FOUNDATION FOR DEFENSE OF DEMOCRACIES

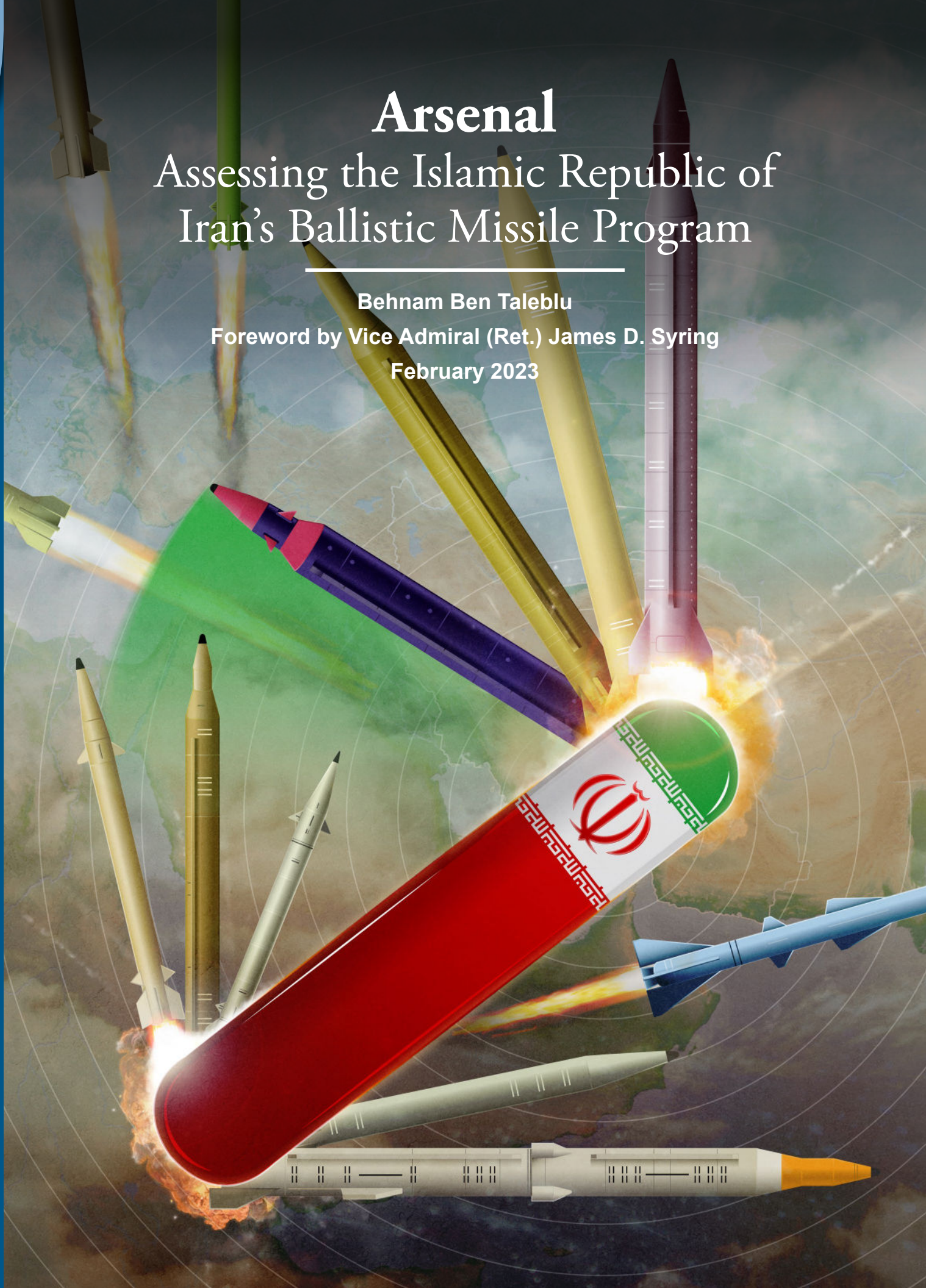
Arsenal

Assessing the Islamic Republic of Iran's Ballistic Missile Program

Behnam Ben Taleblu

Foreword by Vice Admiral (Ret.) James D. Syring

February 2023



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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.

Vice Admiral (Ret.) James D. Syring
Former Director, U.S.
Missile Defense Agency
January 2023

Glossary

AIO ..... Aerospace Industries Organization

ARI ..... Aerospace Research Institute

ASBM ..... Anti-Ship Ballistic Missile

ASCM ..... Anti-Ship Cruise Missile

BMD ..... Ballistic Missile Defense

CAATSA ..... Countering America's Adversaries Through Sanctions Act

CEP ..... Circular Error Probable

CRBM ..... Close-Range Ballistic Missile

DIO ..... Defense Industries Organization

EPAA ..... European Phased Adaptive Approach

GCC ..... Gulf Cooperation Council

HCOC ..... Hague Code of Conduct

IAEA ..... International Atomic Energy Agency

ICBM ..... Intercontinental Ballistic Missile

IDF ..... Israel Defense Forces

IFPC ..... Indirect Fire Protection Capability

INF ..... Intermediate-Range Nuclear Forces

INKSNA ..... Iran, North Korea, and Syria Nonproliferation Act

IRIB ..... Islamic Republic of Iran Broadcasting

IRBM ..... Intermediate-Range Ballistic Missile

IRGC ..... Islamic Revolutionary Guard Corps

IRGC-AF ..... Islamic Revolutionary Guard Corps Aerospace Force

IRGC-RSSJO ..... Islamic Revolutionary Guard Corps Research and Self-Sufficiency Jihad Organization

IRGC-AF-SSJO ..... Islamic Revolutionary Guard Corps Aerospace Force Self-Sufficiency Jihad Organization

IRGC-GF ..... Islamic Revolutionary Guard Corps Ground Force

IRGC-QF ..... Islamic Revolutionary Guard Corps Quds Force

ISA ..... Iranian Space Agency

ISRC ..... Iran Space Research Center

JCPOA ..... Joint Comprehensive Plan of Action

LACM ..... Land-Attack Cruise Missile

LEO ..... Low Earth Orbit

LoL ..... Left of Launch

MaRV ..... Maneuverable Re-entry Vehicle

MRBM ..... Medium-Range Ballistic Missile

MODAFL ..... Ministry of Defense and Armed Forces Logistics

MTCR ..... Missile Technology Control Regime

PGM ..... Precision-Guided Munition

PMD ..... Possible Military Dimensions

PSI ..... Proliferation Security Initiative

RV ..... Re-entry Vehicle

SBIG ..... Shahid Bagheri Industrial Group

SHIG ..... Shahid Hemmat Industrial Group

SLV ..... Space/Satellite Launch Vehicle

SMG ..... Shiite Militia Group

SRBM ..... Short-Range Ballistic Missile

SSM ..... Surface-to-Surface Missile

UCAV ..... Unmanned Combat Aerial Vehicle

UNSCR ..... United Nations Security Council Resolution

WMD ..... Weapon of Mass Destruction

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."[1]

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.[2]

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.

1. U.S. Department of Defense, "Missile Defense Review," 2019, page II. (https://www.defense.gov/Portals/1/Interactive/2018/11-2019-Missile-Defense-Review/The%202019%20MDR_Executive%20Summary.pdf)
2. Behnam Ben Taleblu, "New Iran Nuclear Deal? Same Old Missile Problems.," *The Dispatch*, March 8, 2022. (https://thedispatch.com/p/new-iran-nuclear-deal-same-old-missile)

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.

