventional arms markets.

Compared to advanced fighter aircraft, ballistic missiles require significantly less infrastructure to launch and cost considerably less to develop and maintain. While fighter aircraft may offer more diverse striking options given the array of weapons they can carry (not to mention their reusability), ballistic missiles offer speed and surprise. Moreover, the comparatively high velocity of a ballistic missile makes it harder to intercept than a fighter jet.

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in the short-to-medium term. But coupled with the revocation of UN missile prohibitions in 2023, the arms embargo’s lapse will enable Tehran to improve its military, rocket, and missile programs gradually. Iran’s missile advances will force its adversaries to continue investing in more expensive air and missile defenses, a fact the IRGC appears to grasp and is intent on exploiting. Given Iran’s unique experience in the Iran-Iraq War, ballistic missiles are certain to remain central to Iran’s national security strategy.

**Delivery Vehicle for Potential WMD Capabilities**

During the war, the need to deter and punish Iraq’s leadership led the nascent Islamic Republic to develop both ballistic missiles and weapons of mass destruction (WMDs), specifically chemical weapons. U.S. intelligence has documented how Iran’s perceived need to respond to Iraq’s widespread use of chemical agents during the Iran-Iraq War led Tehran to employ this WMD despite earlier “moral and possibly religious” prohibitions the regime harbored. According to the CIA, “in April 1987, Iran clearly crossed the chemical barrier.” There may come a day when Tehran opts to cross the nuclear barrier, too.

According to other U.S. intelligence reports, “Iran’s ballistic missiles are inherently capable of delivering WMD.” Should the regime ever develop nuclear weapons, “it would choose a ballistic missile as its preferred method of delivering” them. A nuclear weapons program has three main requirements: fissile material (i.e., weapons-grade uranium or reprocessed plutonium), weaponization (i.e., warhead development), and a delivery vehicle. Iran has clearly worked on all three. Several classes of Iran’s ballistic missiles already surpass the MTCR range and payload thresholds for nuclear-capable...
systems. Continual refinement of this arsenal through flight-testing, re-entry vehicle (RV) design, and other improvements makes Tehran less likely to face delays related to having a functional delivery vehicle. According to the late Michael Elleman, Iran is “the only country to have developed” a 2,000-kilometer-range missile without “first having developed nuclear weapons.”

Evidence from Tehran’s atomic archive — a trove of nuclear documents Israel seized in 2018 — that pertains to Iran’s crash program for a bomb known as the AMAD plan indicates a link between Iran’s missiles and quest for a nuclear weapon. Several International Atomic Energy Agency (IAEA) reports describing components of the AMAD plan specifically mention Iran’s Shahab-3 MRBM. Notably, a May 2008 IAEA report mentions correspondence between an Iranian military contractor specializing in liquid-propellant missiles (the Shahid Hemmat Industrial Group, or SHIG) and Iran’s top military-nuclear scientist at the time, Mohsen Fakhrizadeh. The IAEA report also notes that Iran conducted studies involving “the testing of at least one full scale hemispherical, converging, explosively driven shock system that could be applicable to an implosion-type nuclear device.”

The AMAD plan, Fakhrizadeh, and a project to redesign the Shahab-3 were also mentioned in the annex of a November 2011 IAEA report, which observed “a link between nuclear material and a new payload development programme.” The report also revealed that Tehran had “conducted computer modelling studies of at least 14 progressive design iterations of the payload chamber and its contents to examine how they would stand up to the various stresses that would be encountered on being launched and travelling on a ballistic trajectory to a target.”

While a 2015 IAEA report on the possible military dimensions (PMD) of Iran’s nuclear program noted that Tehran conducted nuclear weapons-related activities “prior to the end of 2003 as a coordinated effort, and that some activities took place after 2003,” the report failed to address the evolution of Iran’s nuclear weapons efforts. Fakhrizadeh continued to be involved in nuclear-related entities that evolved

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80. Ibid.
Iran's Missiles in Action

Aside from parading ballistic missiles to herald a new system or capability, Iran has three primary means of missile employment: tests, transfers, and military use during peacetime. These actions offer three unique levels of analysis to view Iran's capabilities and intentions.

Tests and Drills

To reap strategic dividends from ballistic missiles as a deterrent, as a substitute for airpower, and as a potential nuclear delivery vehicle, Tehran must ensure these weapons are functional. Continuous flight testing and military drills help accomplish this. A delay in testing leads to foreign inferences about the reliability of older systems, the performance of newer ones, budgetary considerations, or even political restraint. However, a failed test — that is, an inability to launch or an explosion mid-air — can be as much a learning opportunity as a political or technical setback. According to IRGC-AF commander Hajizadeh, Iran guards against missile failure during drills by employing several missiles against a single target. Tests in which Iran fires multiple missiles also offer insight into potential Iranian operations, such as saturation attacks.

At the most basic level, flight testing provides critical data about the readiness, reliability, precision, destructive capacity, and overall performance of a missile. It also speaks to the proficiency of missile...
crews, which may be called upon to erect and launch these projectiles at any time.

Launches can also serve as a signal of resolve against sanctions or international prohibitions on the regime’s ballistic missile activities, such as UNSCR 2231. In recent years, Iranian officials have grown more attuned to the political impact of launches. In February 2016, Hajizadeh alluded to the interest of foreign intelligence services in Iran’s missile testing, noting, “Every time we launch a missile, their spy planes begin working.”

Unlike wind-tunnel tests, outdoor engine tests, and laboratory simulations, flight-testing a complete missile system is the most public trial the regime can undertake short of an actual operation. It is therefore the most controversial. In April 2015, former IRGC Commander and current Vice President for Economic Affairs Mohsen Rezaei revealed:

> It is 10 years that we are engaging in missile drills, but in the last two years, in cooperation with the government, our brothers in the IRGC have not been publicizing their drills so that our friends in the current of nuclear negotiations have the opportunity for discussions... drills are a kind of operation, when we commence drills it causes those who think about threatening Iran to back down and realize that today is not yesterday. Also, by holding missile drills, the readiness of our missile forces increases, and we will be able to test our missiles. 89

Iran’s cognizance of the political implications of public testing peaked in 2017, when Hajizadeh reprimanded Iranian authorities for removing an SLV from a launchpad due to concerns over what the Trump administration might do in response. 90

The target or type of missile fired may carry significance. 91 All of Iran’s MRBMs, for instance, surpass the MTCR threshold qualifying them as nuclear-capable platforms. As such, Iranian MRBM testing may be an effort to refine a nuclear delivery vehicle. After an MRBM drill in March 2016, Hajizadeh re-upped the claim that Iran had missiles with a range of up to 2,000 kilometers specifically for the purpose of striking Israel. 92
However, political signaling has its limits. In a 2017 televised debate, then President Hassan Rouhani, seeking a second term, slammed the IRGC for missile launches in 2016 featuring genocidal slogans against Israel. “They wrote slogans on the missiles so that the JCPOA could be disrupted,” Rouhani said.93 Though the former Iranian president has since offered praise for the missile program,94 his critique is instructive, as it sheds light on how missile testing and the missile program more generally may be tools to adjudicate domestic or factional debates. Tehran University political scientist Sadegh Zibakalam similarly cited Iran's missile launches as a tool used by ultra-hardliners to weaken the JCPOA and its domestic proponents.95

While it is not always clear whether a given missile test was pre-planned or conducted in response to events, one thing is certain: Ballistic missile launches are a key tool of both political and military communication for the Islamic Republic.

Since agreeing to the JCPOA in July 2015 through December 2022, Iran appears to have launched at least 228 ballistic missiles, averaging over 32 missiles per year.96 This figure includes failed and successful flight tests, drills, and military operations launched from Iranian territory. It also includes SLV tests but excludes non-SSMs with a ballistic trajectory. Beginning in mid-2018, Iranian media reduced their coverage of missile tests, covering only military operations and drills. This has rendered assessments that do not rely on satellite imagery or official non-Iranian reporting (such as from the U.S. or UN) hard to make. Relatedly, there is no publicly available (or known) U.S. government tally to date of these launches. Appendix A contains a detailed list of all reported launches employing the criteria stated above.

“Since agreeing to the JCPOA in July 2015 through December 2022, Iran appears to have launched at least 228 ballistic missiles, an average of over 32 missiles per year.”

The 228 launches include at least 91 close-range ballistic missiles (CRBMs), 84 SRBMs, 36 MRBMs, 16 SLVs, and one fully unknown platform. Both Iran's post-JCPOA CRBM and SRBM launches almost tripled its MRBM launches, reflecting a drive to develop more precise, shorter-range systems and to employ these projectiles in military operations. The recent rise in SLV launches should also be noted. The spikes in 2018, 2020, and 2022 reflect military operations against targets in Iraq and Syria, while multiple military drills in 2021 explain the spike seen that year.

Transfers

Transferring ballistic missiles or related components, technologies, or capabilities to proxies and partners is another way Tehran uses missiles to support its broader policy goals. The Islamic Republic has been proliferating missiles for over two decades. In 1999, Tehran reportedly inked an agreement with the Democratic Republic of Congo for transfers of

95. For example: [Sadegh Zibakalam], "[I Will Not Invite [People] to Elections and I Will Not Vote, Interview with Sadegh Zibakalam]," YouTube, March 6, 2021. (https://www.youtube.com/watch?v=UL4QXRMyXk);
96. For sourcing, see footnotes on each projectile launch listed in the table found in Appendix A.
modified Iranian Scud missiles. Around the same time, Iran also began to share MRBM production technology with Libya, the country that furnished Tehran with its first Scuds during the Iran-Iraq War. The 2020 removal of Iran's UN arms embargo, which covered both exports and imports, may permit the Islamic Republic to ramp up its proliferation of missiles and military technology.

Alarmingly, the regime does not simply export missiles or missile-related technologies. It is now also an exporter of missile production capabilities. Iranian officials have increasingly highlighted these transfers in their commentary. In 2014, Hajizadeh bragged that the Iranians “learned how to employ [missiles] from [Syria], but we taught [the Syrians] how to produce [missiles]. The factories for the production of the Syrian missile industry have been transferred from Iran to [Syria].” In January 2021, Hajizadeh again boasted, “Gaza and Lebanon are on the frontlines of this conflict, and whatever you see in terms of missile capability in Gaza and Lebanon has taken place with the support of the Islamic Republic of Iran.” These transfers advance three objectives:

1. **Growing the conventional strike capabilities of the “Axis of Resistance.”** Enhancing the strike capabilities of the Axis of Resistance, a term used by Iranian officials to describe their network of proxies and partners, offers Iran two benefits. First, more lethal systems increase the effectiveness of Iran’s proxies in local battles against shared adversaries. Second, the greater the quality and quantity of Iranian proxies’ missiles and rockets, the stronger Tehran’s conventional deterrent. A more lethal capability in the hands of these proxies functions...
as a knife against the neck of U.S. partners in the region aimed at complicating policy planning and eroding both the will and capability to respond to any instance of Iranian aggression.

As John Hannah observes, Tehran’s investment in the conventional military capabilities of its proxies transforms the Israel-Lebanon border into an Iranian version of the situation along the 38th parallel between North and South Korea. Much as Pyongyang uses its ability to bombard Seoul with overwhelming conventional force to deter preemptive attacks on its homeland and nuclear infrastructure, the Islamic Republic arms Lebanon’s Hezbollah to help deter a potential Israeli strike against Iran and increase the costs of action against Hezbollah itself.

2. Cementing political gains through military means. Iran’s material support to terror groups is not just consistent with the regime’s desire to export its Islamic Revolution. It is also aimed at maintaining its partners’ loyalty in a changing Middle East.

3. Developing and testing an arsenal in exile. The wide geographic dispersal of Iranian ballistic missiles and missile-related technology renders inadequate air and missile defenses trained only on launches from Iranian territory. By proliferating missiles and rockets, Iran can assess their performance under battlefield conditions without the risks of a conflict on Iranian soil. The Islamic Republic’s support for its regional proxies may also be leading to the development of systems absent from Tehran’s own arsenal. Often described by Iranian officials and their proxies as indigenously developed weapons, these new systems make Tehran’s role less visible and insulate the regime from blowback.

There are four jurisdictions today where Iranian ballistic missile-related transfers have impacted the regional balance. They are Yemen, Syria, Lebanon, and Iraq. (See Table 1.) Unsurprisingly, these are the same jurisdictions that an Iranian parliamentarian boasted about controlling in 2014: “Currently, four Arab capitals are in the hands of Iran and are dependent on the Islamic Republic of Iran.”


103. Such as the case of Palestinian rockets or Houthi ballistic missiles, cruise missiles, and drones.


105. [Iran Has Dominated 4 Arab Capitals/Why Did Al-Saud Turn its Back on All Yemeni Political Parties?], Young Journalists Club (Iran), October 11, 2014. (https://www.yjc.ir/00L0Q5)
### Table 1: Iranian Ballistic Missile Proliferation in the Middle East

<table>
<thead>
<tr>
<th>Proxy/Partner Name; Jurisdiction</th>
<th>Ballistic Missile(s)/Capability Transferred</th>
<th>Target(s)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houthis (a.k.a. Ansar Allah); Yemen</td>
<td>Modified Scud variant: Burkan-1⁰⁶ and modified Qiam-1 variants: Burkan-2H,¹⁰⁷ Burkan-3/Zolfaghari⁰⁸; More recently, the Hatem (assumed Kheybar Shekan), Karrar (assumed Fateh-110 or Fateh variant), and Falaq (assumed Qiam-2)</td>
<td>Saudi Arabia, UAE,¹ⁱ⁰ potentially Israel in the future¹¹¹</td>
<td>Iran likely supported upgrades to the Badr rocket;¹¹² which is still in use as a precision-guided munition (PGM) called the Badr-1P or Badr-F</td>
</tr>
<tr>
<td>Assad regime; Syria</td>
<td>Fateh-110,¹¹³ missile factories¹¹⁴</td>
<td>Syrian rebels, potentially Israel</td>
<td>Syria has begun producing Fateh-110s under the name M600 and transferring them to Hezbollah.¹¹⁵</td>
</tr>
<tr>
<td>Hezbollah; Lebanon</td>
<td>Fateh-110,¹¹³ PGM kits,¹ⁱ⁶ subterranean missile factories¹¹⁷</td>
<td>Assumedly Israel</td>
<td>As of this writing, Hezbollah has not fired ballistic missiles at Israel.</td>
</tr>
</tbody>
</table>

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107. The whole thread appears here: @EllemaniISS Twitter, January 25, 2019. (https://twitter.com/ellemaniiss/status/1088840870550478848)


111. “Yemen Fires Badr-1-P Ballistic Missile at Saudi Backed Forces’ Position (+Video),” Tasnim News Agency (Iran), November 4, 2018. (https://tn.ai/1868791)


Although Iran has supplied the Palestinian terror groups Hamas and Palestinian Islamic Jihad (PIJ) with Fajr-3 and Fajr-5 rockets, those systems are unguided and thus excluded from this analysis. At the time of this writing, Iran is not believed to have supplied those groups with entire ballistic missiles. According to Hajizadeh, “Palestinians have become self-sufficient in many areas… [I]t is true that they have learned from Iran, we will definitely help any group, any country, that wants to stand against the Zionist regime.”

Should Tehran supply Palestinian terror groups with precision-strike capabilities, it would be consistent with the regime’s evolving approach to weapons proliferation and technology diffusion for its proxies.

The Houthis

In Yemen, where it supports the Houthi rebels against a Saudi-led coalition, Iran has seen the greatest return on its investment in missile proliferation and related technology transfers. Having captured Scud and

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121. Such as the Badr-3, for instance, which is assumed to be Iranian supplied or supported: “رونمایی از بدر ۳؛ موشک جدید جهاد اسلامی فلسطین” [Unveiling of the ‘Badr 3’; Palestinian Islamic Jihad’s New Missile], Fars News Agency (Iran), May 6, 2019. (https://web.archive.org/web/20220424043020/https://www.farsnews.com/newspaper/13980216000081/رونتان-اره-چکر-موشک-جدید-جهاد-اسلامی-فلسطین)  

Tochka SRBMs from the ousted Yemeni government, the Houthis also developed rocket capabilities. While coalition airpower targeted those capabilities early in the conflict, Iranian military assistance has apparently more than compensated for the loss.

Iranian missile transfers have helped grow Houthi long-range strike capabilities, putting civilian population centers at risk, including the Saudi capital, Riyadh. This has eroded the prospect of a Saudi victory at little cost to Tehran. More broadly, Iran's support to the Houthis offers the Islamic Republic an opportunity to establish a foothold on the Arabian Peninsula and Red Sea, bleed its Saudi rival, and contest U.S. economic pressure.

Starting in 2016, the Houthis unveiled and have employed the Burkan-1 SRBM, a Scud variant. Though Tehran's connection to the Burkan-1 remains unproven given the presence of Scuds in Yemen before the war, Iranian support for its redesign would be consistent with its overall strategy. In 2017, the Houthis debuted the Burkan-2H, which featured more telltale signs of Iranian assistance. For example, jet vanes on debris from the system bore markings used by Iranian defense manufacturers.

In addition, the Burkan-2H shares several identifiers with Iran's Qiam-1 SRBM, which is a Scud-C variant. Like the Qiam-1, the Burkan-2H is a finless, single-stage, liquid-propelled Scud variant topped with a triconic, or “baby bottle,” warhead. The UN Panel of Experts on Yemen assessed in January 2018 that Burkan-2H is “an advanced derivative of the Qiam-1.” The panel also suggested that “most likely,” Burkan-2H components were trafficked overland from Oman after smaller “ship to shore transfers.” Photos of the Burkan-2H contain evidence of shoddy welding, vindicating the thesis of local reassembly of larger imported components.

In mid-2018, Washington sanctioned five Iranians for supporting the Houthi missile program. Among them were individuals with ties to the IRGC Quds Force (IRGC-QF), which supports Iranian external operations; the IRGC-AF’s Al-Ghadir Missile Command, which has operational control over Iran’s missile arsenal; and the IRGC’s Research and Self-Sufficiency Jihad Organization (IRGC-RSSJO), which supports Iranian missile research and development.

In 2019, the Houthis launched their first MRBM, the Burkan-3, at targets in eastern Saudi Arabia. This extended-range Burkan, which would reappear

125. Today, Iran or pro-Iran forces like the Houthis can use missiles to threaten maritime chokepoints like the Strait of Hormuz (Iran) and the Bab al-Mandeb Strait (Houthis), both of which are critical to the world economy and oil trade.
128. @EllemanIISS, Twitter, December 14, 2017. (https://twitter.com/EllemanIISS/status/841382431571103744)
in 2021 as the Zolfaghar,\footnote{131} carries a narrower conical warhead than most Iranian MRBMs but has the same tail-section fins at the Qaum family. The Houthis are the only Iranian partner to have received or developed MRBM capabilities. In conjunction with drones and cruise missiles, Houthi Zolfaghar use has broadened beyond Saudi Arabia with attempts to target critical infrastructure\footnote{132} and even a U.S. base in the UAE in early 2022.\footnote{133}

“\textbf{Iran is believed to be behind the move towards precision-guided weapons in Yemen. Starting in 2018, the Houthis unveiled the Badr-1P, the guided version of an older artillery rocket that has since been modified and used in various missions.}”

Iran is believed to be behind the move towards precision-guided weapons in Yemen. Starting in 2018, the Houthi unveiled the Badr-1P, the guided version of an older artillery rocket that has since been modified\footnote{134} and used in various missions, including against attacks on civilian targets like Aden International Airport in December 2020.\footnote{135} The Houthis also possess a host of upgraded shorter-range systems, such as the Qasim and larger Qasim-2, which the Houthis unveiled in an arms exhibition in 2021.\footnote{136} Many of these new systems share design similarities with solid-propellant Iranian SRBMs of the Fateh-110 family, like control fins under the warhead and at the aft section of the missile. These similarities lend credence to the theory of local production with Iranian technical assistance. Cementing that theory are three new SSMs — the Hadem, the Karrar, and the Falag — revealed at a September 2022 military parade in Sana’a commemorating the eighth anniversary of the Houthi takeover of Yemen. These SSMs appear to be carbon copies of Iranian ballistic missiles with precision-strike capabilities.\footnote{137}

\textbf{The Assad Regime and Lebanese Hezbollah}

In the Levant, Iran’s missile support for the Assad regime in Syria and for Hezbollah in Lebanon is inextricably linked. In 2014, the IRGC-AF’s deputy commander, Seyed Majid Mousavi, described Syria...
as a “good bridge” for Iran’s proxies in the Levant.138 Iranian proxies routinely travel across this land bridge, and Tehran uses it to proliferate arms.139 Given the proximity of Syria and Lebanon, the Islamic Republic has looked to the Assad regime to facilitate Iranian support for Hezbollah, including technology transfers when needed, as was the case with the Fateh-110 SRBM, which both Syria and Hezbollah now possess. The Assad regime has reportedly used the Fateh against Syrian rebel groups, but Hezbollah has apparently not employed the missile in combat. IRGC-AF Deputy Commander Mousavi confirmed that the missile capabilities of the “Axis of Resistance” include “the Fateh class of missiles,” enabling Tehran’s proxies to strike all of Israel.140

Hezbollah claims it fired 8,000 rockets at Israel during the 2006 Lebanon War141 out of an estimated arsenal of 13,000.142 In 2010, Israeli military officials estimated that Hezbollah possessed about 40,000 rockets and mortars.143 Recent estimates vary significantly, putting Hezbollah’s arsenal at anywhere from 100,000 to 150,000 rockets and missiles. Meanwhile, Tehran is working to help Hezbollah convert rockets, including Iranian-provided Falaq and Zelzal rockets,144 into precision-guided munitions (PGMs).145 As of February 2021, Israeli intelligence reportedly believed that Hezbollah possessed “a few dozen PGMs.”146 Others believe this number is now in the hundreds.