Birth of the Iranian Ballistic Missile Program

"As I look at the theater and I look at the Iranian threat, that is the most concerning threat to me." That is how then U.S. CENTCOM Commander General Kenneth F. McKenzie, who was responsible for U.S. forces in the Middle East, answered a question in April 2021 about Iran's evolving ballistic missile capabilities. "Over the last five to seven years," he added, "the Iranians have made remarkable qualitative improvements in their ballistic missile force while it has grown quantitatively as well, and now numbers, depending on how you choose to count the weapons, something a little less than 3,000 of various ranges."[3] In an interview that December, General McKenzie went further. A media report paraphrased him as saying Iran's missile program was now more of an "immediate threat than its nuclear program," and that missiles provided Tehran with "overmatch" defined as "the ability to overwhelm" the U.S. military or partner forces in the region.[4]

For years, U.S. directors of national intelligence under both Democratic and Republican administrations have attested that Iran's ballistic missile arsenal is the largest in the Middle East.[5] While analysts have traditionally written off Iran's conventional military capabilities as lackluster, its ballistic missile program has increasingly drawn the attention of Western policymakers, especially after a January 2020 precision strike used short-range ballistic missiles (SRBMs) against bases in Iraq where American forces were located.

3. U.S. Central Command Commander General Kenneth F. McKenzie, Department of Defense, *Press Briefing*, April 22, 2021. (https://www.defense.gov/Newsroom/Transcripts/Transcript/Article/2582980/general-kenneth-f-mckenzie-jr-commander-us-central-command-holds-a-press-briefi)

4. General Kenneth F. McKenzie in: Robin Wright, "The Looming Threat of a Nuclear Crisis with Iran," *The New Yorker*, December 27, 2021. (https://www.newyorker.com/magazine/2022/01/03/the-looming-threat-of-a-nuclear-crisis-with-iran)

5. See, for example: U.S. Office of the Director of National Intelligence, "Annual Threat Assessment of the US Intelligence Community," February 2022, page 15. (https://www.dni.gov/files/ODNI/documents/assessments/ATA-2022-Unclassified-Report.pdf); Director of National Intelligence John D. Negroponte, U.S. Office of the Director of National Intelligence, "Annual Threat Assessment of the Director of National Intelligence," January 11, 2007, page 7. (https://www.dni.gov/files/documents/Newsroom/Testimonies/20070111_testimony.pdf)

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 outweighs 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).[6] 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.[7] The strike marked the first of an estimated 117 Scud missile launches by Iran during the Iran-Iraq War.[8] 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."[9]

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.[10] Iran's first Scud missile launch against Iraq marked a critical juncture in the eight-year war and taught 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.[11] Six months after the victory of the Islamic Revolution was declared, the Iranian army and air force encountered significant shortages and personnel issues.[12] Iranian revolutionary authorities, which already distrusted the armed forces, inherited a military in disarray.[13] The government also slashed Iran's military budget and purged the officer corps of the national military, or Artesh.[14]

6. Elaine Sciolino, "Documents Detail Israeli Missile Deal With the Shah," *The New York Times*, April 1, 1986. (https://www.nytimes.com/1986/04/01/world/documents-detail-israeli-missile-deal-with-the-shah.html)

7. "ماجرای اولین موشکی که ایران به سمت عراق شلیک کرد/ چگونه این موشک به دست ایرانی‌ها اداره شد؟" [The Story of The First Missile That Iran Fired at Iraq / How Was This Missile Operated by the Iranians?]," *Borna News* (Iran), September 23, 2020. (https://www.borna.news/fa/tiny/news-1063164). Note: some sources say the strike was launched at 2:40 a.m. See source in footnote 9 for contrast.

8. One analyst has noted that these strikes "practically never hit any" of Iran's "proclaimed targets." See: Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War Volume II: The Iran-Iraq War* (Boulder, CO: Westview Press, 1990), page 497.

9. "بازخوانی نخستین تنبیه موشکی سپاه در دوران دفاع مقدس [Re-Reading the IRGC's Missile Punishment During the Holy Defense]," *Iranian Students News Agency* (Iran), June 19, 2017. (https://web.archive.org/web/20180615150850/https://www.isna.ir/news/96032916460/بازخوانی-نخستین-تنبیه-موشکی-سپاه-در-دوران-دفاع-مقدس)

10. The title of the documentary *Khatt-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, "مستند «خط مقدم» ["Frontline" Documentary]," *YouTube*, September 30, 2015. (https://www.youtube.com/watch?v=w-LkkVw5Ol4)

11. This is despite CIA warnings from 1979 to the interim revolutionary government in Iran about a potential Iraqi invasion. See: Mark Gasirowski, "US Intelligence Assistance to Iran, May-October 1979," *Middle East Journal*, Vol. 66, No. 4 (Autumn 2012), pages 613-627. On Saddam Hussein's decision to invade, see: Chad E. Nelson, "Revolution and War: Saddam's Decision to Invade Iran," *Middle East Journal*, Vol. 72, No. 2 (Spring 2018), pages 246-266.

12. Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War Volume II: The Iran-Iraq War* (Boulder, CO: Westview Press, 1990), page 66.

13. Ayatollah Khomeini said that the Artesh has "the Shah in their blood." See: Steven R. Ward, *Immortal: A Military History of Iran and its Armed Forces* (Washington, DC: Georgetown University Press, 2007), page 238.

14. Shahram Chubin and Charles Tripp, *Iran and Iraq at War* (London: I.B. Tauris, 1988), pages 33-34.

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.[15] By 1984, Tehran had earned a U.S. designation as a State Sponsor of Terrorism,[16] instituting a complete ban on U.S. arms sales and exports of controlled dual-use goods to Iran.[17]

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.[18] 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.[19] 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.[20]

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[21] — the Libyans cut off assistance and attempted to sabotage Iran's remaining stockpile.[22] 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."[23]

Iran fired its first Scud without any foreign assistance on January 11, 1987.[24] Later that year, Tehran received

15. Michael Eisenstadt, "Can the United States Influence the WMD Policies of Iraq and Iran?" *The Nonproliferation Review*, Summer 2000, page 67. (https://www.nonproliferation.org/wp-content/uploads/npr/72eisen.pdf)
16. U.S. Department of State, Bureau of Counterterrorism, "Country Reports on Terrorism 2019: Iran," (https://www.state.gov/reports/country-reports-on-terrorism-2019/iran/)
17. Kenneth Katzman, "Iran Sanctions," *Congressional Research Service*, February 2, 2022, pages 3-4. (https://fas.org/sgp/crs/mideast/RS20871.pdf)
18. "از دِمونتاژ محرمانه و مهندسی معکوس تا ساخت موشک‌های نقطه‌زن/تلاش‌های مرد پشت‌پرده موشکی ایران برای تولید موشک‌های بومی، [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/از-دمونتاژ-محرمانه-و-مهندسی-معکوس-تا-ساخت-موشک-های-نقطه-زن-تلاش-های)
19. A. Ekramian, "مستند «خط مقدم» ['Frontline' Documentary]," *YouTube*, September 30, 2015. (https://www.youtube.com/watch?v=w-LkkVw5Ol4)
20. Ibid.
21. "یک ماجرای موشکی به روایت محسن رفیق دوست [One Missile Story According to Mohsen Rafighdoost]," *Iranian Students News Agency* (Iran), September 27, 2020. (https://web.archive.org/web/20201204023037/https://www4.isna.ir/news/99070604351/یک-ماجرای-موشکی-به-روایت-محسن-رفیق-دوست). Other accounts contend that Libya was pressured by Arab states to cease supporting Iran.
22. This does not appear to have impeded other Iran-Libya ties during the war, which reportedly saw Iran transfer chemical weapons to Libya, while Libya sent Iran mines. See: U.S. Department of State, "Compliance with The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, Condition (10)(C) Report," June 2020, pages 8-12 (https://www.state.gov/wp-content/uploads/2020/06/2020-10C-Report-Unclassified-Version-for-H.pdf); Elaine Sciolino, "U.S. and Soviet Protest to Libya Over Iran Mine," *The New York Times*, September 11, 1987. (https://www.nytimes.com/1987/09/11/world/us-and-soviet-protest-to-libya-over-iran-mines.html)
23. "گزارش: آیا موشکهای ایرانی یادگار هاشمی رفسنجانی است؟ [Report: Are Iranian Missiles A Relic of Hashemi Rafsanjani?]," *Tasnim News Agency* (Iran), January 15, 2019. (https://tn.ai/1921907)
24. "روایتی از قدرت بالستیک ایران/مقایسه توان موشکی قبل وبعد از انقلاب [A Narrative of Iran's Ballistic Power/A Comparison of Missile Capabilities Before and After the Revolution]," *Mehr News Agency* (Iran), March 23, 2020. (https://www.mehrnews.com/news/4843936/روایتی-از-قدرت-بالستیک-ایران-مقایسه-توان-موشکی-قبل-وبعد-از-انقلاب)