The Islamic Republic’s evolving missile support for Hezbollah resembles China’s support for Iran’s missile program in the early 1990s, when Beijing reportedly ceased transferring whole systems but continued transferring technology.147 This speaks to Iranian adaptability in response to external pressure and the local needs of Tehran’s proxies.148 Iran’s evolving proliferation patterns can also be seen in the Israel Defense Forces (IDF) airstrikes against varying targets related to Tehran’s PGM project.149

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138. [How Did The ‘Tondar-69’ Enter Iran’s Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains ‘Fateh’ Missiles], Young Journalists Club (Iran), November 12, 2014. (https://www.yjc.ir/00L8hz)
140. [How Did The ‘Tondar-69’ Enter Iran’s Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains ‘Fateh’ Missiles], Young Journalists Club (Iran), November 12, 2014. (https://www.yjc.ir/00L8hz)
The IDF has identified three phases in Iran’s PGM project. During phase one, from 2013 to 2015, Tehran transferred whole systems to Hezbollah. Phase two, from 2016 to 2018, included the trafficking of select components for PGM kits, such as navigation systems. Phase three, which began in 2019 and is ongoing, involves efforts to develop PGMs entirely in Lebanon. In 2020, the IDF released pictures of factories in Lebanon engaging in this process. As Mousavi stated, “Instead of us giving them a fishing hook, from the beginning, the idea was that we must teach them fishing and construction capabilities.”

Should Iran’s PGM project continue unimpeded, writes Jonathan Schanzer, the Israeli Iron Dome defense system’s “total dominance may come to an end.” Uzi Rubin notes that in the era of PGMs, Iron Dome and other forms of “active defense” will be “necessary but insufficient.” Rubin believes that through a combination of precision and sheer volume, Hezbollah’s arsenal could spell trouble for Israeli defenses, as the terror group could mix PGMs into a volley of rocket fire, hoping Iron Dome will prioritize the lesser threats from unguided projectiles. Increasingly, Iranian officials are wagering that PGMs will render Israel unable to win a war with Hezbollah. Overall, the more precise such projectiles, the less restraint Iran and its proxies may feel against Israel or in the service of Tehran’s regional vision.

### Shiite Militia Groups (SMGs) in Iraq

In August 2018, press reports claimed that Tehran had proliferated Fateh-110 and Zulfiqar solid-propellant SRBMs to proxies in Iraq, along with several launchers. The Islamic Republic uses Iraq for strategic depth, moving select munitions into Iraqi territory to increase their range and mask Iran’s hand in their potential use. In 2021, for example, Iran-backed militias in Iraq launched drones at Saudi Arabia.

The SRBM transfers also provide Iraqi militias with an opportunity to train on new systems. Reuters reported that unnamed Iranian officials said the transfers were part of a project to develop missiles for militias. The report further noted the presence of

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153. How Did The 'Tondar-69' Enter Iran's Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains Missile Precision. [How Did The 'Tondar-69' Enter Iran's Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains 'Fateh' Missiles], Young Journalists Club (Iran), November 12, 2014. (https://www.yjc.ir/00L8hz)


156. Hajizadeh in: [Commander Hajizadeh: We Owe Missile Precision to The Supreme Leader of the Revolution/ US Aircraft Carriers Are a Symbol for Us], Jamaran (Iran), November 22, 2018. (https://www.jamaran.news/fa/tiny/news-1059629)


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missile factories in at least two different parts of Iraq. In December 2019, The New York Times confirmed the SRBM transfers had taken place,\(^\text{160}\) and were intended to augment the unguided rocket and mortar capabilities of Shiite militias in Iraq. Improving the military capabilities of Iran-backed militias such as Kataib Hezbollah could also lead to political gains for these groups.\(^\text{161}\)

**Other Areas?**

There is concern that a combination of diminishing international restrictions and increasing missile capabilities and risk tolerance will encourage Iranian ballistic missile proliferation to jurisdictions outside the Middle East. In mid-October, The Washington Post reported Iran would send additional drones to Russia for use against Ukraine as well as ballistic missiles to include SRBMs like the Fateh-110 and the Zulfiqar.\(^\text{162}\) Reportedly, the Russians sought their improved accuracy.\(^\text{163}\) The transfer would mark the most significant missile transfer by Iran onto European soil and the second instance of Iranian conventional weapons proliferation to Russia. As of December 2022, no such transfer has been reported.\(^\text{164}\)

**Battlefield Use**

“I am Iran’s guardian,”\(^\text{165}\) read a large billboard in Tehran’s Vali Asr Square after Iranian ballistic missile strikes against ISIS in Syria in 2017.\(^\text{166}\) Accompanying the text was the image of a man wearing an IRGC uniform, with missiles being launched from his hand. After a near two-decade lull, the Islamic Republic had openly fired ballistic missiles from its own territory at an adversary.

As of December 2022, Iran has conducted at least 13 ballistic missile operations from its territory since the end of the Iran-Iraq War.\(^\text{167}\) In the first five (which occurred between 1994 and 2001), Iran fired Scuds at

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\(^{165}\) @persepolis_news, Twitter, June 20, 2017. (https://twitter.com/persepolis_news/status/877059788911333376/photo/1)

\(^{166}\) “[The Latest News/The Successful Execution of The IRGC’s Great Revenge/The Missiles’ Precision-Strike on The Positions of Terrorists],” Tasnim News Agency (Iran), June 19, 2017. (https://tn.ai/1440223)

the Mujahideen-e Khalq (MEK), an Iranian dissident organization in Iraq, in retaliation for alleged MEK attacks.\footnote{168} How much publicity the regime wished to shed on those strikes remains unknown. The next eight strikes (which occurred between 2017 and 2022) featured more precise, shorter-range, and domestically produced systems targeting ISIS terrorists in Syria, Kurdish opposition groups in Iraq, U.S. forces in Iraq, and other Kurdish civilian targets in northern Iraq. Iran described most, if not all, of these strikes as retaliatory.

<table>
<thead>
<tr>
<th>Date</th>
<th>Codename</th>
<th>Target</th>
<th>Apparent Rationale</th>
<th>Missiles Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 1994</td>
<td>N/A</td>
<td>MEK base in Iraq</td>
<td>Retaliation for MEK attacks\footnote{171}</td>
<td>Three Shahabs (likely Shahab-1s or Shahab-2s)</td>
</tr>
<tr>
<td>November 1994</td>
<td>N/A</td>
<td>MEK base in Iraq</td>
<td>Retaliation for MEK attacks\footnote{173}</td>
<td>Three Scuds (likely Shahab-1s or Shahab-2s)</td>
</tr>
<tr>
<td>June 1999</td>
<td>N/A</td>
<td>MEK base in Iraq</td>
<td>Unclear; likely retaliation for MEK assassination\footnote{175}</td>
<td>Scud-B (assumed)</td>
</tr>
<tr>
<td>November 1999</td>
<td>N/A</td>
<td>MEK base in Iraq</td>
<td>Unclear; likely retaliation for MEK assassination\footnote{177}</td>
<td>Scuds (assumed)</td>
</tr>
<tr>
<td>April 2001</td>
<td>N/A</td>
<td>MEK bases in Iraq (at least 3 different locations)</td>
<td>Unclear</td>
<td>44 to 77 Scuds (likely Shahab-1s or Shahab-2s)\footnote{179}</td>
</tr>
</tbody>
</table>


169 After the Iran-Iraq War, Iran also engaged in various non-ballistic missile-related military operations abroad. These included various attacks on MEK bases in Iraq as well as a string of more recent cross-border attacks against Kurdish positions in Iraq. See: Mina Aldroubi and Leila Gharagozlou, “Iran shells Kurdish insurgents in Iraq,” The National (UAE), September 20, 2021. (https://www.thenationalnews.com/mena/iraq/2021/09/20/iran-shells-kurdish-insurgents-in-iraq/)


<table>
<thead>
<tr>
<th>Date</th>
<th>Codename</th>
<th>Target</th>
<th>Apparent Rationale</th>
<th>Missiles Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2017</td>
<td>Laylat al-Qadr</td>
<td>ISIS targets in Deir ez-Zour, eastern Syria</td>
<td>Retaliation for ISIS terror attack on Iranian parliament and Ayatollah Ruhollah Khomeini’s shrine</td>
<td>Six SRBMs (Zulfiqars and Qiam-1s)</td>
</tr>
<tr>
<td>September 2018</td>
<td>N/A</td>
<td>Kurdish opposition parties in Iraqi Kurdistan</td>
<td>Uptick in tensions between Tehran and Kurdish insurgent groups</td>
<td>Seven SRBMs (Fateh-110B5) and drones</td>
</tr>
<tr>
<td>October 2018</td>
<td>Zarbat al-Moharram</td>
<td>ISIS targets in eastern Syrian city of Hajin</td>
<td>Retaliation for ISIS terror attack in Ahvaz</td>
<td>Six SRBMs (Zulfiqar and modified Qiams)</td>
</tr>
<tr>
<td>January 2020</td>
<td>Shahid Soleimani</td>
<td>Bases in Ain al-Asad and Erbil housing U.S. forces</td>
<td>For U.S. killing of IRGC-QF chief Qassem Soleimani and Iraqi militia leader Abu-Mahdi al-Muhandis</td>
<td>16 SRBMs (Fateh-313 and modified Qiams)</td>
</tr>
<tr>
<td>March 2022</td>
<td>N/A (assumed Rabi’a 1)</td>
<td>Alleged Israeli presence in Iraq; home of a Kurdish oil tycoon</td>
<td>Retaliation for alleged Israeli attack from Iraqi soil</td>
<td>10 SRBMs (Fateh-110)</td>
</tr>
<tr>
<td>September 2022</td>
<td>N/A</td>
<td>Iraqi Kurdistan; targets affiliated with Kurdish-Iranian opposition groups</td>
<td>Allegedly responding to Kurdish support for protests</td>
<td>73 SSMs reported. Assumed solid-propellant due to size and plume color. Later revealed as Fath-360 CRBM.</td>
</tr>
</tbody>
</table>

Iran’s missile operations are proof that Tehran possesses the ability to punish adversaries using its most prized weapons as well as the commensurate will to overtly launch these weapons from Iranian territory at enemy targets. This willingness contrasts with other covert elements of Tehran’s security policy. Moreover, Tehran may be conducting more missile strikes because it understands American trepidation over Iran’s growing missile force, a point Khamenei underscored while meeting with IRGC commanders after the 2017 Iranian missile strike in Syria. While the strikes from 2017 onward were made possible by Iran’s increasingly precise shorter-range missiles, they were also enabled by the availability of un-defended targets, meaning the regime has yet to employ its most precise ballistic missiles directly against top-tier missile defense assets.

Collectively, recent Iranian ballistic missile operations offer at least five lessons:

1. **Tehran stresses the primacy of deterrence by punishment.** As Khamenei stated in 2018, “The enemy knows that if they hit one, they will receive 10.” The Islamic Republic frames missile strikes as punishment that any potential aggressor would incur. It also helps to refine a message Iranian leaders conveyed for at least two decades: There is no limited war option with Iran. Khamenei has threatened this by saying, “the era of hit and run is over… your leg will become stuck and we...

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196. The caveat here is from Iranian territory, as the Houthis have used ballistic missiles from Iran against Saudi Arabia, and more recently, the UAE, where Patriot and THAAD batteries are present.

will pursue [you].”198 In January 2020, when officials promised a “hard revenge” for the killing of IRGC-QF chief Qassem Soleimani,199 their weapon of choice was ballistic missiles.200

2. Iran’s framing of retaliation matters. Iran's portrayal of missile strikes as purely retaliatory is central to the regime’s revolutionary ethos, which frames the Islamic Republic as innocent, under constant attack, and needing robust defense capabilities to safeguard the Revolution. After the three Iranian missile strikes in 2017-2018, Khamenei is reported to have sought that Iranian retaliation not harm “regular and non-military people.”201 This emphasis on self-defense and avoiding civilian casualties colors Iran’s weapon selection, since less precise projectiles might miss their target completely, embarrass the regime, and undermine the rationale for retaliation. Moreover, if Iran portrays itself as responding to an attack, Iranian officials will seek to maintain public support by describing foreign aggression as the root of the conflict while ignoring Iranian provocations that may have actually led to the attack.202

3. Tehran uses missile strikes to communicate to both domestic and foreign audiences. Iranian officials believe their missiles convey “a very decisive message” to Tehran’s adversaries,203 who draw important conclusions from Iran’s missile strikes.204 To foreign audiences, the retaliatory missile strikes are designed to deter any would-be aggressors by conveying Tehran’s political resolve, military strength, and, more recently, risk tolerance. Following Iran’s 2018 strike on ISIS in eastern Syria, the secretary of Iran’s Supreme National Security Council noted the operation also sent a message to America, as the missiles struck within three miles of U.S. forces.205 Domestically, regime officials want both the elite and the general public to believe that the Islamic Republic is strong206 and that Tehran’s adversaries cannot pressure it into changing course. As Hajizadeh declared after a 2017 Iranian missile operation launched in retaliation for ISIS attacks inside Iran, “We responded to the fireworks of takfiri terrorists with missiles.”207 Hajizadeh echoed this message in 2018, claiming Iran responded with “missiles” to ISIS “bullets.”208

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201. [The Message of the IRGC’s Missile Operation to America and its Allies/ We Have a Multitude of 2,000 Kilometer Precision Missiles],” Defa Press (Iran), September 13, 2018. (https://defa-news.ir/308836)
202. Some Iranian missile strikes, such as the barrage against U.S. bases in Iraq after the killing of Soleimani, not only responded to but escalated an ongoing crisis.
203. [The Message of the IRGC’s Missile Operation to America and its Allies/ We Have a Multitude of 2,000 Kilometer Precision Missiles],” Defa Press (Iran), September 13, 2018.
204. [The Message of The IRGC’s Missile Operation for Enemies Was Much Bigger Than an Incident for Terrorists],” Islamic Republic News Agency (Iran), June 25, 2017. (https://irna.ir/sjkVb3)
207. [Leader of The Revolution: If You Strike, You Will Be Stricken, The Era of Hit and Run is Over],” YouTube, March 13, 2022. (https://www.youtube.com/watch?v=aX5zfX5EbCo)
209. [Commander Hajizadeh: We Responded to The Takfiri's Firecrackers with Missiles],” Iran’s Metropolis New Agency (Iran), June 19, 2017. (https://www.imna.ir/news/307401)
4. Iran's ballistic missile capabilities have improved, but their military effectiveness varies. Iran's January 2020 precision strikes against the Al-Asad base in Iraq shocked much of the world.209 Although the United States confirmed that no American service members were killed, the regime claimed to have struck America's "command [and] control center" in Iraq.210 Through the attack, regime officials conveyed an advanced capability that even U.S. military officials acknowledged.211

"Iran's precision-strike revolution should not be confused with consistent performance. Everything from missile crew training to proper target selection to pre-strike intelligence collection can determine the success of an attack, not to mention the individual missile's functionality."

However, Iran's precision-strike revolution should not be confused with consistent performance. Everything from missile crew training to proper target selection to pre-strike intelligence collection can determine the success of an attack, not to mention the individual missile's functionality. For example, Israeli observers have noted that during Iran's 2017 strike on Syria, just one of the five Zulfiqar missiles hit its target, while the other four landed in the desert.212 Conversely, during its 2018 strike on Kurdish dissidents in northern Iraq, Iran employed a Fajr-110B and fared significantly better. The next strike, against ISIS in eastern Syria in 2018, featured a combined operation employing the modified Qiam with finlets, the Zulfiqar SRBM, and armed drones.213 That operation apparently found more success than Iran's 2017 strike in eastern Syria,214 with Tehran claiming that 40 ISIS terrorists were killed.215 And in 2022, Iran attacked northern Iraq several times, once in the spring and three times in the fall. Each time, it struck ostensibly civilian targets. Of note, Iran's IRGC Ground-Forces (IRGC-GF), rather than the IRGC-AF, conducted the latter three operations, which for the first time featured CRBMs rather than SRBMs. Regardless of the unit or missile class, the military effectiveness of Iran's ballistic missiles remains a toss-up but will likely improve significantly over the medium-to-long term.

5. Tehran's own conclusions matter more than Washington's.客观地说，伊斯兰共和国的袭击没有杀死任何美国人。2020年1月，伊朗对伊拉克的弹道导弹袭击震惊了全世界。209尽管美国证实没有美国军事人员伤亡，但政权声称袭击了美国在伊拉克的“指挥和控制中心”。210袭击消息传出后，伊朗官员还表示具有先进能力，甚至美军官员也认同。211

然而，伊朗的精确打击革命不应与一致性能相混淆。导弹乘员训练、目标定位和预警、导弹前哨情报收集等，均可能决定攻击的成功，而不是单独导弹的功能性。

例如，以色列观察员指出，2017年伊朗对叙利亚的导弹袭击中，仅一枚Zulfiqar导弹击中目标，而其余四枚则落在沙漠中。212相反，2018年对库尔德分离分子在北部伊拉克的袭击中，伊朗使用了改进过的Qiam导弹，带有垂直稳定器，Zulfiqar SRBM和武装无人机。213那次袭击明显比2017年的叙利亚东部袭击更成功。214伊朗声称有40名ISIS恐怖分子被击毙。215而且在2022年，伊朗对伊拉克北部进行了多次袭击，一次在春季，三次在秋季。每次袭击都突袭了表面上看起来是平民的目标。值得注意的是，伊朗革命卫队地面部队（IRGC-GF）而非革命卫队空中部队（IRGC-AF）执行了后三次行动，这是首次使用CRBMs而非SRBMs。无论是单位还是导弹种类，伊朗弹道导弹的军事效能仍然是一个胜负难测，但可能在中长期显著提高的情况。
likely would have forced the United States to respond militarily.\textsuperscript{216} But this is not the lesson Tehran took away. A three-part IRIB documentary from 2021 called “Deterrent” asserted that Iranian missile power deterred U.S. retaliation. At the end of that documentary, Hajizadeh argued that Iran had bested its militarily superior foe thanks to Tehran’s willingness to use its power, drawing a sharp distinction between will and capability.\textsuperscript{217} This increased willingness to use ballistic missiles likely drove Tehran to employ the weapon again in March 2022. Iran allegedly responded to an Israeli threat against Iran from Iraqi territory but ended up striking the home of a Kurdish oil tycoon near Erbil.\textsuperscript{218}

The January 2020 attack marked the first time Iran had conducted a ballistic missile strike against U.S. forces, signaling an increased comfort with direct rather than proxy warfare against a more powerful adversary. America’s previous failure to respond kinetically to Iranian regional escalation may have inadvertently signaled that Washington lacks the will to retaliate. The absence of a U.S. response to Iran’s January 2020 attack likely entrenched this perception: As Hajizadeh said in the aftermath of the strike, “not one bullet was fired towards our missiles.”\textsuperscript{219} Such a perception appears to be lowering the threshold for overt Iranian aggression using ballistic missiles. Indeed, in late September 2022, the IRGC-GF launched a reported 73 CRBMs from a base in northwestern Iran at Iraqi Kurdistan.\textsuperscript{220} The attack killed 13 persons, including one U.S. citizen.\textsuperscript{221} This is the largest reported Iranian missile operation in at least two decades and marks the first known instance in which a U.S. citizen died in an Iranian ballistic missile attack. To date the U.S. has not responded kinetically.

### Unpacking Iran’s Arsenal

**Ballistic Missile Basics**

Ballistic missiles are armed projectiles equipped with guidance systems,\textsuperscript{222} whereas unguided armed projectiles are classified as rockets. Ballistic missiles can use liquid or solid fuel for propulsion, and both types can be found in the Iranian arsenal. Ballistic missiles differ from cruise missiles (which fall outside the scope of this study) in terms of flightpath, altitude, and engine or motor. While ballistic missiles follow a parabolic flightpath, cruise missiles fly low and parallel to the earth. Depending on their range and if they were fired on a lofted trajectory, ballistic missiles can follow an endoatmospheric or exoatmospheric flightpath. Cruise missiles stay within the atmosphere and use an air-breathing engine (often a turbojet or turbofan, but for significantly higher speeds, a ramjet) for propulsion.

Iran has an evolving land-attack cruise missile (LACM) capability as well as a significant anti-ship cruise missile (ASCM) capability. Cruise and ballistic missiles carry

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\textsuperscript{216} The strikes did lead to more than 100 American servicemembers being diagnosed with traumatic brain injuries.