An Iranian Scud missile from the Iran-Iraq War with the following written in both Persian and Arabic, "Death to America, Death to the Soviet Union, Death to Israel, Death to Saddam."(Islamic Republic News Agency)

an estimated 100 Scud missiles from North Korea.[25] Many of these Scuds struck population centers during the "war of the cities,"[26] 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.[27] Iran later developed another rocket, named the Nazeat, variants of which remain in service today.[28] 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.[29] 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.[30]

Foreign military support also continued into the post-war period.[31] China provided at least one whole SSM system, dubbed the Tondar-69,[32] as well as gyroscopes and other missile-related technologies.[33] Russia also provided technical assistance and raw materials for the

25. "Iran Missile Milestones: 1985-2021," *Iran Watch*, July 29, 2021. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2021)
26. See: "'War of Cities' Truce Ends as Iraqi Missile Hits Tehran," *Associated Press*, March 14, 1988. (https://www.latimes.com/archives/la-xpm-1988-03-14-mn-734-story.html)
27. Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War Volume II: The Iran-Iraq War* (Boulder, CO: Westview Press, 1990), page 498.
28. "بررسی عملکرد راکت «نازعات» [Investigating the Performance of the 'Nazeat' Rocket]," *Iranian Students News Agency* (Iran), December 14, 2015. (https://web.archive.org/web/20160627201110/http://www.isna.ir:80/news/94092313151/بررسی-عملکرد-راکت-نازعات)
29. Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), pages 46-47.
30. Behnam Ben Taleblu, "Solid-Propellant Motor Test Proves Iran's Continuing Missile Advancement," *The National Interest*," February 2, 2022. (https://nationalinterest.org/feature/solid-propellant-motor-test-proves-iran%E2%80%99s-continuing-missile-advancement-200245)
31. Erik A. Olson, "Iran's Path Dependent Military Doctrine," *Strategic Studies Quarterly*, Summer 2016, pages 75-77. (https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-10_Issue-2/Olson.pdf)
32. "تندر 69" چگونه وارد سازمان موشکی ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی مقاومت به موشک‌های «فاتح» [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)
33. "Iran Missile Milestones: 1985-2021," *Iran Watch*, July 29, 2021. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2021)

Iranian missile program in the 1990s.[34] China remains a key jurisdiction for procuring dual-use goods for the regime's missile program.[35]

"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.[36] 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.[37] 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.[38]

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.[39] 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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34. "Iran Missile Milestones: 1985-2021," *Iran Watch*, July 29, 2021. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2021). See also: Robert Walpole, "Prepared Testimony by Robert Walpole Before the U.S. Senate Governmental Affairs Committee Hearing: Iran's Arms Proliferation," *Testimony Before the U.S. Senate Government Affairs Committee*, September 21, 2000. (https://www.iranwatch.org/library/government/united-states/congress/hearings-prepared-statements/prepared-testimony-robert-walpole-senate-governmental-affairs-committee-hearing)

35. For example: "Li Fangwei," Federal Bureau of Investigation, Most Wanted, accessed August 17, 2022. (https://www.fbi.gov/wanted/counterintelligence/li-fangwei); Will Green and Taylor Roth, "China-Iran Relations: A Limited but Enduring Strategic Partnership," *U.S.-China Economic and Security Review Commission*, June 28, 2021. (https://www.uscc.gov/sites/default/files/2021-06/China-Iran_Relations.pdf)

36. "Iran Missile Milestones: 1985-2021," *Iran Watch*, July 29, 2021. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2021)

37. Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), pages 23-27.

38. See the case of the BM-25 Musudan and Khorramshahr/Khorramshahr-2 in: "North Korea Missile Overview," *Nuclear Threat Initiative*, December 6, 2020. (https://www.nti.org/analysis/articles/north-korea-missile/); United Nations Security Council, "Letter dated 25 March 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," March 27, 2019, page 2. (https://undocs.org/S/2019/270)

39. See comments by Amir-Ali Hajizadeh in: A. Ekramian, "مستند «خط مقدم» ['Frontline' Documentary]," *YouTube*, September 30, 2015. (https://www.youtube.com/watch?v=w-LkkVw5Ol4)

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.[40] 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.[41] While the overarching goal of Iran's national security strategy is the perpetuation of the regime,[42] other aims include regional primacy and self-reliance.[43]

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."[44] 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."[45]

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

40. See references to status driving the late Shah's nuclear program in: David Patrikarakos, *Nuclear Iran: The Birth of An Atomic State* (London: I.B. Tauris, 2012) and U.S. Central Intelligence Agency, "Special National Intelligence Estimate: Prospects for Further Proliferation of Nuclear Weapons," August 23, 1974, page 38. (https://digitalarchive.wilsoncenter.org/document/113914.pdf?v=1d0611a0e27c3147885760b47381b740)

41. Daniel Byman, Shahram Chubin, Anoushiravan Ehtehshami, and Jerrold Green, *Iran's Security Policy in the Post-Revolutionary Era* (Santa Monica, CA: RAND Corporation, 2001), page 99.

42. See imperative of regime survival in: Hassan Rouhani, تصمیم‌گیری در سیاست خارجی جمهوری اسلامی ایران: ساختارها و چالش‌ها [Decision Making in the Foreign Policy of the Islamic Republic of Iran: Structures and Challenges] (Tehran: Center for Strategic Research, 2013), pages 61-64.

43. Aggregated from: U.S. Defense Intelligence Agency, "Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance," 2019, pages 12-13. (https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Iran_Military_Power_LR.pdf); Michael Eisenstadt, "The Strategic Culture of The Islamic Republic of Iran: Operational and Policy Implications," *Middle East Studies – Marine Corps University*, August 2011, page 3. (http://edocs.nps.edu/2014/May/MESM%20No1,%20August%202011%20'The%20Strategic%20Culture%20of%20the%20Islamic%20Republic%20of%20Iran'.pdf)

44. "یادتان هست موشکی قدرت اقتدار درباره ای بیانات امام خامنه +نماهنگ؛ ['Do You Remember'; Imam Khamenei's Statements About Missile Power + Clip]," *Tasnim News Agency* (Iran), June 13, 2018. (https://tn.ai/1748900)

45. Mohsen Rezaie, in: Manuchehr Ienziran, "Hasan Tehrani Moghadam, Sardar Rahim Safavi, Mohsen Rezai tell story of missile in Iran," *YouTube*, November 17, 2012. (https://www.youtube.com/watch?v=b3nuUIgTujk)

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

46. Analyses of Harry Kazianis, Vipin Narang, Fabian Hinz, and Jeffrey Lewis of Iran's January 2020 ballistic missile strikes were noted in the following IRIB documentary: Aminjarahi, "(مستند « بازدارنده » - قدرت موشکی ایران | قسمت سوم (آخر [Documentary 'Deterrent' – Iran's Missile Power | Part Three (Final)]," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=z17xVAm7rKM). For coverage of Mi6, see: "ایران به مرحله نوینی از بازدارندگی رسیده است [Iran Has Reached A New Stage of Deterrence]," *Kayhan* (Iran), April 18, 2021. (http://kayhan.ir/fa/news/215027). For coverage of Israeli assessments, see: "بیینید | روایت کارشناس صهیونیست درباره دقت موشک های ایرانی [Watch | The Narration of a Zionist Expert About the Precision of Iranian Missiles]," *Donya-e-Eqtesad* (Iran), April 22, 2020. (https://donya-e-eqtesad.com/بخش-سایت-خوان-62/3647010-بیینید-روایت-کارشناس-صهیونیست-درباره-دقت-موشک-های-ایرانی); "پدر صنعت موشکی رژیم صهیونیستی: به احترام توان موشکی ایران کلاه از سر بر می‌دارم! + فیلم [The Father of The Zionist Regime's Missile Industry: I Take My Hat Off In Honor of Iran's Missile Capability]," *Mizan* (Iran), October 8, 2018. (https://www.mizan.news/458105). More recently, see how Hajizadeh framed American descriptions of Iranian missile power in: "سردار حاجی‌زاده مطرح کرد: جزئیات جلسه مهم فرماندهان سپاه با روحانی در حضور حاج قاسم [Commander Hajizadeh Said: Details of the Important Meeting of IRGC Commanders With Rouhani in The Presence of Haj Qassem]," *Student News Network* (Iran), January 12, 2022. (https://web.archive.org/web/20220112065650/https://www.snn.ir/fa/news/989593/سردار-زاده-مطرح-کرد-جزئیات-جلسه-مهم-فرماندهان-سپاه-با-روحانی-در-حضور-حاج-قاسم%E2%80%8Cحاجی)