\textsuperscript{217} See: Aminjarahi, “Documentary ‘Deterrent’ – Iran’s Missile Power | Part Three (Final),” YouTube, January 16, 2021. (https://www.youtube.com/watch?v=z17xVAm7rKM)


\textsuperscript{220} Images From the IRGC’s Operation Center Against Separatist Terrorists,” Mehr News Agency (Iran), September 28, 2022. (https://www.mehrnews.com/news/5598936/)

\textsuperscript{221} Dan De Luce and Abigail Williams, “An American citizen was killed in an Iranian attack in Iraq, the State Department says,” NBC News, September 29, 2022. (https://www.nbcnews.com/news/world/amERICAN-citizen-was-killed-iranian-attack-iran-state-department-says-rcna50056)

\textsuperscript{222} For more on the importance of these definitions, see: William Gallo, “North Korea’s Latest Weapon: A Rocket or a Missile?” Voice of America, August 1, 2019. (https://www.voanews.com/east-asia-pacific/north-koreas-latest-weapon-rocket-or-missile)
conventional (high-explosive) or unconventional (nuclear, chemical, or biological) payloads. Iran also has other types of ballistic missiles that are not surface-to-surface missiles (SSMs), such as anti-ship ballistic missiles (ASBMs), which are designed for naval targets but follow a ballistic trajectory.\footnote{This report covers only SSMs with a ballistic trajectory. ASBMs, ballistic missiles that are air-launched or submarine-launched, and all types of cruise missiles fall outside the scope of this report.}

Some ballistic missiles can carry separating warheads, which detach from the missile’s body during flight. These warheads contrast with non-separating warheads, which make an easier target for missile defenses. Ballistic missile warheads can be equipped with unitary or cluster munitions. (The latter munitions shower the targeted area with bomblets prior to impact.) Iran has ballistic missiles that can be outfitted with all of the above.\footnote{For more, see: “سرجنگی بارانی مسکن‌های ایران چگونه عمل می‌کند؟/ تخریب و سوزانی با کلاه‌های ایران و کارآمد بی‌تصویری” [How Does Iran's Showering Warheads Work?/ Extensive Destruction With Cheap and Efficient Warheads + Pictures],” Tasnim News Agency (Iran), September 30, 2020. (https://tn.ai/2359270)}

Range is another important metric. This report employs range definitions used by the U.S. government: CRBMs can travel up to 300 kilometers. SRBMs travel between 300 and 1,000 kilometers. MRBMs travel between 1,000 and 3,000 kilometers. IRBMs travel between 3,000 and 5,500 kilometers. Finally, ICBMs travel beyond 5,500 kilometers.\footnote{John Pike and Steven Aftergood, “Ballistic Missile Basics,” Federation of American Scientists, June 4, 2000. https://fas.org/nuke/intro/missile/basics.htm}

Precision is another measure to track. A missile’s precision is assessed through its circular-error probable (CEP), a calculated radius within which roughly half of all strikes will fall. The smaller the CEP, the more precise the missile and the more useful it is as a battlefield weapon. By way of example, the Scud-B, which Iraq and Iran fired at one another during the Iran-Iraq War,\footnote{Central Intelligence Agency, Directorate of Intelligence, “Iran-Iraq: Ballistic Missile Warfare and its Regional Implications,” March 1986. (https://www.cia.gov/readingroom/docs/CIA-RDP88T00096R000100120003-6.pdf)} has a CEP of 450 meters.\footnote{“SS-1 ‘Scud,’” Center for Strategic and International Studies, August 2, 2021. (https://missilethreat.csis.org/missile/scud)} Conversely, the Fateh family of missiles used in more recent Iranian military operations reportedly has a CEP of 10 meters.\footnote{Agnès Levallois, Vincent Tourret, and Stéphane Delory, “Iranian operations against el-Asad and Erbil bases: what can be learned from the imagery? Part One,” Fondation Pour La Recherche Strategie, February 12, 2020. (https://www.frstrategie.org/en/publications/strategic-imagery/iranian-operations-against-el-asad-and-erbil-bases-what-can-be-learned-imagery-part-one-2020)}

Organizing Iran’s Ballistic Missiles

There are various ways to group Iran’s ballistic missiles. Some scholars divide them based on class, which prioritizes range. Others have focused on missile family, clustering systems based on their progenitor. Still others divide Iran’s arsenal based on propellant or chronology of development. It is also possible to divide Iran’s missiles by mission or by whether they meet the MTCR understanding of a “nuclear-capable” system. There is no right or wrong way. This report employs a combination of these approaches. Appendix B describes in detail every known ballistic missile in the Iranian arsenal designed for surface-to-surface use, while Table 3 lists those munitions and provides relevant data about each system, drawing on Persian-language reporting. The table and appendix both omit reference to a November 2022 claim by Iranian officials about having built a hypersonic ballistic missile due to the lack of any detail or image.\footnote{“Iran says it has built hypersonic ballistic missile -Tasnim,” Reuters, November 10, 2022. (https://www.reuters.com/world/middle-east/iran-says-it-has-built-hypersonic-ballistic-missile-tasnim-2022-11-10)}
Table 3: Known Iranian Ballistic Missiles

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
<th>Class</th>
<th>Propellant</th>
<th>Reported Range (km)</th>
<th>Missile Diameter (cm)</th>
<th>Missile Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tondar-69</td>
<td>Thunder-69</td>
<td>CRBM</td>
<td>Solid</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fateh-110 (A/B/C/D)</td>
<td>Conquerer-110</td>
<td>SRBM</td>
<td>Solid</td>
<td>250 (A) 300 (B/C/D)</td>
<td>61</td>
<td>8.8</td>
</tr>
<tr>
<td>Fateh-313</td>
<td>Conquerer-313</td>
<td>SRBM</td>
<td>Solid</td>
<td>500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zulfiqar</td>
<td>Lord of the Spines SRBM</td>
<td>Solid</td>
<td>-</td>
<td>700</td>
<td>68</td>
<td>10.3</td>
</tr>
<tr>
<td>Fateh Mobin</td>
<td>Clear Conquer</td>
<td>SRBM</td>
<td>Solid</td>
<td>700</td>
<td>236</td>
<td>-</td>
</tr>
<tr>
<td>Dezful</td>
<td>Named after city of Dezful</td>
<td>SRBM/MRBM</td>
<td>Solid</td>
<td>~1,000</td>
<td>~68</td>
<td>~10.3, 234 1231</td>
</tr>
</tbody>
</table>

230. This table covers only known or reported ballistic missiles in the arsenal of Iran (not proxies). It includes surface-to-surface missiles and omits rockets, even if modified (such as the Zelzal family), as well as any specifically designated anti-ship missile variants. SLVs can serve as the basis for longer-range missiles but are addressed separately. Unless otherwise indicated through footnotes, this table's figures were sourced from the IRIB documentary "Deterrent." See: [Partisan Documentary], [Partisan Documentary], [Partisan Documentary], [Partisan Documentary], and [Partisan Documentary].

231. See: "[How Did The ‘Tondar-69’ Enter Iran’s Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains ‘Fateh’ Missiles],” Young Journalists Club (Iran), November 12, 2014. (https://www.yjc.ir/00L8hz)


233. Reportedly negotiated up from 125 kilometers by the Iranians when procuring from China, see: "[How Did The ‘Tondar-69’ Enter Iran’s Missile Organization?/ 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains ‘Fateh’ Missiles],” Young Journalists Club (Iran), November 12, 2014. (https://www.yjc.ir/00L8hz)

234. See: "[Features of The IRGC’s New Missiles],” Young Journalists Club (Iran), January 16, 2021. (https://www.yjc.ir/00L8hz)


236. Importantly, the Dezful family of missiles has been reported to have reached a range of 1,000 kilometers. This is a significant increase from the previous range of 700 kilometers. See: "[Features of The IRGC’s New Missiles],” Donya-e Eqtesad (Iran), August 20, 2020. (https://www.hamshahrionline.ir/news/542075)


240. Estimate: @imamedia_org, January 22, 2021. (https://twitter.com/imamedia_org/status/1352671565821968384/photo/1)
<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
<th>Class</th>
<th>Propellant</th>
<th>Reported Range (km)</th>
<th>Missile Diameter (cm)</th>
<th>Missile Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra'ad-500 (a.k.a. Zouhair)</td>
<td>Thunder-500 (Name of companion of Imam Hussein at Karbala)</td>
<td>SRBM</td>
<td>Solid</td>
<td>500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shahid Haj Qassem</td>
<td>Martyr Haj Qassem</td>
<td>MRBM</td>
<td>Solid</td>
<td>1,400</td>
<td>-85-95</td>
<td>11</td>
</tr>
<tr>
<td>Fath</td>
<td>(a.k.a BM-120; assumedly Fath-360)</td>
<td>Conquest (Conquest-360)</td>
<td>CRBM</td>
<td>80-100, -130-170,24 or 120 14</td>
<td>40-50% smaller than Fateh-110, -30</td>
<td>40-50% smaller than Fateh-110, -4</td>
</tr>
<tr>
<td>BM-250</td>
<td>N/A</td>
<td>CRBM</td>
<td>Solid</td>
<td>250</td>
<td>45.6</td>
<td>7.235</td>
</tr>
<tr>
<td>Kheibar Shekan</td>
<td>Breaker of Kheibar</td>
<td>MRBM</td>
<td>Solid</td>
<td>1,450</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sejjil-2/Sejjil</td>
<td>Baked Clay-2</td>
<td>MRBM</td>
<td>Solid</td>
<td>2,000</td>
<td>125</td>
<td>17.5,18</td>
</tr>
<tr>
<td>Shahab-1</td>
<td>Meteor-1</td>
<td>SRBM</td>
<td>Liquid</td>
<td>300</td>
<td>88</td>
<td>11</td>
</tr>
<tr>
<td>Shahab-2</td>
<td>Meteor-2</td>
<td>SRBM</td>
<td>Liquid</td>
<td>500</td>
<td>88</td>
<td>11</td>
</tr>
</tbody>
</table>

Other sources allege the range can stretch up to 1,700-1,800 kilometers.

Other estimates of the new Fath's range, weight, and diameter can be found here:
- [The 'Breaker of Kheibar' Ballistic Missile with a Range of 1,450 Kilometers was Unveiled + Film], Tasnim News Agency (Iran), February 9, 2022. (https://tn.ai/2659706)
- [The Sejjil Ballistic Missile; A Symbol of Iran's Long-Range and Precise Missiles + Video], Mashregh News (Iran), January 21, 2021. (https://www.mashreghnews.ir/news/1171101/)
- [Pictures and Specifications of the Fateh Family of Missiles Which Has 13 Members | Iran's Longest-Range Tactical Ballistic Missile is Unveiled], Hamshahri (Iran), August 20, 2020. (https://www.hamshahrionline.ir/news/542075/
- [Pictures and Specifications of the Fateh Family of Missiles Which Has 13 Members | Iran's Longest-Range Tactical Ballistic Missile is Unveiled], Hamshahri (Iran), August 20, 2020. (https://www.hamshahrionline.ir/news/542075/
### Toward Longer-Range Capabilities: Space/Satellite-Launch Vehicles

In 2011, several Iranian military officials said the Islamic Republic would not produce missiles with a range of over 2,000 kilometers. Khamenei himself reportedly called for that range limit. Such an injunction would theoretically inhibit Iran from developing IRBMs or ICBMs and thus lock in Tehran's existing MRBM and SRBM arsenal. Many analysts welcomed the news of Tehran's voluntary range cap even though it was a political rather than a legal or technical prohibition.

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**Name** | **Meaning** | **Class** | **Propellant** | **Reported Range (km)** | **Missile Diameter (cm)** | **Missile Length (m)**
--- | --- | --- | --- | --- | --- | ---
Qiam-1, Qiam-2 (a.k.a. Modified Qiam) | Uprising-1/2 | SRBM | Liquid | 700 (1,000 for Qiam-2, updated) | 88 | 11.5 (11.846 for Qiam-2)
Shahab-3 | Meteor-3 | MRBM | Liquid | 1,150-2,000 | 125 | 15.86
Ghadr-1(101) and F/H/S | Magnitude-1(101) and F/H/S | MRBM | Liquid | 1,350-1,950, 1,750 (H), and 1,950 (F) | 125 | 15.86
Emad | Pillar | MRBM | Liquid | 1,700-2,000 | 125 | 15.5
Rezvan | Satisfaction/Contentment; Gatekeeper of Paradise | MRBM | Liquid | 1,400 | - | -
Khorramshahr, Khorramshahr-2 (a.k.a. Modified Khorramshahr) | Named after city of Khorramshahr | MRBM/potentially IRBM | Liquid | 2,000 (potentially up to 3,000 for Khorramshahr-2) | 150 | 13

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252. [The Qiam Missile's Range Reached 1,000 kilometers], *Tasnim News Agency* (Iran), January 3, 2022. (https://tn.ai/2637608)
253. Ibid.
254. The U.S. government assesses that the Shahab-3 can travel up to 2,000 kilometers. See: “Ballistic and Cruise Missile Threat,” *National Air and Space Intelligence Center*, 2020, page 25. (https://fas.org/irp/threat/missile/bm-2020.pdf) Iranian outlets have analyzed the varying Shahab-3 ranges based on payload as well. For examples, see: [The Most Terrifying Ballistic Missiles of Iran From the Shahab-3 to the Sejjil], *Young Journalists Club* (Iran), December 15, 2019. (https://www.yjc.news/00U6Dj)
Iranian Ballistic Missile Reach

**Key:** Distance from Kermanshah, Iran

<table>
<thead>
<tr>
<th>Ballistic Missile</th>
<th>Range (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fateh-110</td>
<td>300</td>
</tr>
<tr>
<td>Qiam-1</td>
<td>700</td>
</tr>
<tr>
<td>Emad</td>
<td>+1,700</td>
</tr>
<tr>
<td>Shahab-1</td>
<td>300</td>
</tr>
<tr>
<td>Zulfiqar</td>
<td>700</td>
</tr>
<tr>
<td>Ghadr</td>
<td>~2,000</td>
</tr>
<tr>
<td>Fateh-313</td>
<td>500</td>
</tr>
<tr>
<td>Dezful</td>
<td>~1,000</td>
</tr>
<tr>
<td>Sejjil-2</td>
<td>2,000</td>
</tr>
<tr>
<td>Shahab-2</td>
<td>500</td>
</tr>
<tr>
<td>Shahab-3</td>
<td>+1,150</td>
</tr>
<tr>
<td>Khorramshahr</td>
<td>+2,000</td>
</tr>
</tbody>
</table>
However, this cap did not end Iran’s quest for longer-range missiles. The regime’s space program, including its SLV production and testing, offers another pathway, but under a civilian guise. Tehran has long employed a “civilian” or scientific rationale to justify other security pursuits, like its nuclear program, which always had military dimensions.

As noted earlier, the regime’s quest for status and recognition is a key driver of its military capabilities. Along with a strategy of nuclear hedging, this “status discrepancy,” as Shahram Chubin notes, “accounts for Iran’s space ambitions.”\(^\text{260}\) Tehran genuinely covets the respect afforded to nations that can put satellites into orbit and develop other space-based capabilities. Iran frames scientific accomplishment, particularly while under sanctions, as the fruits of its defiance against perceived Western attempts to impede Iranian power. But this alone does not define the Islamic Republic’s interest in SLVs.

According to the U.S. Defense Intelligence Agency, progress on SLVs can also “aid Iran’s development of longer-range ballistic missiles because SLVs use inherently similar technologies.”\(^\text{261}\) Likewise, a 2017 report by the U.S. Air and Space Intelligence Center said, “Tehran’s desire to have a strategic counter to the United States could drive it to field an ICBM. Progress in Iran’s space program could shorten a pathway to an ICBM.”\(^\text{262}\) The 2020 version of the report reiterated that assessment.\(^\text{263}\) SLV production and testing teach countries about thrust, staging, and boosters for carrier rockets that can be reconfigured as ICBMs. SLVs and long-range missiles both require guidance systems (to varying degrees) as well as telemetry equipment to inform ground-based crews about mid-flight changes in the projectile’s speed or temperature.

“Tehran has long employed a ‘civilian’ or scientific rationale to justify other security pursuits, like its nuclear program, which always had military dimensions.”

Yet while SLVs share many similarities with ICBMs, they do have differences,\(^\text{264}\) such as contrasting trajectories based on the engines or motors employed in each projectile.\(^\text{265}\) More importantly, ICBMs require ablative coatings and heat shields that enable their RVs to re-enter the atmosphere and deliver their payload to the target. SLVs, on the other hand, do not use RVs. As of this writing, the Islamic Republic does not have an ICBM but has tested several different types of SLVs, five of which deserve attention here.

The first two SLVs, the Safir and Simorgh, rely on liquid-propellant engines, are based on the Shahab-3/ Nodong-A MRBM, and have achieved mixed results in putting satellites into low-Earth orbit (LEO). Iran first tested the Safir in 2008. The Safir utilizes the

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Ghadr-1 (which is a Shahab-3 variant) for its first stage and has a smaller second stage. The Safir has been used to deliver almost all of Iran's satellites that remain in LEO. Between 2006 and 2013, however, Iran relied on another liquid-propellant SLV known as the Kavoshgar sounding rocket to put satellites into LEO. While one class of Kavoshgar rockets is reportedly based on the Shahab-3, there are several earlier versions modeled on artillery rockets. Some of these Kavoshgar rockets continue to be used to support the Iranian space program. In October 2022, for example, Iran used an older Kavoshgar carrier rocket to launch an orbital transfer block named the Saman, presumably to function as a tug between satellites in the future.

Conversely, the Simorgh, which Iran first unveiled in 2010 but tested in 2016, has failed to put a satellite into orbit. Despite these failures, Iran will likely continue to test the Simorgh, which is only one of several platforms associated with Iran’s large liquid-propellant SLV program run by the Iranian Space Agency (ISA). These include the prospective Sarir SLV at 35 meters long and 2.4 meters in diameter, which Tehran hopes will one day put a one-ton payload into a 1,000-kilometer orbit. Also under development is the Sorouch SLV, with a diameter of 4 meters, which will allegedly be able to put a 15-ton payload into a 300-kilometer orbit.

Compared to the Safir, the Simorgh is a larger, two-stage SLV that reportedly relies on four Shahab-3 engines for its first stage. Analysts have noted these engines are similar to the North Korean three-stage Unha carrier rocket. The U.S. Treasury Department revealed in 2016 that Iranian defense contractors from the Shahid Hemmat Industrial Group (SHIG)—a subsidiary of Iran’s Aerospace Industries Organization (AIO), which in turn is a subsidiary of Iran’s Ministry of Defense and Armed Forces Industries Organization—used the Simorgh in North Korea. 


274. For example, Gunter Krebs, “Kavoshgar (Type B),” Gunter’s Space Page, accessed August 15, 2022. (https://space.skyrocket.de/doc_lau/kavoshgar-b.htm)


276. The North Korean three-stage Unha carrier rocket also uses Nodong-A engines. The Shahab-3 is the Iranian version of the Nodong-A. For more, see: Jeffrey Lewis, “Will Iran's Simorgh Space Launcher Appear in North Korea?,” Nuclear Threat Initiative, July 8, 2016. (https://www.nti.org/analysis/articles/will-iran-simorgh-space-launcher-appear-north-korea/)


Forces Logistics (MODAFL) — worked with Pyongyang on an 80-ton rocket booster. SHIG officials previously attended the launch of the Unha rocket in North Korea in 2012. The UN Panel of Experts on North Korea raised these concerns about SLV cooperation in a March 2021 report.

In a recent letter to the UN secretary general, Israeli officials raised a similar issue related to “unusual activity” from December 2021 that they assessed was “connected to the development of a new, 80-ton thrust liquid propellant engine that was tested at the location. This type of engine could be used for future satellite launch vehicles and could potentially be implemented in intercontinental ballistic missile projects.” Open-source experts and imagery analysts continue to raise concerns over Iranian liquid-propellant engine testing, noting that Tehran likely engaged in a long-range or potential liquid-propellant engine test between late May and early June of 2022. The location of the test, a facility in Khojir, is believed to be overseen by SHIG.

Although Iranian officials claim that Tehran is committed to the ‘peaceful use of space,’ the IRGC-AF deputy commander admitted otherwise with reference to Iran’s solid-propellant program.

The other three SLVs tested by Iran, the Qased and the Zuljanah, both employ solid-propellant in at least one stage and are therefore more worrisome. As exemplified by India, nations driven by status and security considerations have used solid-propellant SLVs, and space programs more generally, to develop ICBMs.

Although Iranian officials claim that Tehran is committed to the “peaceful use of space,” the IRGC-AF deputy commander admitted otherwise with reference to Iran’s solid-propellant program. Hassan Tehrani-Moghadam, who led the IRGC’s missile force during the Iran-Iraq War, reportedly chose to work on SLVs and solid-propellants once limitations were placed
on advancing Iran’s missile range so as “to keep this path moving forward.” 287 Lest anyone think this work was unauthorized, Iran’s supreme leader reportedly termed it a “clear path.” 288 Tellingly, after his death, Tehrani-Moghadam’s brother alleged that Hassan’s final project was “related to an intercontinental ballistic missile and was in the final stages.” 289

In April 2020, the IRGC-AF conducted a surprise launch of a three-stage SLV called the Qased. The SLV’s second stage utilized the recently unveiled Salman solid-propellant motor, which in February 2020 was shown to have thrust-vectoring capabilities, a sign of advancing Iranian rocketry. The motor also indicates a desire to move toward longer-range missile development. The Salman is the first Iranian motor with this capability and is produced by the IRGC-RSSJO,290 which supports Iranian missile research and development. 291 In February 2022, the IRGC unveiled a new, much larger solid-propellant motor called the Ra’afe,292 also with thrust-vectoring capabilities. The Ra’afe is estimated to be 12.5 tons, 9 meters long, and 1.25 meters in diameter293 and can reportedly generate 68 tons of thrust.294 An ultra-hardline Iranian daily heralded the Ra’afe with the following headline: “5,000 Kilometer Missiles Are More Within Reach Than Ever.”295 For his part, the IRGC-AF commander used the Ra’afe’ unveiling to claim that Iran could build an all-solid-propellant SLV by 2023.296

According to the IRGC-AF chief, the Qased SLV used a liquid first stage simply for cost-saving purposes, and Iran is close to developing a fully solid-propellant SLV.297 The combination of a functioning solid-propellant motor, a surprise launch,298 the use of a

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288. Ibid.
298. “دسترس‌تر در از کیلومتری همیشه قاصد را چگونه ساخت؟ [How Did the IRGC Create the Three-Stage Qased Missile?],” Tasnim News Agency (Iran), May 6, 2020. (https://tn.ai/2258410)
transporter-erector launcher (TEL) rather than a launch pad with a gantry tower, and the involvement of the IRGC-AF rather than the ISA raises worries about the direction of IRGC-AF’s parallel solid-propellant space program.

In February 2021, Iran revealed video footage of a new three-stage solid-propellant SLV called the Zuljanah, which the regime tested without a satellite. Two of its three stages employed solid-propellant motors, but they were not reported to be the Salman. Reportedly, the Zuljanah weighs 52 tons and is 25.5 meters long and 1.5 meters in diameter. It can generate 75 tons of thrust.

While the ISA, not the IRGC, carried out the Zuljanah test, the SLV’s body bore the AIO logo, also seen on the Safir and Simorgh SLVs. This should be cause for concern, as AIO is Iran’s chief entity responsible for missile production, and its logo appears on numerous solid-propellant platforms, such as variants of the Fateh SRBM and the Sejjil MRBM.

Given that Iran aims to put more satellites into orbit and Iranian President Ebrahim Raisi has promised to reinvigorate and fully fund Iran’s space program, SLVs will remain a growth industry for the regime. Already, the head of the ISA has promised more launches before the end of the Iranian calendar year 1401, which ends in March 2023.


301. The program was previously called the Qa’em project. See: “گزارش ویژه تسنیم: پروژه فضایی پرورده پژوهی شهید طهرانی-پورزشی با محوریت پژوهشی و 1000 کیلومتری با موشک چهارمرحله‌ای قائم | تسنیم، TASNIM Special Report: Decoding Martyr Tehrani-Moghadam’s Most Important Space Project/ Movement Towards a 1,000 Kilometer Orbit with The Four-Stage Qaem Missile,” TASNIM News Agency (Iran), November 16, 2019. (https://tn.ai/2141185)


Table 4: Select SLVs Tested by Iran

<table>
<thead>
<tr>
<th>Name</th>
<th>Meaning</th>
<th>First Revealed/Tested</th>
<th>Last Tested</th>
<th>Motor/Engine</th>
<th>Stages</th>
<th>Length (m)</th>
<th>Overseen By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safir</td>
<td>Ambassador</td>
<td>2008&lt;sup&gt;316&lt;/sup&gt;</td>
<td>August 2019&lt;sup&gt;317&lt;/sup&gt;</td>
<td>Liquid</td>
<td>2</td>
<td>22&lt;sup&gt;308&lt;/sup&gt;</td>
<td>ISA</td>
</tr>
<tr>
<td>Simorgh</td>
<td>Phoenix</td>
<td>2010/2016</td>
<td>December 2021&lt;sup&gt;319&lt;/sup&gt;</td>
<td>Liquid</td>
<td>2</td>
<td>27&lt;sup&gt;310&lt;/sup&gt;</td>
<td>ISA</td>
</tr>
<tr>
<td>Qased</td>
<td>Messenger</td>
<td>2020</td>
<td>March 2022&lt;sup&gt;321&lt;/sup&gt;</td>
<td>Hybrid (currently: liquid-solid-solid)</td>
<td>3</td>
<td>17.75&lt;sup&gt;312&lt;/sup&gt;-18.1&lt;sup&gt;313&lt;/sup&gt;</td>
<td>IRGC-AF</td>
</tr>
<tr>
<td>Zuljanah</td>
<td>Name of Imam Hussein’s horse</td>
<td>Assumed late 2020/early 2021</td>
<td>June 2022&lt;sup&gt;314&lt;/sup&gt;</td>
<td>Hybrid (currently: solid-solid-liquid)</td>
<td>3</td>
<td>25.5&lt;sup&gt;316&lt;/sup&gt;</td>
<td>ISA</td>
</tr>
<tr>
<td>Qa'em-100</td>
<td>Upright-100</td>
<td>November 2022</td>
<td>November 2022</td>
<td>Solid</td>
<td>3</td>
<td>20&lt;sup&gt;318&lt;/sup&gt;</td>
<td>IRGC-AF</td>
</tr>
</tbody>
</table>

While Iran would have to make considerable strides in RV technology, engine or motor development, control, and guidance to develop a fully functioning ICBM, the Simorgh SLV can provide Tehran with a pathway to at least an IRBM capability if reconfigured. A more effective route to ICBMs for Tehran, however, would be through the Qased or Zuljanah SLV, both of which can serve as the bedrock for an all solid-propellant system, as Iran previously hinted. Potentially, Iran could try to mix and match its solid-propellant motors in SLVs at different stages for an altogether new system.

In November 2022, Iran revealed its interest precisely in this option when the IRGC-AF’s space division made good on an earlier promise by the IRGC-AF to launch a new and hitherto unseen SLV named the Qa'em.<sup>319</sup> On November 5, the IRGC-AF engaged in a suborbital launch of the Qa'em-100, billed as a three-stage solid-propellant SLV. The IRGC-AF Space Force commander claimed that the SLV was tested without its upper second and third stages because it previously tested them on the hybrid Qased SLV.<sup>320</sup> The successful test of the Ra'afe...
— a large solid-propellant motor first unveiled and static tested in January 2022 — in the Qa'em as its first stage motor, development of smaller solid-propellant motors, as well as promise to develop more Qa'em variants all point towards the IRGC's success in developing an all-solid-propellant SLV.

While the IRGC-AF commander has since stated that the Qa'em-100 would be used to place the Nahid satellite into orbit by the end of the Iranian calendar year (March 2023), the Qa'em program is also a qualitative leap forward for Tehran's long-range strike capabilities. One Iranian outlet has already called the Qa'em “in reality, a tactical intercontinental missile.” As the program expands, these advancements should be seen for what they are: an ICBM effort.

Notably, the Qa'em bears the same name of the projectile Tehrani-Moghadam, the founder of Iran's missile program, was working on at the time of his death. The TEL for the Qa'em's launch at Shahroud also bore a large poster of Tehrani-Moghadam, further linking the projects. Should this be the same system, too, it would serve as the clearest indication to date of Iran using its space program to further its military capabilities and develop long-range strike platforms.

**Wherein Lies the Threat?**

The more Iran improves its ballistic missile arsenal, the greater the incentive for the regime to use these weapons. When speaking in 2020 about the range of Iran's missiles and the proximity of American military installations to Iran, Hajizadeh likened the vulnerability of these facilities to being “like meat under teeth.” Elsewhere, Hossein Amir-Abdollahian, now Iran's foreign minister and previously a special advisor to the speaker of the Iranian parliament, has contrasted Iran's willingness to use its missiles with the risk-averse behavior of its pro-American neighbors, which he mocked as “having turned into storage depots of advanced Western weapons.”

More capable missiles will add greater credence to Iranian threats and coercive diplomacy in the region, which in turn, might further tempt Tehran towards overt military force to accomplish its aims. This is especially true for improvements in missile precision, which stands to offer the regime more battlefield-ready weapons.

But even if an increase in capability does not directly yield a decrease in the threshold for their use, a more robust missile force — coupled with the regime's perception that missiles deter enemies — may lead Iran to take more risks when pursuing its regional security strategy. In so doing, Tehran may misread an adversary's red lines for the use of force, employ or transfer a certain weapon or technology, and beget an unintended war.

Below are seven areas where the Islamic Republic's ballistic missile program is expected to improve in the medium term.

**Precision:** Iran's ballistic missiles have undergone a revolution in precision from their Scud-based origins. According to the commander of Iran's IRGC-AF, Khamenei sought to improve the precision of Iran's
missile force. “I want precision from you” was how Amir-Ali Hajizadeh recalled his charge from Khamenei in 2009. Since then, the regime has unveiled numerous variants of the Fateh-110 SRBM, Iran’s most precise missile family. Tehran has used these platforms in recent military operations (2017-2022), achieving better results than expected. Meanwhile, Tehran is improving the precision of its proxies’ rocket forces by providing guidance and control technology to turn older rockets into precision weapons. The more precise the missiles, the greater their ability to deter attacks and strike Iran’s adversaries in the region.

Reliability: Missiles must perform under difficult conditions, including but not limited to inclement weather. Given the size and age of Iran’s arsenal, frequent test launches from a variety of locations can ensure reliability. Starting in mid-2018, Iranian outlets stopped publicizing most individual missile launches. This shift can imply that the rationale behind Iran’s ongoing missile launches has more to do with maintaining the military utility and readiness of Iran’s large missile arsenal than using tests to signal resolve.

Patterns of Force Employment: Recent Iranian military drills (such as Great Prophet 15 and 17) have seen employment of loitering munitions, also known as suicide or kamikaze drones, against targets that were subject to ballistic missile attacks. In October 2018, the IRGC-AF engaged in a combined arms operations using SRBMs and Unmanned Combat Aerial Vehicles (UCAVs) against Islamic State targets in eastern Syria. Iran’s embrace of training for combined arms operations offers insight into how the regime may employ its ballistic missiles, in the future.

Warheads: Different warhead types and shapes can suggest different payloads. They also reflect the regime’s efforts to make its missiles more aerodynamic and stable upon re-entry. Warhead advances can be seen with respect to separating warheads and maneuverable RVs; the latter can be found on the Qiam-2, Khorrarmshahr-2, and Emad missiles. Iranian warheads can be unitary or configured to carry submunition payloads. The diversity of warheads reflects the diversity of missions assigned to Tehran’s various missiles, as well as Iran’s progress in design and engineering. Triconic warheads have a lower radar cross-section and higher re-entry speeds. While some scholars assert that the triconic shape of the Ghadr and Qiam-1 warheads could be an indicator of their potential nuclear use, as that shape is often associated with miniaturized nuclear payloads, documents from the seized atomic archive indicate that Iran originally planned to put a nuclear device in the Shahab-3’s conical RV.

Solid-Propellants: Solid-propellant missiles require less preparation time prior to launch and are more road mobile than liquid-fuel missiles. These advantages make

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328. سردار حاجی‌زاده‌ها: وقتی شاهب سه دقت موشک‌ها را تدوین دیدیم رهبر معظم انقلاب سربازی/ نوحه‌های نوی ایمی امریکا برای ما یک سیله هستند.” [Commander Hajizadeh: We Owe Missile Precision to the Supreme Leader of the Revolution/ America’s Aircraft Carriers Are a Symbol for Us!], Jamaran (Iran), November 22, 2018. (https://www.jamaran.news/fa/tiny/news-1059629)


330. Iranian outlets did, of course, publicize drills and military operations.


332. @FarsNews_Agency, Twitter, October 1, 2018. (https://twitter.com/FarsNews_Agency/status/1046736014696488960)

333. This need not only occur with drones. In his seminal work on cruise missile proliferation, Dennis Gormley posited that weapons like cruise missiles will support, rather than replace, ballistic missiles, creating a more complex air and missile defense challenge. See Dennis M. Gormley, Missile Contagion: Cruise Missile Proliferation and the Threat to International Security (Annapolis, MD: Naval Institute Press, 2008)

334. See: سرجکی برای موشک‌های ایران چگونه عمل می‌کند؟ تکریم با کلاه‌کهنه ایران و کارآمد بیشتری [How Do Iran’s Showering Warheads Work? Extensive Destruction With Cheap and Efficient Warheads + Pictures], Tamin News Agency (Iran), September 30, 2020. (https://tn.ai/2359270)


solid-propellant missiles less susceptible to pre-emptive, or “left-of-launch,” strikes.\textsuperscript{337} Iran has made significant progress on solid-fuel systems, as seen in variants of its Fateh-family missiles and in its production of solid-propellant motors for the Qased and Zuljanah SLVs. Iranian officials have commented on the role shorter-range solid-propellant systems will play in phasing out their Scud-based SRBMs, though it is unclear if Tehran is phasing out the latter because of inferior precision and age or because of the challenge of producing liquid-fuel motors.

**Range:** Iran’s SLV program offers Tehran ways to skirt the self-imposed 2,000-kilometer range cap and work towards developing an IRBM and ICBM capability that could one day be used to threaten the European continent or U.S. homeland. Years of reverse-engineering missiles and producing various missile classes have also taught Iran about stretching airframes and building them with lighter composite materials to increase missile range. The same applies to the production of composite solid-propellant motors, such as the Ra’ad-500. A recent Fateh-family derivate, the Kheibar Shekan, is more proof of the regime’s investment in various solid-propellant MRBM platforms and follows the unveiling of the Shahid Haj Qassem MRBM. By lightening the warhead, Iran has reportedly increased the range of the Khorramshahr MRBM to a potentially IRBM threshold weapon.\textsuperscript{338}

**Survivability and Mobility:** Most, if not all, of Iran’s SRBMs and MRBMs are mobile, which increases survivability. The regime also continues to develop new underground missile depots complete with transportation and firing systems, such as a new missile train that fires Emad missiles on an automatic clip, as unveiled in November 2020.\textsuperscript{339} Iran is also developing subterranean missile production\textsuperscript{340} and storage centers.\textsuperscript{341} These underground missile complexes are reportedly the largest in the Middle East.\textsuperscript{342} In June 2020, as part of the Great Prophet 14 military drill, Iran launched its first-ever ballistic missile from underground.\textsuperscript{343}

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\textsuperscript{340} Ali Javid, “Rise Fortieth, Deep depth, Iran Missile Cities, underground bases,” YouTube, February 21, 2019, (https://www.youtube.com/watch?v=DmjcP9-hB1g)

The Domestic ‘Engine’ Propelling Iran’s Ballistic Missile Program

Numerous U.S. government reports have stressed over the years that Tehran remains reliant on foreign technology for its missile and military programs. In 2001, the National Intelligence Council noted, “foreign assistance — particularly from Russia, China, and North Korea — will remain crucial to the success of the Iranian missile program” through 2015. In 2010, the Pentagon conditioned Iran’s ability to develop an ICBM by 2015 on Tehran’s receipt of “sufficient foreign assistance.” And in 2019, a Defense Intelligence Agency report said Iran’s missile program “continues to depend on foreign suppliers for critical components and technology.”

Still, the regime has made significant strides toward missile self-sufficiency. This does not diminish the role that secondary sanctions, export controls, warning lists, sabotage, and interdictions have played in countering Iran’s ballistic missile program. Rather, the program owes its advances to support from a domestic architecture of individuals, entities, and even entire industries and sectors of the Iranian economy.

Laying the Foundation: Personnel

Although success has a thousand fathers, Iran’s missile program is purported to have had just one: Hassan Tehrani-Moghadam. Despite his modest technical background, Tehrani-Moghadam laid the foundation for domestic missile production by reverse-engineering missiles during the Iran-Iraq War. Today, Tehrani-Moghadam is an iconic figure for the regime and its supporters. Music, books, and documentaries chronicle his life and the evolution of Iran’s ballistic missiles. Upon his death in 2011, the regime gave him the honorific of Shahid, or martyr.

Tehrani-Moghadam began his IRGC career in an intelligence unit in northern Iran at the age of 21. In 1981, one year after the start of the Iran-Iraq War, the regime sent him to the front lines, tasking him with organizing mortar support based on a plan he had proposed to IRGC leaders. Less than a year later, Tehran tasked him with developing the IRGC’s first artillery unit. Soon after, the regime dispatched

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349. [Choral/Plan for the Father of Iran's Missiles], “Mashregh News” (Iran), November 13, 2012. (https://www.mashreghnews.ir/photo/170549)
350. [From Frontlines to The Conqueror of Jerusalem], Center for the Study of Resistance Literature and Culture (Iran), November 11, 2020. (http://www.oral-history.ir/?page=post&id=9567)
352. [Martyr Tehrani-Moghadam; A Pious Manager and Scientist], Islamic Republic News Agency (Iran), October 27, 2020. (www.irna.ir/news/84089795/)
353. [From Secret Disassembly and Reverse Engineering to Producing Precision-Strike Missiles/The Efforts of the Man Behind The Curtain to Domestically Produce Missiles], Khabar Online (Iran), November 12, 2019. (https://www.khabaronline.ir/news/1320450/)
him to Syria as part of a 13-man team for a crash course on missiles.

Upon Iran's first delivery of Scuds from Libya, Tehrani-Moghadam reportedly asked to take apart and reverse-engineer one of them. Drawing on his experiences in Syria as well as technical support from North Korea (where he later traveled), Tehrani-Moghadam and his team were able to repair and launch missiles when Libyan assistance to Iran ended. In 1985-1986, Tehran appointed him head of the IRGC-AF's first-ever missile command. Tehrani-Moghadam reportedly then went to Lebanon to lay the foundation for Hezbollah's missile capabilities.

After the Iran-Iraq War, Tehrani-Moghadam produced and upgraded the Shahab liquid-propellant platform while also supporting Iran's burgeoning rocket program, which would provide the basis for Iran's solid-propellant systems a generation later. In 1997/1998, Iran's supreme leader promoted Tehrani-Moghadam to the rank of brigadier general. Tehrani-Moghadam reportedly then went to Lebanon to lay the foundation for Hezbollah's missile capabilities.
If Tehrani-Moghadam is the father of Iran's missile program, Mohsen Rafighdoost is its reported “grandfather.”366 Rafighdoost served as Iran's first IRGC minister, a position abolished after the Iran-Iraq War. Rafighdoost's memoirs describe arms procurement trips abroad, including a visit to an underground bunker in North Korea.367 But it was Rafighdoost’s travels to Syria and Libya that laid the foundation for Iran's missile arsenal, securing agreements on missile training for the IRGC and procurement of Scud-Bs, respectively.368 Rafighdoost has not held a military position since the end of the Iran-Iraq War.


362. [What Important Project Was Tehran-Moghadam Occupied With When Martyred?/New Details of The IRGC's Space Program], “Tasnim News Agency” (Iran), November 11, 2020. (https://tn.ai/2387289)

363. “میر 69” چگونه با همکاری آمریکا تیرندازی کرد؟ [How Did the “Tondar-69” Enter Iran's Missile Organization?] 2,000-Kilometer Missiles to Strike the Zionist Regime/ The Resistance Attains “Fateh” Missiles,” Young Journalists Club (Iran), November 12, 2014. (https://www.jyc.ir/00L8hz)


365. [What Important Project Was Tehran-Moghadam Occupied With When Martyred?/New Details of The IRGC's Space Program], “Tasnim News Agency” (Iran), November 11, 2020. (https://tn.ai/2387289)


Another pivotal IRGC member in Iran’s missile program is Brigadier General Amir-Ali Hajizadeh. Since 2009, he has served as commander of the IRGC-AF. Under Hajizadeh, Iran’s ballistic missiles saw the greatest improvements in survivability, mobility, solid-propellant platform development, and precision. Known for his bellicosity and media engagement, Hajizadeh is one of the original IRGC members who created Iran’s missile command. During the Iran-Iraq War, Tehrani-Moghadam personally chose Hajizadeh to handle a missile shipment in his stead and to serve as deputy commander of Tehrani-Moghadam’s newly formed IRGC missile unit, Hadid. Hajizadeh also took a procurement trip to North Korea. According to documents from Iran’s atomic archive analyzed by the Institute for Science and International Security, Hajizadeh’s signature appears on a 2002 document for “an underground tunnel complex” designed for developing “and building nuclear warheads for ballistic missiles.”

These figures could not have succeeded without political support. One source of support came from the now-deceased former Iranian President Ali-Akbar Hashemi Rafsanjani. During the war, Rafsanjani served as parliament speaker, as Khomeini’s...
representative on Iran's Supreme Defense Council, and briefly as acting commander-in-chief of Iran's Armed Forces. During Rafsanjani's presidency (1989-1997), Tehran developed its missile and rocket program as part of its larger post-war reconstruction efforts, soliciting support from China, Russia, and North Korea. According to Rafsanjani's memoirs, he was the one who tasked Rafighdoost with going to North Korea after procurement trips to Libya and Syria. Rafsanjani visited North Korea on a procurement trip in the 1980s while serving as parliament speaker.

Rafsanjani also visited Libya during the war with another influential Iranian politician, Iran's then president and current supreme leader, Ayatollah Ali Khamenei. President for six of the war's eight years, Khamenei reportedly took a keen interest in Iranian missile development, even visiting missile sites and personnel. After the Libyan Scud team left Iran, Khamenei reportedly instructed the IRGC to begin domestic missile production. Since becoming supreme leader and commander-in-chief of Iran's armed forces in 1989, Khamenei has had the final say over the regime's defense policy, including its missile program. According to Hajizadeh, Khamenei specifically tasked him with improving Iranian missile precision after Hajizadeh became IRGC-AF commander in 2009.