47. "بیانات در دیدار نخبگان جوان علمی [Statements in a Meeting With Young Scientific Elites]," *Khamenei Website* (Iran), October 18, 2017. (https://farsi.khamenei.ir/speech-content?id=37949)

48. "پایه گذار صنعت موشکی کشور مقام معظم رهبری است [The Founder of The Country's Missile Industry is the Supreme Leader]," *Mehr News Agency* (Iran), June 23, 2017. (https://www.mehrnews.com/news/4012890/پایه-گذار-صنعت-موشکی-کشور-مقام-معظم-رهبری-است)

49. "سردار غیب‌پرور: توان موشکی خط قرمز است/ در حوزه موشک هر روز پیشرفت می‌کنیم [Commander Gheibparvar: Missile Power is Our Red Line/We Are Making Progress in The Missile Field Every Day]," *Tasnim News Agency* (Iran), date. (https://tn.ai/1744731)

50. Noted by Hamid Baeidnejad in: "نگرانی آمریکا، اسرائیل از قدرت بازدارندگی برنامه موشکی ایران [US-Israel Concerns Over the Deterrent Power of Iran's Missile Program]," *Alef* (Iran), May 31, 2019. (https://webcache.googleusercontent.com/search?q=cache:ike774hPQykJ:https://www.alef.ir/news/3980310093.html&cd=2&hl=en&ct=clnk&gl=us)

51. Michael Eisenstadt, "The Role of Missiles in Iran's Military Strategy," *The Washington Institute for Near East Policy*, November 2016, page 2. (https://www.washingtoninstitute.org/media/1940)

52. U.S. Central Intelligence Agency, Directorate of Intelligence, "Iran-Iraq War: Ballistic Missile Warfare and Its Regional Implications," March 1986. (https://www.cia.gov/readingroom/docs/CIA-RDP88T00096R000100120003-6.pdf)

warfighting.[53] Near the end of the conflict, however, as Baghdad's missile capabilities improved and Tehran fell within range of Iraqi Scuds, Iranian officials saw the devastating impact these projectiles had on Iran's population. Wartime morale dropped significantly, and citizens fled the capital.[54] This had an enduring psychological effect on Iranian leaders.[55]

Today, Iranian officials use the example of the eight-year war to illustrate the cost aggressors would pay in a conflict[56] and believe several wars have already been prevented as a result.[57] They also believe the war was the source of the regime's deterrent and defensive capabilities.[58] As Kenneth Pollack notes, after the war, Iranians armed themselves not against renewed Iraqi aggression, but against a far more powerful adversary: America.[59] Tehran has focused on how best to contest American military dominance and deter a U.S. attack while advancing its revolutionary foreign policy.[60] Iranian military officials assert that the regime's strength and deterrence power has robbed adversaries, including the United States, of the will to fight,[61] enabling Iran to pursue its regional ambitions with greater ease.

Such thinking assumes that as the regime conducts its regional policy — exporting its ideology and creating, co-opting, and supporting local armed groups[62] — Iran will need tools to offset conventionally superior adversaries who have a vested interest in maintaining the regional order that Iran seeks to overturn.[63] To adapt an analogy developed by Karim Sadjadpour,[64] 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.

53. "بیانات در دیدار نخبگان جوان علمی [Statements in a Meeting With Young Scientific Elites]," *Khamenei Website* (Iran), October 18, 2017. (https://farsi.khamenei.ir/speech-content?id=37949)
54. Thomas L. McNaugher, "Ballistic Missiles and Chemical Weapons: The Legacy of the Iran-Iraq War," *International Security*, Vol. 15, No. 2, (Fall 1990), pages 5-34.
55. J. Matthew McInnis, *The Future of Iran's Security Policy: Inside Iran's Strategic Thinking* (Washington, DC: American Enterprise Institute, 2017), page 98.
56. "در چهل سالگي جنگ تحميلي [In the Fortieth Anniversary of the Imposed War]," *Etemad* (Iran), September 19, 2020. (https://www.etemadnewspaper.ir/fa/main/print/155055)
57. "قدرت بازدارندگی ایران مانع 3 جنگ شده است [Iran's Deterrent Power Prevented 3 Wars]," *Tabnak* (Iran), November 30, 2012. (https://www.tabnak.ir/fa/news/288270/قدرت-بازدارندگي-ايران-مانع3--جنگ-شده-است)
58. "افزایش قدرت بازدارندگی مدیون دفاع مقدس است [The Increase in Deterrent Power is Due to The Sacred Defense]," *Resalat News* (Iran), September 22, 2020. (https://web.archive.org/web/20220630015508/https://resalat-news.com/افزايش-قدرت-بازدارندگي-مديون-دفاع-مقد)
59. Kenneth M. Pollack, *The Persian Puzzle: The Conflict Between Iran and America* (NYC: Random House, 2005), pages 425-426. For more on the sources of Iran's motivations and threat perceptions at this time, see: Michael Eisenstadt, *Iranian Military Power, Capabilities and Intentions* (Washington, DC: The Washington Institute for Near East Policy, 1996), pages 1-4.
60. J. Matthew McInnis, *The Future of Iran's Security Policy: Inside Iran's Strategic Thinking* (Washington, DC: American Enterprise Institute, 2017), page 24.
61. "آیت‌الله خامنه‌ای نیروهای مسلح را به بازدارندگی رساندند/ توصیه رهبری درباره سربازان وظیفه [Ayatollah Khamenei Delivered the Armed Forces to Deterrence/The Leadership's Advice on Conscripts]," *Rahborde Moaser* (Iran), July 1, 2019. (https://rahbordemoaser.ir/fa/news/15062/آیت%E2%80%8Cالله-خامنه-ای-نیروهای-مسلح-را-به-بازدارندگی-رساندند-توصیه-رهبری-درباره-سربازان-وظیفه)
62. On the export of the revolution, see: "(مبانی نظری صدور انقلاب از منظر امام خمینی(س) [Theoretical Foundations on the Export of the Revolution From the Perspective of Imam Khomeini (PBUH)]," *Khamenei Website* (Iran), September 23, 2007. (https://farsi.khamenei.ir/others-article?id=10232). For the imperative of supporting proxies known as the "Axis of Resistance," see: "همکاری ایران با محور مقاومت در راستای تأمین امنیت ملی است [Iran's Cooperation with The Axis of Resistance is Aimed at Ensuring National Security]," *Mashregh News* (Iran), August 14, 2019. (https://www.mashreghnews.ir/news/983903/همکاری-ایران-با-محور-مقاومت-در-راستای-تأمین-امنیت-ملی-است)
63. U.S. Defense Intelligence Agency, "Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance," 2019, page 12. (https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Iran_Military_Power_LR.pdf)
64. This sword and shield analogy was originally devised to describe the utility of Iran's political and military elite. See: Karim Sadjadpour, "The Return of Iranian Hard-Liners' Favorite Moderate," *The Atlantic*, March 7, 2019. (https://www.theatlantic.com/ideas/archive/2019/03/what-does-javad-zarifs-return-mean/584305/)

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"[65] 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.

"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)."

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). These improvements may embolden Tehran to take more risks, as demonstrated by a January 2020 barrage against U.S. positions in Iraq. Scholars believe that the increasing precision of Iran's missile forces may lead it to adopt a more offensive military doctrine over time.[66] Combined with Iranian perceptions of U.S. irresolution and risk aversion, an enhanced arsenal may lead to a lower threshold for the use of ballistic missiles.[67]

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.[68] 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)[69] 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

65. As specified by Alexander George, the "image" represents one side's perception or cost of a war or a crisis. The greater or worse this image is, the more likely an actor is to be incentivized toward cooperation or restraint. See: Alexander L. George, *Forceful Persuasion: Coercive Diplomacy as an Alternative to War* (Washington, DC: U.S. Institute of Peace, 1991), page 70.
66. Bilal Y. Saab and Michael Elleman, "Precision Fire: A Strategic Assessment of Iran's Conventional Missile Program," *Atlantic Council*, September 2016. (https://www.atlanticcouncil.org/wp-content/uploads/2016/09/Precision_Fire_web_0907.pdf). Also affirmed in the author's conversations with J. Matthew McInnis in January 2021 and August 2021.
67. Behnam Ben Taleblu, "Strikes on Iraq Reveal Iran's Embrace of Missile Operations," *The National Interest*, March 27, 2022. (https://nationalinterest.org/feature/strikes-iraq-reveal-iran%E2%80%99s-embrace-missile-operations-201431)
68. Daniel Byman, Shahram Chubin, Anoushiravan Ehtehshami, and Jerrold Green, *Iran's Security Policy in the Post-Revolutionary Era* (Santa Monica, CA: RAND Corporation, 2001), pages 94-96.
69. For more, see: "MTCR Guidelines and Annex," *Federation of American Scientists*, accessed August 17, 2022. (https://nuke.fas.org/control/mtcr/text/mtcr_handbook_guide-annex.pdf)

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.[70] Given Iran's unique experience in the Iran-Iraq War, ballistic missiles are certain to remain central to Iran's national security strategy.

A subterranean Iranian SRBM assembly line with a poster (left) quoting Iran's Supreme Leader Ali Khamenei as saying, "Our enmity with America is eternal." (Young Journalists Club)

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."[71] 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.[72] A nuclear weapons program has three main requirements: fissile material (i.e., weapons-grade uranium or reprocessed plutonium), weaponization (i.e., warhead development),[73] 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

70. See Hossein Salami's reference to missile defense systems in: "برد موشک‌ها شعاع تأثیر ایجاد می‌کند/ موشک‌ها محور بازدارندگی راهبردی نظام و انقلاب [The Range of Missiles Creates a Radius of Influence/Missiles Are the Axis of Strategic Deterrence for the System and the Revolution]," *Young Journalists Club* (Iran), November 16, 2014. (https://www.yjc.news/00L9bx). For an example of how Tehran frames the financial versus political cost of missile and air defense in the case of Iron Dome, see: "روایتی از ضربه مهلک و خاموش موشک‌های مقاومت به صهیونیست‌ها/ وقتی گنبد آهنین و اقتصاد اسرائیل با هم نابود می‌شود [A Narrative of the Silent and Deadly Blow of the Missiles of the Resistance to the Zionists/When Iron Dome and the Israeli Economy are Destroyed Together]," *Young Journalists Club* (Iran), May 12, 2021. (https://www.yjc.news/fa/news/7755740/روایتی-از-ضربه-مهلک-و-خاموش-موشک-های-مقاومت-به-صهیونیست-ها-وقتی-گنبد-آهنین-و-اقتصاد-اسرائیل-با-هم-نابود-می-شود)

71. U.S. Central Intelligence Agency, Director of Central Intelligence, "Impact and Implications of Chemical Weapons Use in the Iran-Iraq War," April 1988, page 11. (https://www.cia.gov/readingroom/docs/DOC_0001030207.pdf)

72. James R. Clapper, "Worldwide Threat Assessment of the US Intelligence Community," *Testimony Before the U.S. Senate Select Committee on Intelligence*, January 29, 2014, page 6. (https://www.dni.gov/files/documents/Intelligence%20Reports/2014%20WWTA%20%20SFR_SSCI_29_Jan.pdf)

73. For an understanding of the component parts of weaponization, see: Kelsey Davenport, Daryl G. Kimball, and Greg Thielman, "Solving the Iranian Nuclear Puzzle: Toward a Realistic and Effective Comprehensive Nuclear Agreement," *Arms Control Association*, June 2014, pages 8-24. (https://www.armscontrol.org/files/files/ACA_Iran_Briefing_Book_Update_June_2014.pdf)

systems.[74] 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.[75] 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."[76]

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[77] indicates a link between Iran's missiles and quest for a nuclear weapon.[78] 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.[79] 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." [80]

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."[81]

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,"[82] the report failed to address the evolution of Iran's nuclear weapons efforts. Fakhrizadeh continued to be involved in nuclear-related entities that evolved

74. For background, see: Kelsey Davenport, "The Missile Technology Control Regime at a Glance," *Arms Control Association*, March 2021. (https://www.armscontrol.org/factsheets/mtcr)
75. Michael Eisenstadt, "Testing the Limits: Iran's Ballistic Missile Program, Sanctions, and the IRGC," *Testimony Before the U.S. House Committee on Foreign Affairs*, March 29, 2017. (https://docs.house.gov/meetings/FA/FA13/20170329/105800/HHRG-115-FA13-Wstate-EisenstadtM-20170329.pdf)
76. Michael Elleman, "Iran's Ballistic Missile Program," *Testimony Before the U.S. Senate Committee on Banking, Housing, and Urban Affairs*, May 24, 2016. (https://www.banking.senate.gov/imo/media/doc/052416_Elleman%20Testimony.pdf)
77. For an explainer, see: David Albright, Olli Heinonen, and Andrea Stricker, "Summary of Report: Breaking Up and Reorienting Iran's Nuclear Weapons Program [1] - Iran's Nuclear Archive Shows the 2003 Restructuring of its Nuclear Weapons Program, then called the Amad Program, into Covert and Overt Parts," *Institute for Science and International Security*, March 6, 2019. (https://isis-online.org/isis-reports/detail/summary-of-report-breaking-up-and-reorienting-irans-nuclear-weapons-program/8)
78. "From Iran's Nuclear Archive: Schematics of Warhead in a Shahab-3 Re-entry Vehicle," *Institute for Science and International Security*, May 17, 2019. (https://isis-online.org/isis-reports/detail/from-irans-nuclear-archive-schematics-of-warhead-in-a-shahab-3-re-entry-veh/8)
79. International Atomic Energy Agency, Board of Governors, "Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions 1737 (2006), 1747 (2007) and 1803 (2008) in the Islamic Republic of Iran," May 26, 2022. (https://www.iaea.org/sites/default/files/gov2008-15.pdf)
80. Ibid.
81. International Atomic Energy Agency, Board of Governors, "Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran," November 8, 2011. (https://www.iaea.org/sites/default/files/gov2011-65.pdf)
82. International Atomic Energy Agency, Board of Governors, "Final Assessment on Past and Present Outstanding Issues regarding Iran's Nuclear Programme," December 2, 2015. (https://www.iaea.org/sites/default/files/gov-2015-68.pdf)

into the Organization of Defensive Innovation and Research (SPND).[83] SPND retained AMAD plan staff and expertise as a hedging strategy with overt and covert components.[84] While Fakhrizadeh was assassinated in late 2020, there is no indication that his death ended Tehran's nuclear aspirations. Iran's latest nuclear moves have given the regime irreversible nuclear knowledge that helps put it in striking distance of a potential nuclear weapons threshold capability.[85]

Given Iran's threat perceptions, revolutionary foreign policy, and obsession with deterrence, acquiring nuclear weapons would be a logical step. It is no accident that Iran's nuclear and ballistic missile programs draw from the same wellspring of experience: the Iran-Iraq War.[86] Tehran's desire to keep its nuclear options open also explains why the regime was willing to endure significant sanctions pressure. Iran consented to the JCPOA specifically because it did not permanently block Tehran's path to the bomb.