Many others have contributed to the program. Every CEO of AIO, the chief missile subsidiary of Iran's MODAFL, has expanded Tehran's missile capabilities. This includes Mehrdad Akhlaghi — the former head of AIO's Shahid Bagheri Industrial Group (SBIG) as well as Seyyed Mehdi Farhi and Ahmad Vahid Dastjerdi.

382 [From Secret Disassembly and Reverse Engineering to Producing Precision-Strike Missiles/The Efforts of the Man Behind The Curtain to Domestically Produce Missiles], Khabar Online (Iran), November 12, 2019. (https://www.khabaronline.ir/news/1320450/)
383 [Commander Hajizadeh: We Owe Missile Accuracy to The Supreme Leader of the Revolution/ America's Aircraft Carriers Are a Symbol for Us], Jamaran (Iran), November 22, 2018. (https://www.jamaran.ir/news/1059629)
386 [The Head of the Aerospace Industries Organization of the Ministry of Defense: Variable Range and Radar Evasion; Two Important Traits of the Qiam Ballistic Missile], Resalat (Iran), August 22, 2010. (https://www.magiran.com/article/2139574)
All the past commanders and deputy commanders of Iran's IRGC-AF have also strengthened the regime's missile capabilities. In 2017, Hajizadeh revealed that during Mohammad Bagher Qalibaf’s tenure as IRGC-AF chief (1997-2000), “[m]easures were devised to build a missile base in each city and province,” which likely led to Iran's underground missile cities. For his part, the IRGC-AF’s current deputy commander, Majid Mousavi, has provided critical insight into the regime's thinking about its missile program. Mousavi first revealed that Tehrani-Moghadam pursued a space program to circumvent Khamenei's range cap. More recently, as first discovered by Fabian Hinz, Mousavi publicly claimed that Tehran has ICBMs, an assertion Iranian media later removed from footage of his remarks.

Building on the Foundation: Entities

In 2016, IRGC-AF Commander Hajizadeh boasted that “[m]ore than 85 percent of our basic needs are met internally, and in other cases, we are in the final stages of research.” Underwriting Iran's domestic missile production is a robust military-industrial complex engaging in research, development, design, acquisition, testing, transportation, storage, solicitation, end-user obfuscation, and control over other elements of Iran’s missile supply chain. Iran also has a network of financial institutions that process transactions for or otherwise directly support these entities. The United States and the European Union have already identified and sanctioned many of these entities, which are listed in Appendix C.

These same entities also support Iran’s MODAFL. MODAFL’s various subsidiaries research, produce, and procure military technologies for the IRGC and for Iran's conventional military, and have done so even at the peak of U.S. sanctions. MODAFL subsidiaries, such as AIO, whose logo appears on many Iranian ballistic missiles, are chiefly responsible for missile development but also have their own subsidiaries specializing in different ballistic missile components and technologies. These subsidiaries, in turn, have their own...
specialized subsidiaries contributing to Iran's domestic missile supply chain.\footnote{391}{\textit{Aerospace Industries Organization (AIO)}, \textit{Iran Watch}, October 28, 2019. (https://wwwiranwatchorgiranian-entitiesaerospace-industries-organization-aio)}


**Bolstering the Foundation: Sectors**

IRGC-AF Commander Hajizadeh boasted (somewhat erroneously) in an interview, “Today [our missiles], from idea to product, are in truth completely Iranian. … This work is being done by way of the whole country.”\footnote{394}{پارتیزان مستند [Partisan Documentary], ”Deterrent Part 2,” \textit{YouTube}, January 5, 2021. (https://wwwyoutube.com/watch?v=VtMEzxDxvDU)} In addition to the defense and military contracting sectors, at least six other sectors of the Iranian economy support the Islamic Republic's ballistic missile program. Research centers and universities with engineering and aerospace studies departments help Iran’s military with conceptualization, design, and computer testing. Multiple sectors produce military-grade materials used in the ballistic missile program.\footnote{395}{For an excellent analysis of sectors of relevance, see: Saeed Ghasseminejad, “Iran’s Ballistic Missile Program and Economic Sanctions,” \textit{Foundation for Defense of Democracies}, March 2016. (https://wwwfddorganalysis20160316irans-ballistic-missile-program-and-economic-sanctions/)} For example, the mining sector provides materials that can be refined for military use, such as developing aluminum powder from bauxite.\footnote{396}{Bozorgmehr Sharafedin and Pratima Desai, “Special Report: Inside Iran's secret project to produce aluminum powder for missiles,” \textit{Reuters}, June 24, 2020. (https://wwwreuterscomarticleus-iran-missiles-programme-specialreport/special-report-inside-iran-secret-project-to-produce-aluminum-powder-for-missiles-idUSKBN23V1K1)} The steel industry, which produces and procures high-strength metals, helps develop airframes and motor casings. Iranian steel companies routinely use cut-outs abroad to procure goods with military applications.\footnote{397}{New York CEO gets prison for Iran conspiracy plea,” \textit{Associated Press}, September 8, 2017. (https://wwwtimesofisraelcomnew-york-ceo-gets-prison-for-iran-conspiracy-plea)}

The telecommunications and communications technology sectors help improve precision through control and guidance equipment while providing technical support for ground crews. The construction sector supports the digging of subterranean missile bases and underground missile “cities,” which the regime uses to move, store, fire, and assemble ballistic missiles. The connective tissue between these sectors is the IRGC, which has a robust presence in the Iranian economy overall and has a constellation of veterans, supporters, and partners across the aforementioned sectors.
The U.S. Policy Conundrum

Tehran is dedicated to growing the quantity and quality of its ballistic missile arsenal. Iran’s missile program still managed to expand under peak U.S. economic and military pressure (2018-2021), underscoring the centrality of missiles to the regime’s national security strategy. Tehran has refused to discuss its missile program during diplomatic talks and has not refrained from proliferating and flight-testing key systems. This intransigence underscores the need for U.S. policies that Washington can enact unilaterally or with allies to hamper Iran’s missile program.

U.S. and Iranian Missile Goals

Despite current partisan differences in the United States, there was once greater consensus between Republicans and Democrats on how to address Iran’s ballistic missile threat. After the Iran-Iraq War ended, arms control scholars recommended what amounted to a “strict cartel” to restrict Iranian military development and hinder its long-range strike capabilities. To that end, Washington relied on a combination of trade controls and economic sanctions both to impede Iran’s missile programs and to prevent Tehran from importing or producing components or technologies related to nuclear weapons. This approach complemented Washington’s policies toward Iran’s support for terrorism, regional destabilization, and domestic human rights abuses. Following revelations about Iran’s nuclear program in the mid-2000s, however, U.S. Iran policy began to focus on it obsessively at the expense of other issues.

The Evolution of the JCPOA-Centric Approach

The pursuit of multilateral consensus led U.S. policymakers to embrace an artificial and counterproductive distinction between the “nuclear” and “non-nuclear” threats posed by Iran. In this vein, if policymakers addressed ballistic missiles, it was mostly

through the prism of thwarting a potential nuclear delivery vehicle.

This narrow framing unfortunately divorced Iranian capabilities from the strategies and ideologies behind them, eventually leading policymakers to seek a technical solution (nuclear diplomacy and arms control) to a political problem (U.S.-Iran enmity and the Islamic Republic’s security policy).400

Nowhere was this more evident than in 2014 comments by then Under Secretary of State Wendy Sherman, who testified that the Obama administration’s concern was not with Iran’s “ballistic missiles, per se. It is about when a missile is combined with a nuclear warhead. That is the issue here.”401 Such thinking — in addition to staunch Iranian refusals to broaden negotiations to include missiles — helps explain why the Obama administration and its P5+1 partners did not include Iran’s missile arsenal in nuclear negotiations from 2013 to 2015. The JCPOA, the result of those negotiations, does not address missiles.

UNSCR 2231 (2015), the resolution endorsing the JCPOA, did address the missile issue, but in a less than ideal manner. Annex B of that resolution contains watered-down injunctions against Iranian ballistic missile tests and against weapons transfers to and from Iran. In previous resolutions, such restrictions were permanent. UNSCR 2231 made them subject to eight- and five-year sunsets, respectively.402 UNSCR 2231 calls on the Islamic Republic “not to undertake any activity related to ballistic missiles designed to be capable of delivering nuclear weapons, including launches using such ballistic missile technology, until the date eight years after the JCPOA Adoption Day or until the date on which the IAEA submits a report affirming the peaceful nature of Iran’s nuclear activities, whichever is earlier.”403

By contrast, a previous resolution on Iran, UNSCR 1929 (2010), barred Tehran from “undertak[ing] any activity related to ballistic missiles capable of delivering nuclear weapons, including launches using ballistic missile technology.” The resolution also required other countries to “take all necessary measures to prevent the transfer of technology or technical assistance to Iran related to such activities.”404 In short, not only did UNSCR 2231 prohibit ballistic tests for only eight years; it also gave the regime an ostensible loophole to exploit to continue certain missile tests during the JCPOA period by distinguishing between the “intention” and “design” of these systems as a potential nuclear delivery vehicle.405

Worse, UNSCR 2231 did away with two critical UN bodies: the 1737 Sanctions Committee and its Panel of Experts. Both were created pursuant to previous Iran-related UNSCRs and could have helped probe

Iranian violations of UNSCR 2231, such as missile tests or transfers.\textsuperscript{407}

On the sanctions side, the JCPOA significantly undermines transatlantic efforts to counter Iran's ballistic missile program through economic tools. While the Obama administration waived certain U.S. sanctions that contained missile-related provisions,\textsuperscript{408} America's transatlantic partners plan to go one step further. By October 2023, according to the JCPOA's implementation timeline,\textsuperscript{409} the European Union will delist much of the brain trust behind Iran's missile program, including entities with ties to MODAFL.\textsuperscript{410} That will undermine future U.S. efforts to restrict Iranian missile procurement and production through multilateral measures, be they sanctions or export controls.

Despite sporadically imposing sanctions against Iran's missile program in 2016 (the first year of the JCPOA's implementation and the last year of the Obama administration),\textsuperscript{411} the United States opted against broad sanctions targeting the sectors of Iran's economy behind missile production. Presumably, Washington adopted this policy in the interest of keeping the JCPOA alive and avoiding friction with Tehran.

Washington's approach changed in 2017 when a Trump administration policy review rejected the Obama administration's "myopic" nuclear focus, stressing the need to counter Iran's missile program and regional destabilization.\textsuperscript{412} Initially, the Trump administration tried to "fix" the JCPOA with its transatlantic partners,\textsuperscript{413} with a focus on missiles.\textsuperscript{414} Then U.S. President Donald Trump explicitly asked, "What kind of deal is it where you are allowed to test missiles all over the place?"\textsuperscript{415}

Between the JCPOA's finalization in 2015 and May 2018, when the Trump administration left the
accord, Iran tested at least 27 ballistic missiles. While America’s transatlantic allies criticized these launches, they did not issue a single sanction or other penalty in response.

After leaving the nuclear accord, the Trump administration embraced a unilateral economic pressure policy, dubbed “maximum pressure,” that aimed to attain a better deal and to inhibit Tehran’s adventurism.

Lessons Learned from the Obama and Trump Administrations

The Obama era proved that diplomacy could produce an agreement that trades away economic pressure to get Tehran to curb, though not terminate, elements of its nuclear program for a limited period of time. The logic behind such an approach requires intentionally not addressing the Islamic Republic’s residual nuclear or missile and military capabilities. The Obama administration assumed that less friction, coupled with more economic integration, would over time build sufficient trust to dampen such threats from the regime. As such, the JCPOA was an attempt at threat management and reduction.

A lesson here is that even a limited agreement can inhibit an administration from acting resolutely against Iran’s missile and regional activities for fear of disrupting a purported diplomatic achievement. Other lessons are more obvious, such as the inability of time, economic integration, or trust to moderate the Islamic Republic’s foreign and security policy.

By contrast, the Trump era proved that unilateral economic pressure could have an impact. The logic behind pursuing a more comprehensive policy while increasing sanctions is two-fold: Risks can and should be tolerated en route to a better deal, and macroeconomic pressure will ultimately increase transaction costs for the regime, which, in turn, can influence its behavior. One major lesson from Trump’s policy is that key components of Iranian foreign and security policy, such as militias, terrorism, and ballistic missiles, are relatively cheap, so sanctions must be crippling and sustained to have strategic rather than just economic effect. Another lesson is that any containment policy that relies almost exclusively on economic pressure will inevitably invite escalation, particularly if the regime believes that Washington is risk averse.

Sadly, neither experience settles debates over proximate causes versus root causes of Iranian missile advances or about the regime’s responsiveness to pressure.

As the Biden administration takes stock of these experiences, it faces a more robust Iranian ballistic missile threat. Tehran’s increasingly precise projectiles, its broader radius of missile and technology proliferation, its increased willingness to use missiles in conflict, and greater confidence in its capability to deter adversaries by punishment will further complicate U.S. security policy in the Middle East while eroding the security of U.S. allies.

Policy Parameters

Outlining Acceptable End States for Missile Diplomacy

As Iranian officials have routinely made clear, Tehran refuses to negotiate over its ballistic missile program. But should Iran float certain missile restraints as part of prospective nuclear diplomacy, Washington must be able to assess the restraints’ sufficiency. The goal of any missile diplomacy should be to impose both physical and political constraints on Iranian missiles. Physical constraints might involve the destruction of certain systems. Political constraints might permit Iran to retain a certain capability but require it to curtail particular activities.417

Before negotiating, Washington should be clear about its objectives. To that end, policymakers must be able to answer the following questions:

1. What limitations are both desirable and achievable vis-à-vis Iran’s missile program through diplomacy?
2. Is a trade-off between sanctions and missile capability consistent with U.S. law and national security?418
3. What verification mechanisms exist or need to be created to adequately determine compliance?
4. What tools can Washington use to impact Iranian missile capabilities regardless of any missile deal?

Washington should discuss acceptable end states for Iran’s missile program with European and Middle Eastern partners, although dissonance between the European and American positions is likely to persist.

Ahead of discussions, Washington should think through the following eight challenges:

- **Framework**: The framework for any potential negotiations matters greatly. For example, trying to cover all “nuclear-capable” systems as defined by the MTCR, could cover nearly all of Iran’s arsenal, making diplomacy and verification more challenging. Conversely, a metric too narrow, such as the language found in Annex B of UNSCR 2231, would render diplomacy ineffective. The Washington therefore needs a new framework that accounts for a missile’s age, historical use, range, precision, or other indicators.419

- **Baseline**: Significant uncertainties about the size, scope, and location of Iran’s missiles and related infrastructure affect the types of limitations needed and their verifiability. To verify its compliance with any prospective agreement limiting the size of Iran’s arsenal, Tehran should have to declare its entire missile inventory. There are some international treaties that offer a precedent for or means of enforcing this requirement, such as the now-defunct Intermediate-Range Nuclear Forces (INF) Treaty. Attempting to restrict Iran’s missile arsenal without better understanding its current size and Tehran’s future ambitions would make verification next to impossible.

- **Range Limit**: The 2,000 kilometer-range cap floated by Iran does not sufficiently address the current Iranian missile threat given that shorter-range systems can threaten U.S. interests in the region. Absent an agreement that stems Iran’s use of SLV technology to grow its long-range strike capabilities, this upper-tier range cap leaves open a

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path to nuclear weapons delivery. A shorter-range limit, coupled with permanent restrictions on payload, deployment, and SLV use, could constrain the Iranian missile threat.

- **SLV Challenge:** SLVs are one way Tehran can continue to circumvent Western efforts to hinder its development of long-range strike capabilities. India benefited from first developing SLVs prior to ICBMs. Given that Washington has sanctioned actors involved in Iran’s liquid- and solid-propellant SLV programs, the wisest course of action would be to prohibit SLV launches altogether and, perhaps, even require the destruction of certain systems. If Tehran is permitted to retain an SLV program, it should be required to provide advance notice of SLV launches, which should be held at only one location. Moreover, as Michael Elleman has suggested, Iran could be barred from using main engines, whether employing either solid or storable-liquid propellants, “to launch satellites or space-related experiments, except for legacy systems.”

- **Moratorium on Missile Upgrades:** Most Iranian ballistic missiles are variants of older platforms. The Fateh serves as the bedrock for all of Tehran’s solid-propellant SRBMs. It is also Iran’s most upgraded and most precise missile. Similarly, the Shahab-3 is the foundation for all the Islamic Republic’s liquid-propellant MRBMs, such as the Ghadr and Emad platforms. A moratorium on upgrades might broadly cover research, development, design, and production activity, improving the precision or reliability of existing platforms. Alternatively, the moratorium could be narrowly tailored to ban upgrades to select components, such as RVs. It could also be expanded to proscribe altogether the production of new missile systems. Admittedly, attaining such a moratorium would first require an agreed definition of what constitutes an upgrade. Verification would also be challenging given the myriad locations at which these upgrades could take place.

- **Moratorium on Flight Tests and Engine/Motor Tests:** Flight testing not only helps Iran project power and establish deterrence, it enables Tehran to build a more ready and reliable missile force. Similarly, static engine tests are used to develop new and improved propulsion systems. Moratoriums can be placed on both activities and can be staggered based on the capabilities of the given missile. For instance, Washington should push for a full moratorium on Iranian ballistic missile flight and engine testing until the IAEA declares Iran’s nuclear program as purely peaceful and gets adequate responses to the agency’s queries. After that, Tehran should be required to adhere to the

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Hague Code of Conduct Against Ballistic Missile Proliferation (HCOC), which would require advance warning for tests.

**Deployment and Readiness:** IRGC Commander Hossein Salami has bragged that Iran has a “‘jungle’ of missiles … kept in tunnels, silos, and special headquarters,” and it has a series of missiles on standby at all times. In the event of a missile deal, the geographic deployment of Iran’s missiles will need to be agreed upon by all parties.

**Export Injunction:** Iranian officials claim to have supported the missile capabilities of various proxy groups across the Middle East. Iran is the most significant foreign force behind the Houthis’ long-range strike platforms, such as the Burkan-2H SRBM and the Zolfaghar MRBM. Tehran has also proliferated missiles and rockets to Shiite militia groups in Iraq and Syria and is helping Hezbollah upgrade its rockets to PGMs. Even with stricter multilateral prohibitions in place, the Islamic Republic will not respect export prohibitions, making them challenging to attain in any agreement with Iran.

If securing a diplomatic agreement on any of these areas were not already challenging enough, verification and monitoring are where Washington will face the most trouble. Verification of constraints on Tehran’s missile program can draw upon the IAEA’s history with Iran as well as lessons from military inspections in other countries — whether under UN-mandated missions, such as the UN Special Commission in Iraq, or under bilateral treaties, such as the INF Treaty between the United States and Russia.

Iranian officials remain opposed to inspections of military facilities under the auspices of nuclear verification and would likely oppose inspections related to a ballistic missile agreement. Former IRGC Commander Mohsen Rezaie said as much, positing that America would use inspections of Iranian missile bases to pass military secrets to the Israelis, among others. To an extent, public-private partnerships between Western governments and open-source intelligence analysts can facilitate some verification measures, but there remains no substitute for access to Iranian military facilities.

**Policy Recommendations**

Unless otherwise specified, these recommendations apply to U.S. policymakers only.

**Diplomatic:**

- **Enforce all UNSCRs related to Iranian weapons proliferation.** Although multilateral enforcement of UNSCR 2231 prohibitions on Iranian arms transfers...
and missile tests has been lacking, there are still country-specific UNSCRs whose strict enforcement would hinder Iranian proliferation. UNSCR 2216 (2015) contains an arms embargo on the Houthi rebels.\textsuperscript{429} UNSCR 1701 (2006) contains an arms embargo on transfers to non-state actors in Lebanon and prohibits arms transfers without the permission of the Lebanese government.\textsuperscript{430}

- **Work with partners to resurrect the UN arms ban on Iran.** Washington should work to restore and extend the UN arms ban on Iran, which lapsed in October 2020.\textsuperscript{431} The United States should press the UN Security Council to extend the ban in perpetuity, tying it to Iran’s status as a state sponsor of terrorism. If Russia and China veto the ban, Washington should work with European allies to create a code of conduct to make their territories no-go zones for Iranian procurement.\textsuperscript{432} The United States and its European allies should also threaten sanctions — such as those found in the Countering America’s Adversaries Through Sanctions Act (CAATSA) — should any weapons transfers occur.\textsuperscript{433}

- **Press for unilateral adherence to international control regimes.** Participation by Iran in international control regimes, even non-binding ones, can provide transparency. The Missile Technology Control Regime (MTCR) synchronizes policies related to the export of WMD delivery vehicles such as missiles.\textsuperscript{434} Washington should work with MTCR partners to impede Iranian efforts to procure capabilities or technology covered by Category I and Category II of the MTCR Annex. Similarly, Washington should stress the importance of having Iran adhere to the MTCR as a non-member, as Israel has,\textsuperscript{435} rather than join it. The Hague Code of Conduct against Ballistic Missile Proliferation (HCOC), which builds on MTCR guidelines, calls for annual declarations about missile doctrine, launches, and more.\textsuperscript{436} Notably, Iran has twice voted against HCOC-related resolutions at the United Nations.\textsuperscript{437}

- **Press for adherence to other UN missile endeavors.** Two other multilateral efforts at the United Nations can help impede Iran’s missile proliferation. UNSCR 1540 (2004) prohibits states from helping non-state actors develop WMD or associated delivery
vehicles. The UN Register of Conventional Arms calls on states to submit “relevant data on imports and exports of conventional arms.”