Attaining a nuclear weapons capability would likely foster a sense of invincibility in an already revolutionary regime and could, in turn, lead to more regional conflict. Given the speed that ballistic missiles travel, prudence dictates that if Iran developed a nuclear weapons capability, the region would have to go on high alert each time the Islamic Republic flight-tested or employed ballistic missiles in military operations.

Iran's Missiles in Action

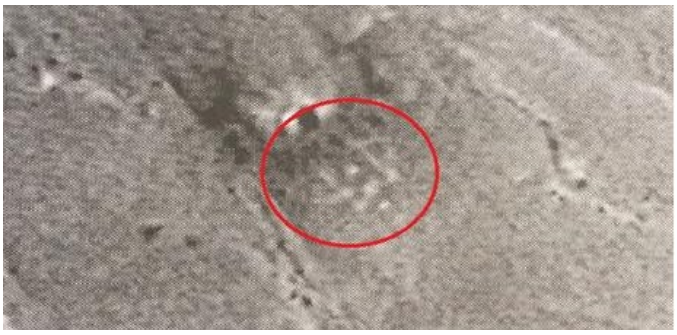
Aside from parading ballistic missiles to herald a new system or capability, Iran has three primary means of missile employment: tests, transfers, and military use during peacetime. These actions offer three unique levels of analysis to view Iran's capabilities and intentions.

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.[87] 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

83. U.S. Department of State, Office of the Spokesperson, "Additional Sanctions Imposed by the Department of State Targeting Iranian Proliferators," August 29, 2014. (https://2009-2017.state.gov/r/pa/prs/ps/2014/231159.htm)
84. David Albright, Olli Heinonen, and Andrea Stricker, "Breaking Up and Reorienting Iran's Nuclear Weapons Program," *Institute for Science and International Security*, October 29, 2018. (https://isis-online.org/uploads/isis-reports/documents/Reorienting_AMAD_Program_29Oct2018_Final.pdf)
85. Andrea Stricker and Anthony Ruggiero, "Iran Approaches the Nuclear Threshold: Washington's Narrowing Policy Options," *Foundation for Defense of Democracies*, March 3, 2022. (https://www.fdd.org/analysis/2022/03/03/iran-approaches-the-nuclear-threshold/)
86. Behnam Ben Taleblu, "The Long Shadow of the Iran-Iraq War," *The National Interest*, October 23, 2014. (https://nationalinterest.org/feature/the-long-shadow-the-iran-iraq-war-11535)
87. See comment by Hajizadeh in: "سردار حاجی‌زاده: دقت موشک‌ها را مدیون تدبیر رهبر معظم انقلاب هستیم/ ناوهای هواپیمابر آمریکا برای ما یک سیبل 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)



Satellite imagery presented to the United Nations by Israeli Ambassador Danny Dannon on June 28, 2017, shows a Star of David-shaped target being used in Iranian missile test (Source: Israel Ministry of Foreign Affairs)

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."[88]

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]

88. "موشك‌های ما از ایده تا محصول کاملًا ایرانی هستند/ در بخش تأمین تسلیحات وابستگی نداریم" [Our Missiles are Completely Iranian From Idea to Product/We Have No Dependency in the Area of Arms Supplies]," *Islamic Republic News Agency* (Iran), February 14, 2016. (www.irna.ir/news/81963631)

89. "آمریکا و اسرائیل ۵ بار قصد حمله به ایران داشتند؛ توان موشکی ایران مانع حمله شد/ آمریکا می‌خواهد موشک را از ما بگیرد" [The United States and Israel Tried to Attack Iran Five Times; Iran's Missile Power Thwarted the Attack/America Wants to Take the Missile From Us]," *Tasnim News Agency* (Iran), April 2, 2015. (https://tn.ai/1038012)

90. "آقایان با یک تشر، موشک ماهواره‌بر را به انبار بردند!" [With One Threat, the Gentlemen Took the Satellite-Launch Missile into Storage!]," *Kayhan* (Iran), March 10, 2017. (https://kayhan.ir/fa/print/99832)

91. Note the genocidal slogans painted on an Iranian MRBM in 2016 and the launching of a missile at a Star of David-shaped target. See: Tim Hume and Alireza Hajihosseini, "Iran fires ballistic missiles a day after test; U.S. officials hint at violation," *CNN*, March 9, 2016. (https://www.cnn.com/2016/03/09/middleeast/iran-missile-test/index.html); "Iran is using the Star of David as target practice for missile tests," *The Independent* (UK), June 29, 2017. (https://www.independent.co.uk/news/world/middle-east/israel-iran-nuclear-ballistic-missile-tests-star-of-david-isis-tehran-attack-a7815276.html)

92. "سردار حاجی‌زاده: اعزام نیرو به سوریه متوقف نشده/ موشک‌های ۲۰۰۰کیلومتری سپاه مخصوص زدن اسرائیل است" [Commander Hajizadeh: The Deployment of Troops to Syria Has Not Stopped/The IRGC's 2,000-kilometer Missiles are for Striking Israel]," *Tasnim News Agency* (Iran), March 9, 2016. (https://tn.ai/1023309)

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

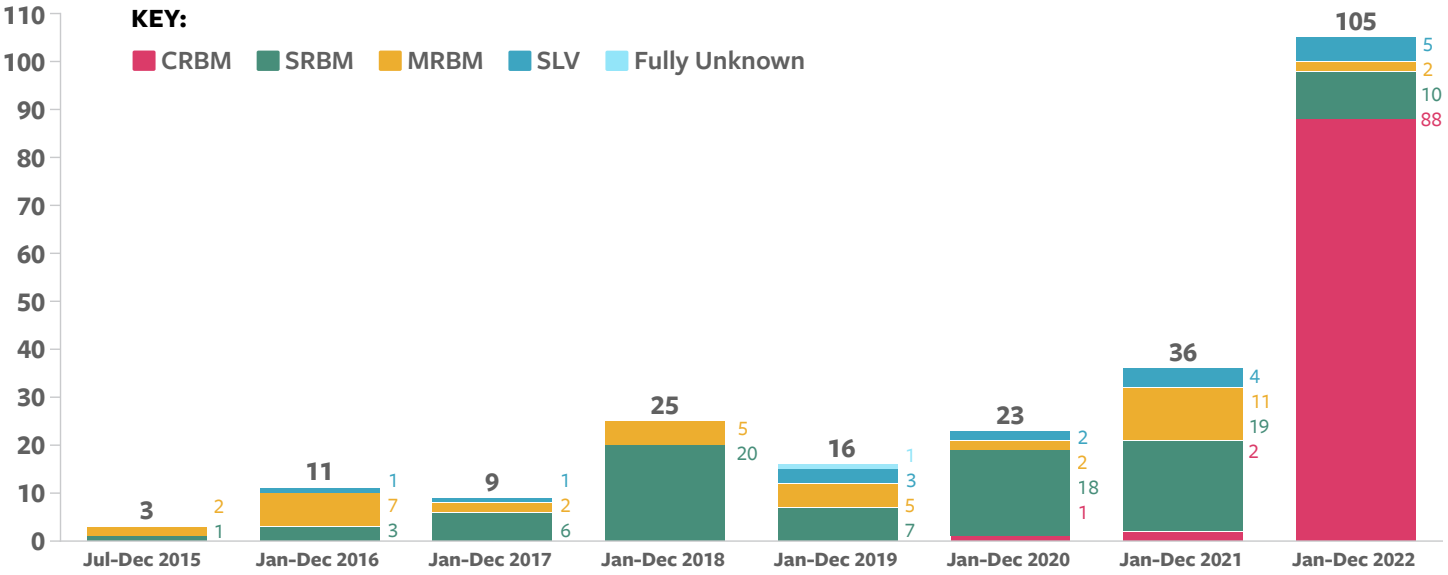
93. "انتقاد روحانی از سپاه پاسداران واکنش ستاد کل نیروهای مسلح را برانگیخت [Rouhani's Criticism of the Guard Crops Provoked a Reaction from the General Staff of the Armed Forces]," *Radio Farda*, May 5, 2017. (https://www.radiofarda.com/a/f4_rouhani_statemtn_revolutionary_missile_program_reaction_military/28470502.html)

94. For example: Sewell Chen, "Rouhani Lashes Back at Trump, as Iran Unveils New Missile," *The New York Times*, September 22, 2017. (https://www.nytimes.com/2017/09/22/world/middleeast/rouhani-trump-missile.html)

95. صادق زیباکلام [Sadegh Zibakalam], "به انتخابات دعوت نمی کنم و رای هم نمی دهم، مصاحبه صادق زیباکلام [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=uVI4QXRMyXk); "انتقاد شدید زیباکلام از آزمایش موشک عماد!/ جیسون رضاییان "بخت‌برگشته" کدام اطلاعات را می‌خواست به بیگانگان بدهد؟ [Zibakalam's Firm Criticism of Testing the Emad Missile!/What Information Did 'Unlucky' Jason Rezaian Give to Foreigners?]," *Serat News* (Iran), October 25, 2015. (https://www.seratnews.com/fa/print/264669)

96. For sourcing, see footnotes on each projectile launch listed in the table found in Appendix A.

Iranian Ballistic Missile Launches by Year and Class: Post-JCPOA to December 2022



modified Iranian Scud missiles.[97] Around the same time, Iran also began to share MRBM production technology with Libya,[98] the country that furnished Tehran with its first Scuds during the Iran-Iraq War.[99] 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]."[100] 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."[101] 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

97. To date, it is unclear if this agreement was implemented. See: "Iran Said Selling Scud Missiles," Associated Press, November 22, 1999. (https://apnews.com/article/c621846e0b17cd1149cd1026a07db701)
98. See multiple references in: "Libya Missile Chronology," *Nuclear Threat Initiative*, February 2011. (https://media.nti.org/pdfs/libya_missile.pdf)
99. "Libya and the Scud, the onset for Iran turning into missile power," *Islamic Revolution Documents Center* (Iran), November 8, 2015. (http://irdc.ir/en/news/52/libya-and-the-scud-the-onset-for-iran-turning-into-missile-power)
100. Hajizadeh in: "کارخانه های موشکی سوریه ساخت ایران است/سیر تکامل موشک های "اسرائیل زن" ایران [Syrian Missile Factories are Made by Iran/The Evolution of Iran's 'Israel-Hitting' Missiles]," *Tasnim News Agency* (Iran), November 11, 2014. (https://tn.ai/554227)
101. "هرچه از قدرت موشکی در غزه و لبنان می‌بینید با حمایت ایران است/ محدودیت برد ۲هزار کیلومتر موشکی ابدی نیست [Whatever You See of Missile Power in Gaza and Lebanon is With Iranian Support/The 2 Thousand-Kilometer Range Limit is Not Permanent]," *Mashregh News* (Iran), January 2, 2021. (https://www.mashreghnews.ir/news/1163016/هرچه-از-قدرت-موشکی-در-غزه-و-لبنان-می-بینید-با-حمایت-ایران-است)

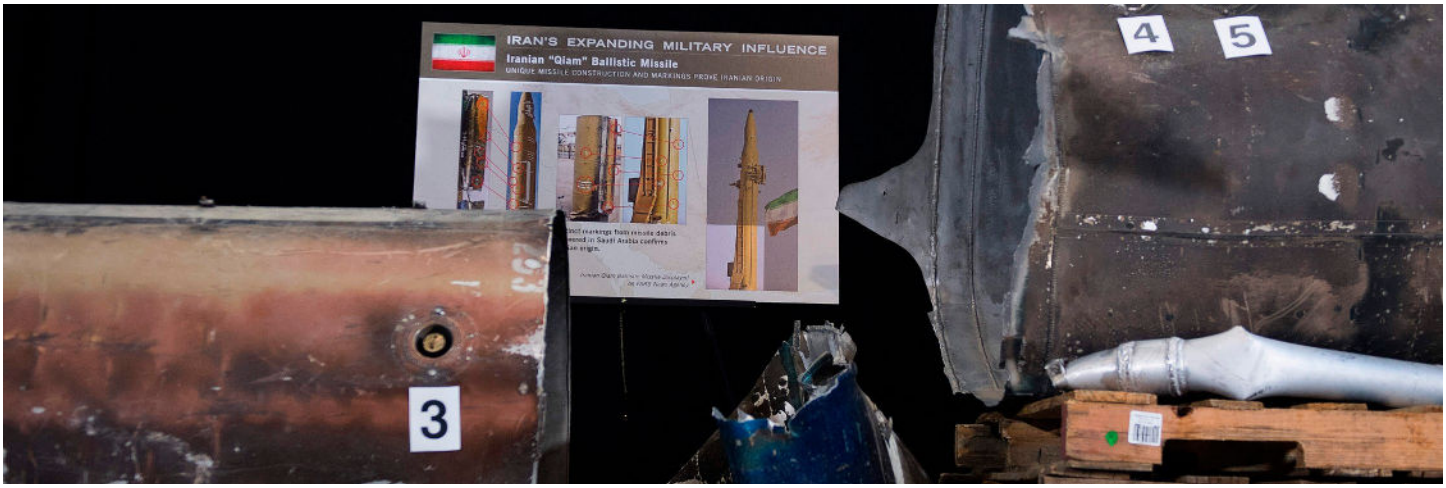
as a knife against the neck of U.S. partners in the region aimed at complicating policy planning and eroding both the will and capability to respond to any instance of Iranian aggression.

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[102] 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.[103] 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.[104]

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."[105]



Pieces of an Iranian Qiam Ballistic Missile fired by Houthis in Yemen at Saudi Arabia are on display during a press conference at Joint Base Anacostia in Washington, DC, on December 14, 2017. (Photo by Jim Watson/AFP via Getty Images)

102. See: John Hannah, "Iran's North Korean Playbook to Protect Its Nuclear Program," *Foreign Policy*, December 22, 2017. (https://foreignpolicy.com/2017/12/22/irans-north-korean-playbook-to-protect-its-nuclear-program)
103. Such as the case of Palestinian rockets or Houthi ballistic missiles, cruise missiles, and drones.
104. Explained with relevance to rockets in: Behnam Ben Taleblu, "Redefining Iran's Role in its Latest 'Shadow War' Against Israel," *The National Interest*, May 24, 2021. (https://nationalinterest.org/feature/redefining-iran%E2%80%99s-role-its-latest-%E2%80%98shadow-war%E2%80%99-against-israel-185947). Regardless of the different names of such systems, assessments drawing on imagery in parades, launches, or wreckage will continue to aid in ascertaining similarities with known Iranian systems, capabilities, and design features.
105. "ایران بر 4 پایتخت عربی مسلط شده است/ چرا آل سعود به تمام احزاب سیاسی یمن پشت کرد؟" [Iran Hs 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

Proxy/Partner Name; Jurisdiction	Ballistic Missile(s)/Capability Transferred	Target(s)	Notes
Houthis (a.k.a. Ansar Allah); Yemen	Modified Scud variant: Burkan-1[106] and modified Qiam-1 variants: Burkan-2H,[107] Burkan-3/Zolfaghar.[108] More recently, the Hatem (assumed Kheybar Shekan), Karrar (assumed Fateh-110 or Fateh variant), and Falaq (assumed Qiam-2)	Saudi Arabia, UAE,[109] potentially Israel in the future[110]	Iran likely supported upgrades to the Badr rocket,[111] which is still in use as a precision-guided munition (PGM) called the Badr-1P or Badr-F
Assad regime; Syria	Fateh-110,[112] missile factories[113]	Syrian rebels, potentially Israel	Syria has begun producing Fateh-110s under the name M600 and transferring them to Hezbollah.[114]
Hezbollah; Lebanon	Fateh-110,[115] PGM kits,[116] subterranean missile factories[117]	Assumedly Israel	As of this writing, Hezbollah has not fired ballistic missiles at Israel.