- **Support the Proliferation Security Initiative (PSI).** Created in 2003, the PSI is a global counter-proliferation effort to inhibit illicit WMD and delivery-vehicle trade around the world. Washington should use the PSI statement on “interdiction principles” to develop multinational interdiction forces to thwart Iran's procurement and proliferation of MTCR Category I and II materials. Washington should simultaneously seek both to expand the PSI’s membership and to hold members accountable for reported lapses.

- **Issue a missile-specific executive order.** To address the Iranian missile threat, Washington thus far has relied extensively on Executive Order 13382, which is geared toward WMD and associated delivery vehicles. Given Iran's increasing conventional missile capabilities, the administration should develop an executive order dedicated to Tehran's missile program (or to long-range strike capabilities more broadly, including LACMs and drones). This executive order should authorize the imposition of secondary sanctions against individuals or entities that support the Islamic Republic’s development, procurement, proliferation, testing, storing, transferring, or use of missiles.

- **“Snapback” UN sanctions on Iran.** The Biden administration rescinded its predecessor's unilateral attempt to restore multilateral UN sanctions on Iran's nuclear and missile programs and military imposed by UNSCRs from 2006 to 2010. Rather than seeking to restore the JCPOA, collapsing the political architecture supporting the JCPOA and sunsetting military- and missile-related penalties through snapback would provide for a tougher multilateral position against Iran that the Biden administration could marshal to negotiate a better deal. A snapback of UN sanctions would also restore the permanent prohibition on Iranian ballistic missile activity, including launches.

- **Press for a UN Panel of Experts for UNSCR 2231.** Should the administration opt against snapback, there are other options available to increase scrutiny of Iranian ballistic missile related activity, such as through a UN Panel of Experts. Absent such a panel, Washington lacks an impartial UN body to assess claims related to violations of UNSCR 2231. UN Panels of Experts, like those focused on Yemen, North Korea, Sudan, and Mali, could offer sanctions guidance and impartial conclusions about noncompliance, thereby facilitating enforcement.

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441. To be clear, Washington has other non-proliferation authorities, like the Iran, North Korea, and Syria Nonproliferation Act, but those sanctions exist for only a two-year period and do not list the entity on the U.S. Specially Designated Nationals (SDN) list: “Iran, North Korea, and Syria Nonproliferation Act Sanctions (INKSNA),” U.S. Department of State, accessed August 17, 2022. (https://www.state.gov/iran-north-korea-and-syria-nonproliferation-act-sanctions-inksna/)


• **Continue to prosecute persons who export U.S.-origin goods to Iran.** The Department of Justice should continue to hold accountable persons who violate U.S. export control policies. Stringent penalties can help deter future violations. The administration should also make sure the Department of Commerce’s Export Enforcement Office, which supports the Department of Justice’s efforts, is fully funded, staffed, and empowered to carry out its mission.

• **Make regional air and missile defense a diplomatic priority.** The end of the crisis between Qatar and other Gulf Cooperation Council (GCC) member states offers an opportunity to unify the GCC and integrate its members’ existing air and missile defense systems. The deployment and sharing of radars and other sensors could increase the likelihood of intercepting Iranian missiles using existing ballistic missile defense (BMD) capabilities.

• **Build multiple coalitions to address Iran’s missile threat.** Europeans, for instance, prioritize stemming Iran’s longer-range missile and nuclear capabilities, whereas Middle Eastern nations harbor concerns about Iran’s more precise conventional SRBMs and drones. Other states object to Iranian procurement networks operating on their soil. Washington should leverage all of these to pressure Iran.

• **Press the United Kingdom to restore its “Iran List.”** With the advent of the JCPOA, the United Kingdom (then part of the European Union) dispensed with its “Iran List,” a directory of Iran-based entities of proliferation concern. Washington should press for a resurrection of the Iran List and share more names of banks, businesses, and individuals of proliferation concern for addition to the list.

• **Signal a willingness to address missiles through diplomacy.** While putting more pressure on Iran’s missile capabilities, Washington should clearly offer a diplomatic off-ramp if Tehran changes its behavior.

• **Beware of regional arms control efforts.** Just as the regime in Iran was able to win at the global negotiating table between 2013 and 2015, Tehran could use regional security talks to demand that its pro-American regional adversaries disarm before Iran reciprocates. Moreover, regional arms control conferences offer revisionist states such as Iran — whom the military balance is arrayed against — an opportunity to even the scales without guaranteeing a change of intent.

• **Do not trade a 2,000 kilometer-range cap for sanctions relief.** Regime officials say their missiles are subject to a voluntary range restriction of 2,000 kilometers, per a decree by the supreme leader. Yet those officials also stress the limitation is subject to change. While range caps should be part of any missile negotiations, a 2,000-kilometer prohibition, which would theoretically keep Iranian missiles away from Europe and the U.S. homeland, in exchange for sanctions relief would

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do nothing to address the regime’s SRBMs and MRBMs, which can target U.S. bases and allied nations in the Middle East.

**Informational and Intelligence:**

- **Use the bully pulpit.** Public diplomacy and messaging campaigns can help erode domestic and potentially elite support for the regime’s missile program and expose it as a costly liability. Washington should emphasize the following themes:
  - The quality of Iranian missiles exceeds the conventional capabilities of Iran’s neighbors.
  - Tehran’s missiles now drive insecurity and instability both in Iran and abroad. Unlike during the Iran-Iraq War, Iran’s ballistic arsenal today makes it the aggressor.
  - Failed missile and SLV tests indicate a waste of the Iranian population’s money and other resources.
  - Iran’s ongoing illicit procurement activity means that after four decades and immense costs, the Islamic Republic’s missile program is still not self-sufficient.

- **Use satellite surveillance and related capabilities to publicize Iranian missile launches.** Starting in late 2018, Iranian press outlets began to slow their coverage of Iranian missile tests, making it harder to develop a precise assessment of Tehran’s missile program. Every missile test is an opportunity for Washington to put the spotlight on the Iranian missile program and impose additional sanctions.

- **Encourage defections from Iran’s missile program.** Washington should explore the prospect of targeted campaigns against persons involved in the procurement, production, or proliferation of ballistic missiles or missile technology to promote defection.

- **Task the intelligence community with reporting on Iran-North Korea missile cooperation.** While there is open-source material on this cooperation, it is primarily historical in nature, and the directions of future technology flows are debated by experts. Washington should expose the ongoing cooperation between these two rogue regimes to increase the efficacy of existing international sanctions programs against both countries.

- **Disrupt Iranian missile technology procurement networks.** In 2019, The New York Times revealed that the Trump administration had “accelerated a secret American program” begun during the George W. Bush administration “to sabotage Iran’s missiles and rockets.” Such efforts should continue, especially given the major role that actors linked to the IRGC and Iran’s defense industry play in illicit procurement networks.

- **Back foreign efforts to sabotage Tehran’s missile program.** The summer of 2020 witnessed several large-scale acts of sabotage across facilities relevant

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451. Section 316 of CAATSA (2017) has this reporting requirement but at the time of this writing, no known unclassified report has been produced. For full law, see: Countering America’s Adversaries Through Sanctions Act, Public Law 115-44, August 2, 2017. (https://www.congress.gov/115/plaws/publ44/PLAW-115publ44.pdf)


to Iran’s nuclear program, including cyber-enabled sabotage against a gas storage facility tied to Iran’s missile program. Washington should consider the prospects of supporting such efforts with suitable partners.

Military:

- **Discourage GCC states from purchasing air and missile defenses from America’s near-peer competitors.** Russia has tried to persuade Saudi Arabia, Qatar, and Bahrain to acquire the S-400 SAM system. That would undermine attempts to create an integrated regional air and missile defense architecture focused on the threat from Iran. The best way to avoid purchases of Russian systems is to make American systems available for purchase.

- **Develop a regional air and missile defense architecture benefitting the United States and its partners.** Connecting sensors and shooters and upgrading missile detection capabilities across the GCC would be a pivotal step toward deterring and defeating Iranian missile and drone attacks. Once partners field modernized systems, the Pentagon can connect them to existing American air and missile defense assets, with the aim of conducting joint missile defense exercises simulating Iranian attacks. Doing so would reduce the burden on American missile defense assets.

- **Continue arms sales to regional partners.** Depriving partners of much needed capabilities would embolden Iran and its proxies and endanger common interests. The United States should also back its foreign military sales programs with robust training and maintenance packages.

- **Increase U.S.-GCC and U.S.-Israel military exercises.** Exercises improve the readiness and interoperability of the participating militaries and send a deterrent message to Iran. For example, Abu Dhabi should invite Israel to participate in the next UAE-U.S. Iron Union exercise, which would help all three nations defend against missile and drone threats.

- **Help GCC states and Israel cooperate on missile defense.** Israel has one of the best multilayered air and missile defense networks in the world. America’s Arab partners in the Persian Gulf may be interested in export versions of Israeli systems to counter Tehran’s missiles. While Israel may be sensitive about sharing this technology, even exploratory talks may deepen the goodwill created by the Abraham Accords. This goodwill could enable the United States, Israel, and select GCC countries to synchronize their early warning assets now that Israel has shifted to U.S. Central Command’s area of responsibility.

- **Continue to interdict Iranian weapons traveling by land, sea, and air.** The United States and its partners should more effectively use multinational constructs to coordinate interdictions of missiles and missile-technology to regional conflict zones such as Yemen.

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• **Support base hardening.** Hardening U.S. and partner military bases may help persuade Tehran it cannot accomplish its objectives using missiles. Additional hardening is imperative given the number of military facilities in the Middle East within range of Tehran’s missiles and drones.463

• **Upgrade missile defenses at U.S. bases in the region.** In January 2020, Tehran fired more than a dozen ballistic missiles at Iraqi bases housing American troops, which were not protected by missile defenses.464 While the U.S. military’s insufficient missile defense capacity precludes protection of every installation, major American bases in the Middle East should always have the best missile, rocket, and mortar protection available.

• **Develop and field left-of-launch (LoL) missile defeat capabilities.** Cyber or electronic warfare tools may enable the United States to defeat Iranian missile attacks before they are launched. Effective missile defenses should include both LoL and intercept capabilities. Congress should fully fund DoD LoL science and technology as well as research, development, testing, and evaluation.465

• **Support U.S. space-based early warning capabilities.** U.S. satellites helped save lives through detection and early warning before and during the January 2020 Iranian missile attack in Iraq, giving U.S. troops time to take cover.466 These capabilities are vital components of missile defense.

• **Continue developing GPS jamming capabilities.** GPS jammers can impede the guidance systems of Iran and its proxies’ missiles to the extent they rely on GPS updates. This could be key to neutralizing the growing PGM threat.

• **Support the U.S. Army’s efforts to field a next-generation Indirect Fire Protection Capability (IFPC).** The U.S. Army is developing an urgently needed IFPC to counter threats ranging from subsonic cruise missiles to drones, rockets, and mortars.469 Congress should fully support the Army’s IFPC effort.

• **Fund the Missile Defense Agency and the Navy’s joint Aegis BMD program.** Full funding can ensure this program reaches its goal of 65 ships supporting global BMD demands by 2025. Aegis can also help deter longer-range Iranian missile ambitions through its land-based variant, Aegis.

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467. Although these capabilities are not often discussed publicly, they are occasionally reported to exist. See: Bob Brewin, “Pentagon is probably jamming GPS in Afghanistan, experts say,” *Computer World*, October 26, 2001. (https://www.computerworld.com/article/2585261/pentagon-is-probably-jamming-gps-in-afghanistan--experts-say.html)


Ashore. Aegis Ashore is part of the European Phased Adaptive Approach (EPAA) initiative and has two locations in Europe: Romania and Poland. Reportedly, the operation of the site in Poland was delayed and will not come online until 2023. In the Middle East, U.S. deterrence is bolstered by Aegis-equipped destroyers, which can track and eliminate a range of ballistic missile threats.⁴⁷¹

• **Adapt homeland missile defense to a potential Iranian ICBM threat.** U.S. homeland missile defenses are currently geared toward defending against North Korean ICBMs. To prepare for a prospective Iranian ICBM, Washington could deploy another long-range discrimination radar abroad to track the Iranian missile threat, increase U.S. space-based missile detection capabilities, improve boost-phase intercept capabilities, and consider adding another ground-based midcourse defense site on U.S. soil. The administration should also consider employing the SM-3 IIA interceptor, which successfully shot down an ICBM from an Aegis-enabled destroyer as part of a test.⁴⁷²

• **Pursue deterrence by punishment, not just denial, of Iranian objectives.**⁴⁷³ Signaling U.S. capability and willingness to retaliate against a wide array of Iranian interests in the aftermath of Iranian or Iran-backed escalation can help deter future provocations. To signal this capability and will, Washington should expedite the testing and deployment of select Army ground-based precision-fire systems, slated for delivery by 2023, particularly the Precision Strike Missile.⁴⁷⁴ Ground-based long-range precision-strike systems can reduce the burden on U.S. Navy and Air Force assets in the region. Washington should also lower the threshold for using force against Iran-backed militias in places such as Iraq and Syria and respond more consistently to Iran-backed attacks from where they originate.

**Economic and Financial:**

• **Defend global missile sanctions against Iran.** After October 2023, the United States and its Western allies will have divergent missile sanctions policies toward Iran regardless of U.S. policy on the JCPOA. Washington should encourage the European Union not to delist Iranian missile-related entities named in Annex II of the JCPOA.

• **Do not ease sanctions enforcement to facilitate nuclear negotiations.** Internal Iranian documents concede that oil revenues were low during the peak of the Trump administration's maximum pressure policy.⁴⁷⁵ Diminished earnings from Iran’s most significant sources of revenue — oil as well as other petroleum products — may constrain the regime's missile production and proliferation.

• **Retain and expand sectoral sanctions against Iran.** Several sectors of the Iranian economy produce materials or engage in activities that can be

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⁴⁷⁵. For example: @SGhasseminejad, Twitter, March 17, 2021. (https://twitter.com/SGhasseminejad/status/1372307091877212162)
used to support Tehran’s missile efforts. The IRGC benefits from inputs to the missile program from universities, research centers, military contractors, and heavy industry.

- **Expand sanctions on metals used in Iran’s missile program.** Targeted sanctions against entities that procure or produce metals and other essential materials can create choke points in Iran’s domestic ballistic missile supply chain.

- **Continue to sanction and expose Iran’s procurement and proliferation networks.** The U.S. government has exposed major procurement and proliferation networks led by Karl Lee, Abdollah Asgharzadeh, and Kambiz Rostamian, which supported Iran’s ballistic missile program through illicit financial practices, sanctions evasion, and commerce in dual-use items. More exposures should follow.

- **Encourage partners to sanction Iran’s missile program.** A multilateral consensus would signal to Iran that restraint and diplomacy are the only viable options.

- **Codify existing executive orders into law.** Codifying orders that punish Iranian weapons transfers would both prevent future administrations from repealing these authorities and signal to Iran that there is a bipartisan consensus behind these authorities. Relevant orders include:
  - E.O. 13949: Blocking Property of Persons with Respect to the Conventional Arms Activities of Iran.

- **Consider sanctions against Iranian missile commanders.** The United States has yet to employ counterproliferation designations against Hajizadeh, who leads the IRGC-AF and has overseen Iran’s precision project since 2009. Hajizadeh’s deputy, Majid Mousavi, is also not designated.

- **Expand sanctions against Iran’s space program.** At present, it remains unclear if Washington’s sanctions against the IRGC-AF apply to its space division. The United States should formally designate the IRGC-

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AF’s space division as well as its commander, Second Brigadier General Ali Jafarabadi.  

- **Investigate the applicability of counterproliferation sanctions to entities like the Iran Alumina Company.** According to a 2020 investigation by Reuters, Iran Alumina Company is helping the IRGC and Iran’s solid-propellant missile program by providing aluminum powder from bauxite mining operations. The Iran Alumina Company’s parent entity, Iranian Mines and Mining Industries Development and Renovation Organization, is already subject to secondary sanctions.

- **Consider expanding sanctions against the Artesh.** While IRGC- and MODAFL-affiliated contractors support Iran’s ballistic missile program, they are not alone. The Artesh is a new and evolving actor in this space, having recently developed its own missile unit to support its Ground Forces, as well as using its Self-Sufficiency Organization to aid Tehran’s conversion of rockets into missiles. Iran exports conversion kits to its regional proxies.

### Conclusion

There is no greater measure of Iran’s aspiration for status and security than the size, diversity, and lethality of its ballistic missile arsenal. These weapons are paraded, tested, transferred, and used in military drills and operations. Missiles afford Tehran confidence in its deterrence and warfighting capabilities. They also facilitate coercion and punishment, all while allowing Tehran to keep the nuclear option open.

Qualitative improvements to Iran’s ballistic missiles as well as new types of missile systems will likely continue to lower barriers to their use, making Tehran more aggressive in the years ahead. Despite foreign pressure, the regime’s procurement and production of whole platforms, technologies, and component parts continue, yielding capabilities that Iran boasts about having at home and selectively proliferates to proxies. With the October 2023 lapse of multilateral sanctions against Tehran’s ballistic missile program around the corner, the race to counter Iran’s weapon of choice is already off to a late start.
Appendix A: Iran’s Ballistic Missile Launches Since July 2015 (Post-JCPOA)\textsuperscript{490}

Sourcing and Methodology: The table below covers ballistic missile launches from Iranian territory, including flight tests, military drills, and military operations, that receive a single mention in either English- or Persian-language reporting. The time span ranges from July 14, 2015, the date Iran agreed to the JCPOA, to December 12, 2022, a little more than seven years from that event. This list includes SSMs with a ballistic trajectory and SLVs, but excludes ASBMs,\textsuperscript{491} cruise missiles, and long-range artillery rockets. For simplicity, the table also excludes select projectiles that Iran has upgraded with guidance and control equipment\textsuperscript{492} to become guided rockets.\textsuperscript{493}

<table>
<thead>
<tr>
<th>Date</th>
<th>Type of Launch</th>
<th>Number of Missiles</th>
<th>Missile Name</th>
<th>Missile Type</th>
<th>Propellant</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2015</td>
<td>Test</td>
<td>1</td>
<td>Fateh-313\textsuperscript{44}</td>
<td>SRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>October 2015</td>
<td>Test</td>
<td>1</td>
<td>Emad\textsuperscript{495}</td>
<td>MRBM</td>
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</tr>
<tr>
<td>November 2015</td>
<td>Test</td>
<td>1</td>
<td>Ghadr-110 (a.k.a. Ghadr-1/101)\textsuperscript{496}</td>
<td>MRBM</td>
<td>Liquid</td>
</tr>
<tr>
<td>March 2016</td>
<td>Test/Drill</td>
<td>1</td>
<td>Ghadr-F\textsuperscript{497}</td>
<td>MRBM</td>
<td>Liquid</td>
</tr>
<tr>
<td>March 2016</td>
<td>Test/Drill</td>
<td>2</td>
<td>Ghadr-H\textsuperscript{498}</td>
<td>MRBM</td>
<td>Liquid</td>
</tr>
</tbody>
</table>


\textsuperscript{491} Such as the Khalij-e Fars, Hormuz 1 and 2, and the Zulfqar-e Basir. [The Radius of the Circle of Danger for American Vessels has Grown/ Get to Know The “Zulfqar Basir” Better], \textit{Tasnim News Agency} (Iran), September 28, 2020. (https://tn.ai/2357961). All four derive from the Fateh family of SRBMs.

\textsuperscript{492} This evolution is ongoing in Iran’s military capabilities. See, for example: Michael Peck, “Did Iran Convert a Dumb Rocket Into a Guided Aeroballistic Missile?,” \textit{The Uncommon Defense}, May 20, 2020. (https://theuncommondefense.com/2020/05/20/did-iran-convert-a-dumb-rocket-into-a-guided-aeroballistic-missile)

\textsuperscript{493} This exclusionary list includes the updated Fajr class (such as the guided 4 and 5): @fab_hinz, Twitter, July 28, 2020. (https://twitter.com/fab_hinz/status/1288057073087868928/photo/1). The exclusionary list also includes all Zelzal variants such as the Zelzal Bareshi (upgraded Zelzal with “showering” warhead): [A Story From Iran’s Ballistic Power/Comparing Missile Capabilities From Before and After The Revolution], \textit{Mehr News Agency} (Iran), March 23, 2020. (https://www.mehrenews.com/news/484393963). The list further includes the Labaik, which is a guided Nazeat rocket. See: [The IRGC’s Daim Circle包裹 from Iran’s Ballistic Missile/Comparing Missile Capabilities From Before and After The Revolution], \textit{Tasnim News Agency} (Iran), October 5, 2019. (https://tn.ai/2111200).

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<th>Missile Name</th>
<th>Missile Type</th>
<th>Propellant</th>
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<td>Test/Drill</td>
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<td>Qiam-1⁹⁹</td>
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<td>March 2016</td>
<td>Test/Drill</td>
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<td>Shahab-3⁹⁰⁰</td>
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<td>April 2016</td>
<td>Test</td>
<td>1</td>
<td>Simorgh⁹⁰¹</td>
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<td>Liquid</td>
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<td>April 2016</td>
<td>Test</td>
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<td>Unknown⁹⁰²</td>
<td>Likely MRBM</td>
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<td>BM-25 Musudan (later assumed Khorrarmshahr)⁹⁰³</td>
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<td>September 2016</td>
<td>Test</td>
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<td>Zulfiqar⁹⁰⁴</td>
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<td>November 2016</td>
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<td>Qiam-1⁹⁰⁵</td>
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<td>Liquid</td>
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<td>December 2016</td>
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<td>Shahab-3⁹⁰⁶</td>
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<td>Operation</td>
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<td>Zulfiqar⁹⁰⁵</td>
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<td>Operation</td>
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<td>Qiam-1⁹¹⁰</td>
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<td>Test</td>
<td>1</td>
<td>Simorgh⁹¹²</td>
<td>SLV</td>
<td>Liquid</td>
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500. Ibid.
510. Ibid.
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<th>Missile Type</th>
<th>Propellant</th>
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<td>Shahab-3 variant (likely Ghadr or Emad)</td>
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<td>Liquid</td>
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<tr>
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<td>Test</td>
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<td>Scud variant (assumed Qiam-1 or Shahab-1/2)</td>
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<td>Liquid</td>
</tr>
<tr>
<td>February 2018</td>
<td>Test</td>
<td>1</td>
<td>Zulfiqar</td>
<td>SRBM</td>
<td>Solid</td>
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<tr>
<td>April 2018</td>
<td>Test</td>
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<td>Khorramshahr</td>
<td>MRBM</td>
<td>Liquid</td>
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<tr>
<td>May 2018</td>
<td>Test</td>
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<td>Shahab-3 variant (likely Ghadr or Emad)</td>
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<td>May 2018</td>
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<td>Shahab-3 variant (assumed Ghadr or Emad)</td>
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<td>Qiam-1</td>
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<tr>
<td>August 2018</td>
<td>Test</td>
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<td>Zulfiqar</td>
<td>SRBM</td>
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<tr>
<td>August 2018 (assumed)</td>
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<td>Fateh-Mobin</td>
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<td>September 2018</td>
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<td>Operation</td>
<td>&gt;2-3</td>
<td>Qiam-123 (modified warhead)</td>
<td>SRBM</td>
<td>Liquid</td>
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514. Ibid.

516. Ibid.
517. Ibid.
518. Ibid.
519. Ibid.

521. Ibid.
522. "لحظة اصابة دقيقة موشک بالستیک "فاتح مسیح" به هدف ، فیلم" [The Moment of Precise Impact of the 'Fateh Mobin' Ballistic Missile to the Target + Film], Tasnim News Agency (Iran), August 13, 2018. (https://tn.ai/1801506)
524. The exact number of individual Qiam and Zulfiqar SRBMs fired during the operation remains unknown. The range is an estimate from videos and pictures of the launch online. No more than six SRBMs were likely fired.
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<td>Simorgh535</td>
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<td>Safir134</td>
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<td>(assumed)</td>
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<td>1</td>
<td>Dezful538</td>
<td>SRBM</td>
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526. Ibid.
530. Ibid.
531. Ibid.
532. Ibid.
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<th>Missile Type</th>
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<td>Unknown[539]</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
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<td>Test</td>
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<td>Fateh-110 variant[540]</td>
<td>SRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>April 2019 (assumed)</td>
<td>Test</td>
<td>1</td>
<td>Shahab-3 with maneuvering RV[541] (potentially Emad)</td>
<td>MRBM</td>
<td>Liquid</td>
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<td>May 2019</td>
<td>Test</td>
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<td>Zulfiqar[542]</td>
<td>SRBM</td>
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<td>July 2019</td>
<td>Test</td>
<td>1</td>
<td>Unknown[543] (E3 claimed Shahab-3)[544]</td>
<td>MRBM (assumed)</td>
<td>Liquid (assumed)</td>
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<tr>
<td>August 2019</td>
<td>Test</td>
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<td>Unknown[545]</td>
<td>MRBM (assumed)</td>
<td>Unknown</td>
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<tr>
<td>August 2019</td>
<td>Test</td>
<td>1</td>
<td>Safir[546]</td>
<td>SLV</td>
<td>Liquid</td>
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<tr>
<td>January 2020</td>
<td>Operation</td>
<td>&gt;8[547]</td>
<td>Qiam (modified warhead a.k.a Qiam-2)[548]</td>
<td>SRBM</td>
<td>Liquid</td>
</tr>
<tr>
<td>January 2020</td>
<td>Operation</td>
<td>&lt;8</td>
<td>Fateh-313[549]</td>
<td>SRBM</td>
<td>Solid</td>
</tr>
</tbody>
</table>


540. Ibid.


547. The exact number of Qiam and Fateh-313 missiles used in the operation is unknown, but a total number of 16 has been reported by the United States See: U.S. Department of Defense, “Press Brief by Secretary Esper and General Milley,” January 8, 2020. (https://www.defense.gov/Newsroom/Transcripts/Transcript/Article/2053184/press-brief-by-secretary-esper-and-general-milley)


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<tr>
<th>Date</th>
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<th>Missile Name</th>
<th>Missile Type</th>
<th>Propellant</th>
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<tr>
<td>February 2020</td>
<td>Test</td>
<td>1</td>
<td>Simorgh&lt;sup&gt;551&lt;/sup&gt;</td>
<td>SLV</td>
<td>Liquid</td>
</tr>
<tr>
<td>February 2020</td>
<td>Test</td>
<td>1</td>
<td>Ra’ad-500&lt;sup&gt;552&lt;/sup&gt;</td>
<td>SRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>April 2020</td>
<td>Test</td>
<td>1</td>
<td>Qased&lt;sup&gt;553&lt;/sup&gt;</td>
<td>SLV</td>
<td>Mixed: One liquid, two solid&lt;sup&gt;554&lt;/sup&gt;</td>
</tr>
<tr>
<td>July 2020&lt;sup&gt;555&lt;/sup&gt;</td>
<td>Test/Drill</td>
<td>&gt;1</td>
<td>Unknown&lt;sup&gt;556&lt;/sup&gt; (alleged new, likely Fath)</td>
<td>Unknown (likely CRBM)</td>
<td>Unknown</td>
</tr>
<tr>
<td>July 2020</td>
<td>Test/Drill</td>
<td>&gt;1</td>
<td>Fateh-110&lt;sup&gt;557&lt;/sup&gt;</td>
<td>SRBM</td>
<td>Solid</td>
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<tr>
<td>August 2020 (assumed)</td>
<td>Test</td>
<td>1</td>
<td>Khorramshahr-2&lt;sup&gt;558&lt;/sup&gt;</td>
<td>MRBM (possibly IRBM)</td>
<td>Liquid</td>
</tr>
<tr>
<td>August 2020</td>
<td>Test</td>
<td>1</td>
<td>Shahid Haj Qassem&lt;sup&gt;559&lt;/sup&gt;</td>
<td>MRBM</td>
<td>Solid</td>
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552. [The Unveiling of the Ra’ad Missile and the Salman’s Advanced Engine in the Spring of the Islamic Revolution + Film], Young Journalists Club (Iran), February 9, 2020. (https://www.yjc.ir/00UNez)
554. [Important Details of the Third Stage of the IRGC’s Satellite-Launch Vehicles + Pictures], Donya-e Eqtesad (Iran), April 16, 2022. (https://www.donya-e-eqtesad.com/fa/tiny/news-3857837)


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<th>Date</th>
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<th>Missile Name</th>
<th>Missile Type</th>
<th>Propellant</th>
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<tr>
<td>(Revealed) (Revealed) February 2021</td>
<td>Test</td>
<td>1</td>
<td>Zuljanah$^{571}$</td>
<td>SLV</td>
<td>Mixed: Two solid, one liquid$^{572}$</td>
</tr>
<tr>
<td>May 2021$^{73}$</td>
<td>Test</td>
<td>1</td>
<td>Khorramshahr</td>
<td>MRBM</td>
<td>Liquid</td>
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<tr>
<td>June 2021$^{574}$</td>
<td>Test</td>
<td>1</td>
<td>(Assumed) Simorgh</td>
<td>SLV</td>
<td>Assumed Liquid</td>
</tr>
<tr>
<td>June 2021$^{575}$</td>
<td>Test</td>
<td>1</td>
<td>(Assumed) Simorgh</td>
<td>SLV</td>
<td>Assumed Liquid</td>
</tr>
<tr>
<td>November 2021$^{576}$</td>
<td>Test</td>
<td>1</td>
<td>Khorramshahr (unclear if original or variant)</td>
<td>MRBM (possibly IRBM)</td>
<td>Liquid</td>
</tr>
<tr>
<td>November 2021$^{577}$</td>
<td>Test</td>
<td>1</td>
<td>Fateh “type” missile</td>
<td>SRBM (possibly even CRBM)</td>
<td>Solid</td>
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<tr>
<td>December 2021$^{578}$</td>
<td>Test</td>
<td>1</td>
<td>Zulfiqar</td>
<td>SRBM</td>
<td>Solid</td>
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570. Israel, which reported the test to the UNSC, believes the test took place earlier than the day the video aired. See: United Nations Security Council, "Identical letters dated 7 April 2021 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," April 8, 2021. (https://digitallibrary.un.org/record/3907877)

571. "إیرتبت تحقیقاتی ماهواره‌بر وزارت دفاع جنگ ایران در دوران راکت‌سازی، فیلم" [A Research Satellite was Launched on The Ministry of Defense's Zuljanah Film], Young Journalists Club (Iran), February 1, 2021. (https://www.yjc.ir/00W6JV)


577. Ibid.

578. Ibid. This test reportedly occurred on December 6. It should not be confused with the Zulfiqar Iran fired days later in the Great Prophet military drill.

580. Based on missile number, shape, TEL employed, and color scheme, one might deduce that four Dezfuls and four Zulfiqars were launched. See: IMA Media •, "Practicing attack on Weapons of Mass Destruction (WMD) facilities," YouTube, December 27, 2021. (https://www.youtube.com/watch?v=Chc72QeoyAy)


582. See video and images here: "[The Hitting of 16 Ballistic Missiles at One Target/The Last Stage of the Great Prophet 17 Exercise]," Mehr News Agency (Iran), December 26, 2021. (https://www.mehnews.com/news/5382931/) (ایما، "کل هدفهای صهیونیست‌ها,


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<th>Propellant</th>
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<tr>
<td>December 2021</td>
<td>Test/Drill</td>
<td>-8</td>
<td>Zulfiqar and Dezful (unknown what exact combination)</td>
<td>SRBM</td>
<td>Solid</td>
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<td>December 2021</td>
<td>Test/Drill</td>
<td>-1</td>
<td>Sejjil</td>
<td>MRBM</td>
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<tr>
<td>December 2021</td>
<td>Test/Drill</td>
<td>-3</td>
<td>Ghadr and Emad (unknown what exact combination)</td>
<td>MRBM</td>
<td>Solid</td>
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<tr>
<td>Date</td>
<td>Type of Launch</td>
<td>Number of Missiles</td>
<td>Missile Name</td>
<td>Missile Type</td>
<td>Propellant</td>
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<tr>
<td>December 2021</td>
<td>Test/Drill</td>
<td>&gt;2</td>
<td>Fath</td>
<td>CRBM</td>
<td>Solid</td>
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<tr>
<td>December 2021</td>
<td>Test</td>
<td>1</td>
<td>Fateh-110 variant (of greater range)</td>
<td>SRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>December 2021</td>
<td>Test</td>
<td>1</td>
<td>Simorgh</td>
<td>SLV</td>
<td>Liquid</td>
</tr>
<tr>
<td>January 2022</td>
<td>Test</td>
<td>1</td>
<td>Emad</td>
<td>MRBM</td>
<td>Liquid</td>
</tr>
<tr>
<td>February 2022</td>
<td>Test</td>
<td>1</td>
<td>Kheibar Shekan</td>
<td>MRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>February 2022</td>
<td>Test</td>
<td>1</td>
<td>(Assumed) Zuljanah</td>
<td>SLV</td>
<td>Assumed mixed: Two solid, one liquid</td>
</tr>
<tr>
<td>March 2022</td>
<td>Test</td>
<td>1</td>
<td>Qased92</td>
<td>SLV</td>
<td>Mixed: One liquid, two solid</td>
</tr>
<tr>
<td>March 2022</td>
<td>Operation</td>
<td>10</td>
<td>Fateh family (likely Fateh-110)</td>
<td>SRBM</td>
<td>Solid</td>
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</table>

585. This test was also part of the Great Prophet 17 drill. See video of what appears to be the Fath here: "[The Launching of Ballistic Missiles and Naval Cruise [Missiles] by the IRGC]," Alef (Iran), December 21, 2021. [https://web.archive.org/web/20211228013514/https://www.alef.ir/news/4000930094.html]. See also: "گزارش تعمیر از عضو جدید خانواده فاتح/ [Tasnim's Report on the New Member of the Fateh Family/ An Unknown Iranian Missile with a Range of 250 Kilometers + Film]," Tasnim News Agency (Iran), February 2, 2022. [https://tn.ai/2655594]. Also see video: Hossein Daliran, "Film of the Missile Parts of the IRGC's Great Prophet 17 Exercise," YouTube, December 21, 2021. [https://www.youtube.com/watch?v=gYPkHc4mZRY]

586. See video: Hossein Daliran, "Film of the Missile Parts of the IRGC's Great Prophet 17 Exercise," YouTube, December 21, 2021. [https://www.youtube.com/watch?v=gYPkHc4mZRY]. Also note that the Fath and presumably the Fateh-110 variant appear to be fired in earlier days in the drill, likely on day two. For more on that day’s activities, see: "[The Great Prophet (PBUH) 17 Exercise | Practicing Ballistic Missile Operations Against Stationary and Moving Targets of an Assumed Enemy]," Tasnim News Agency (Iran), December 21, 2021. [https://tn.ai/2629873]


589. Military Iran, "[The Kheibar Shekan Missile’s Moment of Launch and Impact Upon Target]," YouTube, February 10, 2022. [https://www.youtube.com/watch?v=6YPkHc4mZRY]

590. @Inbarspace, Twitter, March 1, 2022. [https://twitter.com/inbarspace/status/1498793663861772294?]


592. IMA Media • ای‌پی‌ام‌ای، "Exclusive: footage of preparation and launch of NOUR-02 satellite on board Qased SLV," YouTube, March 10, 2022. [https://www.youtube.com/watch?v=frJUY5XUx]

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<tr>
<th>Date</th>
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<th>Missile Name</th>
<th>Missile Type</th>
<th>Propellant</th>
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<tr>
<td>June 2022</td>
<td>Test</td>
<td>1</td>
<td>Zuljanah</td>
<td>SLV</td>
<td>Mixed: Two solid, one liquid</td>
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<tr>
<td>September 2022</td>
<td>Test/Drill</td>
<td>2</td>
<td>Fath-360</td>
<td>CRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>September 2022</td>
<td>Military Operation</td>
<td>73</td>
<td>Fath-360</td>
<td>CRBM</td>
<td>Solid</td>
</tr>
<tr>
<td>October 2022</td>
<td>Test</td>
<td>1</td>
<td>Kavoshgar</td>
<td>SLV</td>
<td>(Assumed) liquid</td>
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<tr>
<td>November 2022</td>
<td>Test</td>
<td>1</td>
<td>Qaem-100</td>
<td>SLV</td>
<td></td>
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<tr>
<td>November 2022</td>
<td>Military Operation</td>
<td>&gt;12</td>
<td>(Assumed Fath family; Fath-360)</td>
<td>(Assumed CRBM)</td>
<td>Solid</td>
</tr>
<tr>
<td>November 2022</td>
<td>Military Operation</td>
<td>&gt;1</td>
<td>(Assumed Fath family; Fath-360)</td>
<td>(Assumed CRBM)</td>
<td>Solid</td>
</tr>
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597. Depending on how old the variant was, it may have employed solid-propellant instead.


Appendix B: Descriptions of Known Iranian Ballistic Missiles

Note: The following overview of Iran’s known ballistic missile arsenal draws heavily on Persian-language sources with ties to security or political organs in Iran. These sources have incentives to hyperbolize the performance and capabilities of Iranian missiles for political gain.

Solid-Propellant Platforms:

**Tondar-69:** The Tondar-69 is the Iranian name for the Chinese-made two-stage solid/liquid-propellant CSS-8 (M7) CRBM, which appears to be an SA-2 SAM converted into an SSM. Despite attempts to procure this platform during the Iran-Iraq War, Tehran only received it once the conflict had ended in 1989, following negotiations with Beijing in Thailand. According to estimates, the Tondar-69 can carry a 190 kilogram high-explosive warhead for 150 kilometers. Regime officials reportedly refused to settle for the 125 kilometer-range variant when procuring the missile given their desire to strike Baghdad. The missile is still assumed to be operational.

**The Fateh and Its Extended Family:** These are increasingly precise solid-propellant and road-mobile SRBMs and a few MRBMS produced by Aerospace Industries Organization (AIO). They are among Iran’s most capable and battlefield-ready systems.

- **Fateh-110A/B/C/D:** The Fateh-110 is Iran’s oldest single-stage solid-propellant SRBM. Developed in the 1990s, the Fateh was born out of upgrades to Iran’s larger Zelzal class of rockets, which remained inaccurate even with spin stabilization. The Fateh is the first Iranian SRBM with finlets on its warhead. It is also road mobile. Tehran has updated the Fateh several times to extend the range of each variant (A/B/C/D), but with varied maneuverability and precision. Iran first flight-tested the Fateh in 2001 as well as a variant in 2002. The Fateh served as the basis for an entire line of significantly more precise solid-propellant SRBMs that Iran claims to have used on the battlefield. One variant, the Fateh-110B, was used by Iran against Kurdish dissidents in northern Iraq in 2018. The Fateh-110 was also used against the house of a Kurdish oil tycoon in northern Iraq in 2022 in a strike that Tehran claimed was in response to an Israeli attack launched from Iraqi territory.

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604. This production is evident by the AIO stamp on most missile airframes.


• **Fateh-313:** Unveiled and tested by Tehran in 2015,\(^{609}\) the Fateh-313 reportedly extends the range of the Fateh-110 by 200 to 250 kilometers to reach an estimated 500 kilometers.\(^{610}\) The regime likely achieved this longer range with composite solid fuel,\(^{611}\) which Iranian outlets claim the Fateh-313 and another Fateh-110 derivative employ,\(^{612}\) presumably along with a lighter airframe. Iran used the Fateh-313 in its January 2020 attack on bases in Iraq where U.S. forces were located.\(^{613}\) This missile is allegedly also called the Fateh-F.\(^{614}\)

• **Zulfiqar:** Named for the sword of Ali ibn Abu Talib (the cousin and son-in-law of the Prophet Muhammad), the Zulfiqar SRBM was first paraded and flight-tested by Tehran in 2016.\(^{615}\) Continuous improvements to the Fateh family indicate Iran’s interest in a more battlefield-reliable SRBM and in precision-strike capabilities with greater range (in this case, 700 kilometers). The Zulfiqar, like its predecessors, is road mobile and has a separating warhead with finlets.\(^{616}\) The Zulfiqar is battle-tested; Tehran has used it twice in missile operations against the Islamic State in eastern Syria.\(^{617}\) The Zulfiqar also featured in many Iranian missile drills, including the Great Prophet 15 in January 2021\(^{618}\) and the Great Prophet 17 in December 2021.\(^{619}\)

• **Fateh Mobin:** Revealed by Tehran in 2018, the Fateh Mobin is likely equipped with an electro-optical seeker on its separating warhead. Iranian outlets claim that the missile can strike ground and maritime targets, and that its warhead has counter-electronic warfare capabilities. They also claim that the missile’s seeker makes the Fateh Mobin an all-weather SRBM,\(^{620}\) even though that is not the case for an electro-optical system. There has only been one reported flight test of this system, and the missile has not been featured in any military drill or test.
operation. There is also no consensus on the Fateh Mobin’s range in Persian-language sources.621

- **Dezful**: Unveiled in an underground missile production facility622 and tested by Tehran in 2019,623 the Dezful features a warhead that appears to be longer than the Zulfiqar’s.624 The Dezful, like other Fateh-family systems, is a road-mobile solid-propellant SRBM. It is allegedly the first Fateh-family missile to reach a 1,000-kilometer range, making it a threshold weapon (between an SRBM and an MRBM) for Iran’s solid-propellant platform. Its payload weight is unknown. The regime tested the Dezful as part of the Great Prophet 15 military drill in January 2021.625

- **Ra’ad-500**: Unveiled and flight-tested by Tehran in 2020, the Ra’ad-500’s range is shorter (500 kilometers) than that of its most recent predecessors, the Dezful (1,000 kilometers) and the Zulfiqar (700 kilometers). But the Ra’ad-500 kept the Dezful’s nosecone shape and uses a lighter airframe. The Ra’ad is powered by a composite motor, dubbed the Zouhair, and allegedly weighs about 2,000 kilograms, or about one-third less than its original progenitor, the Fateh.626

- **Zouhair**: At a military parade in September 2022, Iranian media reported on a missile called the Zouhair. That system is likely a repainted and renamed Ra’ad-500, the lighter and longer-range Fateh-110 SRBM unveiled in February 2020 with a composite solid-rocket motor. The name change likely serves to highlight the projectile’s composite motor627 and may be a sign of greater interest in using lighter and more cost-efficient composite materials.

- **Shahid Haj Qassem**: Revealed by Tehran in 2020,628 the Shahid Haj Qassem is named after the slain commander of Iran’s IRGC-QF. Reportedly, the missile’s separating warhead can maneuver until impact.629 It is unclear what solid-propellant engine the Haj Qassem employs. The Haj Qassem is the first Fateh-family derivative to cross the 1,000-kilometer-range threshold. It can carry a 500-kilogram warhead up to 1,400 kilometers, making it an MRBM, and is the second solid-propellant MRBM in Iran’s arsenal.

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621. The upper boundary for the range figure is provided in the table below. Iranian media outlets have guessed as to what the lower-range boundary could be, positing 300 kilometers, as in the case of the original Fateh-110. See: “워크: ”زلم« | The Pride-Inspiring Roar of the Zulfiqar, Dezful, and Zelzal Ballistic [Missiles],” Khabar Online (Iran), January 15, 2021. ([https://www.khabaronline.ir/news/1476569/](https://www.khabaronline.ir/news/1476569/))

622. Persian_boy, “Iran Dezful ballistic missile 1000Km range, Underground missile plant,” YouTube, February 8, 2019. ([https://www.youtube.com/watch?v=KsDFAI3CIQ](https://www.youtube.com/watch?v=KsDFAI3CIQ))

623. Persian_boy, “Iran Dezful ballistic missile 1000Km range, Underground missile plant” “موشک بالستیک دزفول” YouTube, February 7, 2019. ([https://www.youtube.com/watch?v=wBVOJhY-QsA](https://www.youtube.com/watch?v=wBVOJhY-QsA))


625. [Tasnim’s report | ‘Qassem’ Brought the Range of Iran’s Tactical Missiles to Israel/ What Peculiarities Does Iran’s Newest Ballistic Missile Have?],” Tasnim News Agency (Iran), August 22, 2020. ([https://tn.ai/2332352](https://tn.ai/2332352))


628. [Tasnim’s report | ‘Qassem’ Brought the Range of Iran’s Tactical Missiles to Israel/ What Peculiarities Does Iran’s Newest Ballistic Missile Have?],” Tasnim News Agency (Iran), August 22, 2020. ([https://tn.ai/2332352](https://tn.ai/2332352))
(the first being the Sejjil). In terms of design, the Haj Qassem's nosecone is conical but blunted, like that of the Zulfiqar and later iterations of the Fateh family.636 The Haj Qassem features twice as many stabilizer fins on its tail than do its predecessors. Regime officials allege the missile is subject to "aerodynamic control," which raises questions about the missile's torque at higher altitudes.631 The Haj Qassem is not reported to have been used in combat or any military drills.

- **Fath:** Unveiled by Tehran in 2020, this is Iran's smallest and most recent addition to the Fateh family but as a CRBM. At first glance, the missile could be mistaken for an artillery rocket with finlets. Iranian outlets have offered only estimates about the missile's specifications, regarding it to be half the size, diameter, and weight of the original Fateh-110.632 This estimate is plausible. The Fath was launched633 in July 2020 during the Great Prophet 14 military drill,634 where it was reported as an unnamed missile.635 Iran once again tested the Fath during Great Prophet 17636 in December 2021 featuring a blunted nosecone.637 The Fath is also known as the BM-120, with 120 being a reference to its upper range limit.638

- **Fath-360:** The Artesh unveiled and tested a missile called Fath-360 during its "Authority 1401" military drill this past September.639 (Tasnim's Report from the Fath-360 missile system in the Aras Exercise)," Mehr News Agency (Iran), August 20, 2020. [https://www.mehrnasnews.com/news/161583/VIDEO-Great-Prophet-14-military-drill-in-south-of-Iran] Goorkan, "Iran IRGC Great Prophet 14 military drill continues a trend of diffusion to the Artesh of technologies and capabilities once associated only with the IRGC-AF. While the suffix 360 might be easily mistaken for the projectile's range, Iranian sources claim its range is 120 km.640 Given that fact, plus its size and name, the missile is likely the same Fath CRBM introduced by Tehran in

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The IRGC-GF used the Fath-360 in cross-border ballistic missile operations in 2022 against Iraqi Kurdistan. The Kheibar Shekan: Dubbed the “Breaker of Kheibar” in reference to early Muslim conquests of a Jewish castle in Arabia, the Kheibar Shekan is Iran’s second attempt at producing an MRBM from the Fateh-family (with the Shahid Haj Qassem being the first). Tehran explicitly states the missile can target Israel. With a reported range of 1,450 kilometers and a separating warhead, the Kheibar Shekan is Iran’s most advanced solid-propellant system outside the Sejjil, which was Iran’s first solid-propellant MRBM. Hajizadeh alleges that the warhead of the Kheibar Shekan has significantly increased the destructive capacity of this weapon over normal explosive material, and that the missile requires considerably less time to prepare prior to launch than its progenitors. The Kheibar Shekan was unveiled and tested in February 2022, days before the 43rd anniversary of the Islamic Revolution. Hajizadeh had alleged earlier that month that Iran would unveil a “strategic” missile, leading many to conclude it was the Kheibar Shekan.

Sejjil/Sejjil-2: Initially called the Ashura, Iran’s solid-propellant two-stage MRBM debuted with a 2008 flight test under the name Sejjil. Solid propellant makes the Sejjil easier to transport and requires less preparation prior to launch. The marker “2” has been attached to the projectile’s name since 2009, but the missile bears no discernable design changes, and it appears the Iranian press uses the names interchangeably. Starting in 2011, the Sejjil saw a nearly decade-long hiatus in flight testing for unknown reasons. However, the missile was reportedly tested as part of the Great Prophet 15 drill in January 2021, during which at least three Sejjil-2s were pictured. The missile was again tested during the IRGC’s Great Prophet 17 drill in December 2021. The Sejjil can be fired from a silo or TEL. Regime officials claim their 2,000 kilometer-range platforms, of which the Sejjil is one, were designed to target Israel. The Sejjil’s stage-separation motors are easily identifiable,
and the entire system is topped with a separating triconic warhead, which aids in re-entry.650

**Liquid-Propellant Platforms:**

The Shahab and Its Extended Family: Iran's Shahab SRBMs and MRBM form the core of its liquid-propellant missile program. While of foreign origin, many of these systems have been either domestically modified or upgraded in the years since procurement. Iran has used some of them, such as the Qiam, in military operations and transfers abroad. All of Iran's liquid-propellant missiles surpass the MTGR's range and payload thresholds for a nuclear-capable missile.651 Shorter-range legacy systems will likely be phased out as Iran's capabilities evolve.

- **Shahab-1:** This is Iran's version of the Scud-B SRBM. Initially procured from Libya and then North Korea,652 Tehran's earliest experience with the Scud-B dates back to the Iran-Iraq War. While the IRGC attempted to reverse-engineer the Scud-B,653 a North Korea-Iran political agreement enabled the Islamic Republic to produce the Scud-B and Scud-C (which Tehran branded the Shahab-1 and Shahab-2) in the early 1990s.654 Iran used the Shahab-1 in military operations against the MEK in the 1990s.655

- **Shahab-2:** This is Iran's version of the Scud-C SRBM, which carries a lighter payload and more propellant, enabling greater range.656 Tehran may have used the Shahab-2 in operations against the MEK in Iraq after the Iran-Iraq War. In 2016, Amir-Ali Hajizadeh declared that Iran would no longer “copy” other missiles and that the regime would terminate and replace production of the Shahab-1 and Shahab-2 with the Zulfiqar solid-propellant SRBM.657

- **Qiam-1/2:** The Qiam-1, first unveiled in 2010,658 is a finless variant of the Scud-C SRBM.659 The absence of fins may imply that the Qiam is equipped with a more advanced jet vane steering capability.660 Its lack of fins also helps reduce detection by radar and missile defenses.661 The Qiam is also equipped with

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650. [The Sejjil Ballistic Missile; A Symbol of Iran's Long-Range and Precise Missiles + Film], Mashregh News (Iran), January 21, 2021. (https://www.mashreghnews.ir/news/1171101/ مسجد البارى + فیلم)


653. “The Shahab-1 Project, the Starting Point for Iran's Missile Power + Film and Images],” Young Journalists Club (Iran), December 18, 2019. (https://www.yjc.ir/00U6pj)


656. Michael Elleman, Iran's Ballistic Missile Capabilities: A Net Assessment (London: The International Institute for Strategic Studies, 2010), page 16.


660. The jet vanes can be seen in most pictures of the missile's aft section.

a separating triconic warhead.662 Iran has transferred the Qiam-1 to Yemen's Houthi rebels,663 which was reassembled there as the Burkan-2H SRBM.664 The Qiam likely provided the basis for other Houthi MRBMs, such as the Burkan-3665 and Zolfaghar. Iran likely used the Qiam-2, a modified Qiam with finlets on its warhead, in strikes in Syria in 2018 and later in strikes in Iraq in 2020.666 Iran unveiled the Qiam-2 in 2018.

- **Shahab-3:** More evidence of North Korean-Iranian missile collaboration can be seen in the Shahab-3, which was Iran's first MRBM. The Shahab-3 is a single-stage liquid-fueled missile with a 125-centimeter diameter, which, when Iran first tested it in 1998, marked the widest and heaviest missile in Iran's inventory at the time. The Shahab-3 is based on North Korea's Nodong-A MRBM, which likely was derived from Scuds.667 Iran purchased the Nodong after reportedly sending a delegation to Pyongyang in the 1990s to observe a Nodong flight test.668

Tehran also reportedly financed the program.669 The early 2000s saw several more Shahab-3 tests670 as well as upgrades and modifications to the Shahab-3 range, eventually leading to the Ghadr MRBM. The original Shahab-3 could carry a 670-kilogram warhead almost 1,200 kilometers. Regime officials say the Shahab-3 was the first Iranian ballistic missile to put Israel within striking range671 and that the desire to develop a missile to strike Israel was allegedly born out of the experience of watching Iraq's inability to retaliate against Israel after its attack on the Osirak nuclear reactor at Tuwaitha in 1981.672

The Shahab-3 MRBM is also the only missile that IAEA reporting has explicitly mentioned when discussing the PMD of Iran's nuclear program. A December 2015 IAEA report confirms that Iran previously "considered a number of technical options for a fuzing, arming, and firing system that would ensure that the new Shahab 3 missile spherical
payload would remain safe until the re-entry vehicle reached its designated target, and that the payload would then function correctly.”

- **Ghadr-1[101] F/H/S:** Initially referred to as the Shahab-3M, the Ghadr and all its variants represent Iran’s attempts to grow the range of the Shahab-3 platform through changes to the missile frame and fins. These gradual changes, coupled with new naming configurations, have led to confusion between the different Shahab-3 variants and over whether the Ghadr program is actually distinct. Successive Ghadr variants have increased Iran’s overall missile range, leading hardline Iranian media to classify the Ghadr-F as an “Israel-hitting missile.” The Ghadr, like the Shahab, can be retrofitted with different warheads and can deliver submunition payloads. The Ghadr has featured prominently in Iranian missile drills and flight-tests that involve liquid-propellant systems.

- **Emad:** Debutted and tested by Tehran in 2015, this MRBM looks similar to its Ghadr predecessor, with one fundamental difference — a distinct biconic warhead that functions as a Maneuverable Re-entry Vehicle (MaRV). The Emad can carry an estimated 750-kilogram warhead almost 2,000 kilometers. The Emad appeared in 2020 in an Iranian underground missile base, where projectiles were mounted onto a mobile missile train that could transport and fire them in rapid succession. Iran launched the Emad during several military drills in 2021 known as Great Prophet 15 and Great Prophet 17.

**Rezvan:** Tehran paraded a new single-stage MRBM called the Rezvan during a military parade in September 2022. The missile is road-mobile and reportedly carries a separating conical warhead and has precision-strike capabilities. The Rezvan can reportedly travel 1,400 km and is the first new Iranian liquid-propellant MRBM since the Khorramshahr, which Tehran unveiled in 2017. The Rezvan is remarkably similar to, if not a copy of, the Houthi Zolfaghar MRBM (formerly Burkan-3) and may signal the regime’s effort to incorporate into its arsenal a ballistic missile it first developed for a proxy, representing a historic first. To date, there has been no reported test of the Rezvan.

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680. @inbarspace, Twitter, December 25, 2021. (https://twitter.com/inbarspace/status/147483806446988288)


Based on its liquid-propellant engine and estimated diameter, it is likely that either the Qiam or Shahab missile served as the progenitor for this projectile.

**Khorramshahr-1/2:** Tehran’s acquisition of the Khorramshahr is another example of missile cooperation with North Korea, which reportedly exported the BM-25 Musudan IRBM to Iran in the mid-2000s. The Musudan is a North Korean copy of a nuclear-capable Soviet submarine-launched ballistic missile. Iran likely tested the Khorramshahr before publicly revealing and naming it in 2017. According to Iranian outlets, the Khorramshahr can carry an 1,800-kilogram payload an estimated 2,000 kilometers,

making it an MRBM, not an IRBM. Unlike its North Korean progenitor, the Khorramshahr does not appear to carry grid or lattice fins on its tail. The Khorramshahr can carry submunition payloads, and Tehran has modified it with a new, lighter warhead with finlets, leading it to be called the Khorramshahr-2. In 2019, the E3 complained to the UN secretary-general about Iran parading the Khorramshahr-2, whose warhead presumably would make the missile lighter and enable it to travel an estimated 3,000 kilometers. If proven, the Khorramshahr-2 would constitute Iran’s first lower-tier IRBM threshold weapon. In September 2019, Iranian outlets revealed that the Khorramshahr had a different, slenderer conical warhead than it did in 2017.
## Appendix C: Entities Supporting Iran’s Ballistic Missile Program

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>U.S. Sanctions</th>
<th>EU Sanctions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artesh (National military/ AJA) Ground-Forces (NEZAJA)</td>
<td>Military</td>
<td>No</td>
<td>No</td>
<td>Ground forces of Iran's national military. Recipient of shorter-range systems from Iranian military contractors. Recently developed a missile unit.</td>
</tr>
<tr>
<td>IRGC(693)</td>
<td>Military</td>
<td>Yes</td>
<td>No</td>
<td>Iran’s ideological military, tasked with safeguarding the revolution. Engages in terrorism and asymmetric warfare. Both supports and benefits from the missile program.</td>
</tr>
<tr>
<td>IRGC-AF(694)</td>
<td>Military</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>IRGC branch that employs missile and other long-range strike capabilities and oversees at least five different missile brigades.</td>
</tr>
<tr>
<td>IRGC-AF Al-Ghadir Missile Command(695)</td>
<td>Military</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>Unit of the IRGC-AF with operational control over Iran's missiles.</td>
</tr>
<tr>
<td>IRGC-AF Space Division(696)</td>
<td>Military</td>
<td>No, unless a broad definition of the IRGC-AF is applied(697)</td>
<td>No</td>
<td>IRGC-AF subunit in charge of space program.</td>
</tr>
</tbody>
</table>


691. All descriptions are derived from open-source description about the entity’s activities found in U.S. Treasury and State Department press releases, the public version of the “risk report” database on the Iran Watch website of the Wisconsin Project on Nuclear Arms Control, or press reporting.


697. Note: This is not listed as an AKA or sub-branch subject to sanctions in the SDN list for the IRGC-AF entry. See: “Sanctions List Search,” U.S. Department of the Treasury, Office of Foreign Assets Control, accessed August 17, 2022. (https://sanctionssearch.ofac.treas.gov/Details.aspx?id=12055). Given that the IRGC-AF Al-Ghadir Missile Command required a separate sanctions entry, this division may require one as well.
<table>
<thead>
<tr>
<th>Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>IRGC-QF</td>
<td>Military</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>Foreign and special operations branch of the IRGC. Has supported missile proliferation to militias in Iraq. Members have engaged in the PGM project to bolster Hezbollah's missile capabilities.</td>
</tr>
<tr>
<td>Artesh Research and Self-Sufficiency Jihad Research Organization</td>
<td>Military affiliate</td>
<td>No</td>
<td>No</td>
<td>Artesh research entity that has helped turn the outdated Nazeat rocket into a guided system called the Labaik-1.</td>
</tr>
<tr>
<td>IRGC-AF Self-Sufficiency Jihad Organization (IRGC-AF-SSJO)</td>
<td>Military affiliate</td>
<td>Yes</td>
<td>No</td>
<td>Research entity serving IRGC-AF. Engaged in missile research and flight testing.</td>
</tr>
<tr>
<td>IRGC Research and Self-Sufficiency Jihad Organization (IRGC-RSSJO)</td>
<td>Military affiliate</td>
<td>Yes</td>
<td>No</td>
<td>IRGC research entity active in ballistic missile testing and production. Has supported Houthi ballistic missile capabilities.</td>
</tr>
<tr>
<td>Iran Space Agency (ISA)</td>
<td>Government</td>
<td>Yes</td>
<td>No</td>
<td>Coordinates national space program and develops satellites and SLV technology.</td>
</tr>
<tr>
<td>Iran’s Aerospace Research Institute (ARI)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>No</td>
<td>Overseen by ISA and has ties to MODAFL. Develops rocket systems for Iran’s SLV program.</td>
</tr>
<tr>
<td>Iran Space Research Center (ISRC)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>No</td>
<td>ISA subordinate research entity involved in past SLV production.</td>
</tr>
</tbody>
</table>

702. Ibid.  
706. “Iranian entities involved in past SLV production.”
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Aerospace Industries Organization (AIO)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>MODAFL subsidiary responsible for Iranian missile development. AIO logo can be found on most Iranian missiles and SLVs.</td>
</tr>
<tr>
<td>Amir Al Mo'menin Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary that engages in missile research and production.</td>
</tr>
<tr>
<td>Defense Industries Organization (DIO)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>MODAFL subsidiary responsible for weapons development. Has reportedly received missile guidance technology from China.</td>
</tr>
<tr>
<td>Fajr Industries Group</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary developing precision-guidance systems and control technology. Has procured high-strength steel for missile components.</td>
</tr>
<tr>
<td>M. Babaie Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>Works on behalf of AIO for missile-related procurement.</td>
</tr>
<tr>
<td>Mizan Machine Manufacturing Group</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO front company used to procure machinery to transport missiles. Reportedly procured precision-guidance equipment for SHIG.</td>
</tr>
<tr>
<td>Sanam Industries Group</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary engaged in missile-related procurement.</td>
</tr>
<tr>
<td>Shahid Ahmad Kazemi Industries Group</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary engaged in missile collaboration with North Korea and missile technology procurement.</td>
</tr>
<tr>
<td>Shahid Bagheri Industrial Group (SBIG)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary overseeing Iran's solid-propellant program. SBIG has procured metals and materials from Chinese firm and oversees multiple affiliates.</td>
</tr>
</tbody>
</table>

713. Listed as Sanam Industrial Group.
<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Shahid Cheraghi Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary that produces liquid propellant.</td>
</tr>
<tr>
<td>Shahid Hemmat Industrial Group (SHIG)</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary overseeing production of Iran's liquid-propellant missile program.</td>
</tr>
<tr>
<td>Shahid Eslami Research Center</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary functioning as an in-house research center.</td>
</tr>
<tr>
<td>Shahid Kalhor Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary that produces missile launcher and other ground-support equipment.</td>
</tr>
<tr>
<td>Shahid Karrazi Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary that helps create missile guidance technology.</td>
</tr>
<tr>
<td>Shahid Moghaddam Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary that produces motor casings.</td>
</tr>
<tr>
<td>Shahid Movahed Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary that has facilitated Iran-DPRK missile ties.</td>
</tr>
<tr>
<td>Shahid Nuri Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary.</td>
</tr>
<tr>
<td>Shahid Sanikhani Industries</td>
<td>Government affiliate (contractor)</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary that helps cast and develop solid-propellant for missiles.</td>
</tr>
</tbody>
</table>

721. Ibid.
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Shahid Sattari Industries</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary that produces missile ground-support gear.</td>
</tr>
<tr>
<td>Shahid Shustari Industries</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>No</td>
<td>SBIG subsidiary.</td>
</tr>
<tr>
<td>Shahid Varamini Industries</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>No</td>
<td>SHIG subsidiary that produces guidance and control platforms.</td>
</tr>
<tr>
<td>Ya Mahdi Industries Group</td>
<td>Government affiliate</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>AIO subsidiary engaged in missile technology procurement.</td>
</tr>
<tr>
<td>Malek Ashtar University</td>
<td>University</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>Reportedly has ties to IRGC, supports MODAFL research requirements, and has developed a missile instruction program with AIO.</td>
</tr>
<tr>
<td>Sharif University of Technology</td>
<td>University</td>
<td>Yes</td>
<td>Yes, until October 2023</td>
<td>Provides research and development support to sanctioned missile-related entities such as MODAFL, IRGC, IRGC-AF, and AIO.</td>
</tr>
</tbody>
</table>

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Cover Illustration by Daniel Ackerman/FDD
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