106. Ian Williams and Shaan Shaikh, "The Missile War in Yemen," *Center for Strategic and International Studies*, June 2020, page 42. (https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/Williams_MissileWarYemen_WEB_FINAL_v2.pdf)
107. The whole thread appears here: @EllemanIISS, *Twitter*, January 25, 2019. (https://twitter.com/ellemaniiss/status/1088840870550478848).
108. These are both believed to be extended-range variants of the already modified Iranian Qiam-1, which, when modified for the Houthis, was first dubbed the Burkan-2H. The Burkan-3/Zolfaghar could also be a variant of a larger liquid-propellant MRBM. For use, see: Jeremy Binnie, "Yemeni rebels claim ballistic missile attack against Dammam," *Janes* (UK), August 2, 2019. (https://www.janes.com/defence-news/news-detail/yemeni-rebels-claim-ballistic-missile-attack-against-dammam); Dan De Luce, "Iranian-backed Houthi rebels in Yemen ramp up drone, missile attacks on Saudi Arabia," *NBC News*, March 12, 2021. (https://www.nbcnews.com/news/world/iranian-backed-houthi-rebels-yemen-ramp-drone-missile-attacks-saudi-n1260488); Ralph Savelsberg, "Houthi 'Terror' Scuds Now Threaten Most Of Saudi Arabia," *Breaking Defense*, June 15, 2021. (https://breakingdefense.com/2021/06/houthi-terror-scuds-now-threaten-most-of-saudi-arabia/)
109. "Types of missiles, drones used in operation against Abu Dhabi," *Mehr News Agency* (Iran), January 18, 2022. (https://en.mehrnews.com/news/183014/Types-of-missiles-drones-used-in-operation-against-Abu-Dhabi)
110. For good analysis on this rising threat, see: Ari Heistein and Elisha Stoin, "Out of Sight, Out of Mind? Understanding the Houthi Threat to Israel," *The Institute for National Security Studies*, April 27, 2021. (https://www.inss.org.il/publication/the-houthi-threat-to-israel)
111. "Yemen Fires Badr-1-P Ballistic Missile at Saudi Backed Forces' Position (+Video)," *Tasnim New Agency* (Iran), November 4, 2018. (https://tn.ai/1868791)
112. Barbara Starr, "U.S. officials: Syria using more accurate, Iranian-made missiles," *CNN*, December 28, 2012. (https://www.cnn.com/2012/12/28/world/meast/syria-missiles)
113. "ایران در حلب سوریه موشک‌هایی ساخت که علیه اسرائیل شلیک شد/ تهدید ایران در تنگه هرمز و خلیج فارس شوخی است [Iran Built Missiles in Syria That Were Fired at Israel/Iran's Threat in the Strait of Hormuz and Persian Gulf is Not a Joke]," *Tasnim News Agency* (Iran), November 11, 2016. (https://tn.ai/1237350)
114. Yaakov Katz and Rebecca Anna Stoil, "Hizbullah received hundreds of Syrian missiles," *The Jerusalem Post* (Israel), May 5, 2010. (https://www.jpost.com/Middle-East/Hizbullah-received-hundreds-of-Syrian-missiles)
115. "فاتح110 برای به زانو درآوردن صهیونیست‌ها کافی است/ شلیک کن و منتظر نابودی هدف باش+ تصاویر [The Fateh-110 is Sufficient to Bring the Zionists to Their Knees/Fire and Await the Destruction of the Target + Images]," *Young Journalists Club*, September 16, 2016. (https://www.yjc.news/fa/news/5777144/فاتح-110برای-به-زانو-درآوردن-صهیونیست-ها-کافی-است-شلیک-کن-و-منتظر-نابودی-هدف-باش-تصاویر);
"دقیق ترین موشک ایرانی که در اختیار حزب الله لبنان است" [Iran's Most Accurate Missile That is in The Hands of Lebanese Hezbollah]," *Borna News* (Iran), July 31, 2020. (https://www.borna.news/fa/tiny/news-1037292)
116. Jonathan Schanzer and Bradley Bowman, "Don't Bailout Tehran's Precision Guided Munitions Project," *Real Clear Defense*, May 15, 2020. (https://www.realcleardefense.com/articles/2020/05/15/dont_bailout_tehrans_precision_guided_munitions_project_115289.html)
117. Judah Ari Gross, "Report sheds light on Iranian missile factories being built in Lebanon," *The Times of Israel* (Israel), July 9, 2017. (https://www.timesofisrael.com/report-sheds-light-on-underground-iranian-missile-factories-being-built-in-lebanon)

Proxy/Partner Name; Jurisdiction	Ballistic Missile(s)/Capability Transferred	Target(s)	Notes
Shiite militia groups[118] (e.g. Kataib Hezbollah); Iraq	Fateh-110, Zulfiqar. No known transfer to militia groups in Syria directly from Iran.	Assumedly Israel or U.S. and coalition forces in Iraq	As of this writing, neither Kataib Hezbollah nor any other Iran-backed group in Iraq has used ballistic missiles against U.S. or Israeli forces.[119] However, rocket attacks against U.S. forces continue.

Although Iran has supplied the Palestinian terror groups Hamas and Palestinian Islamic Jihad (PIJ) with Fajr-3 and Fajr-5 rockets,[120] 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.[121] 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."[122] 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

118. John Irish and Ahmed Rasheed, "Iran moves missiles to Iraq in warning to enemies," *Reuters*, August 31, 2018. (https://www.reuters.com/article/cnews-us-iran-iraq-missiles-exclusive-idCAKCN1LG0WB-OCATP). Note: Table 1 excludes Shiite militia groups operating in Syria and striking at U.S. forces in Syria as they are not known to have received ballistic missiles from Iran while in Syrian territory. Those forces continue to use rockets against U.S. targets. See: "Pro-Iran militias launch rockets at US base in eastern Syria after air strikes," *France 24* (France), June 29, 2021. (https://www.france24.com/en/middle-east/20210629-pro-iran-militias-launch-rockets-at-us-base-in-eastern-syria-after-air-strikes). This analysis further excludes a report about a single alleged MRBM launch from Syria at Israel in January 2019. While a tweet by the IDF calls the projectile a rocket, an IDF spokesperson claimed it was a missile launched by Iranian forces, not Shiite militias. See and compare: @IDF, *Twitter*, January 20, 2019. (https://twitter.com/IDF/status/1087208734298906625); Oren Lieberman, "Israel strikes Iranian targets in Damascus after missile fired at Golan Heights," *CNN*, January 22, 2019. (https://www.cnn.com/2019/01/21/middleeast/israel-strikes-iran-targets-syria-intl); Melanie Lidman, "Missile fire can't dampen Israel's winter wonderland, with record snow on Hermon," *The Times of Israel* (Israel), January 25, 2019. (https://www.timesofisrael.com/missile-fire-cant-dampen-israels-winter-wonderland-with-record-snow-on-hermon). An earlier reported barrage in May 2018 by Shiite militias in Syria at Israel is also discounted, since artillery rockets were used. See: Isabel Kershner, "Iran Fires Rockets Into Golan Heights From Syria, Israelis Say," *The New York Times*, May 9, 2018. (https://www.nytimes.com/2018/05/09/world/middleeast/israel-iran-attack.html). To date, there is no clear instance of ballistic missile use by Shiite militias in Syria against external targets.

119. But they are believed to have used drones against Saudi Arabia. See: Qassim Abdul-Zahra, "Recent drone attack on Saudi royal palace launched from Iraq," *Associated Press*, February 25, 2021. (https://abcnews.go.com/International/wireStory/recent-drone-attack-saudi-royal-palace-launched-iraq-76105660)

120. A 2019 Arabic-language documentary on Iranian TV touted those rockets, among others, as being in the possession of the al-Quds Brigade of the PIJ: "فیلم/ مستند العالم از تونل‌های ساخت موشک غزه" [Film: Al-Alam Documentary On The Production Tunnels of Gaza's Missile[s]]," *International Quran News Agency* (Iran), February 21, 2019. (https://iqna.ir/00Funs). Hamas' al-Qassem Brigades is in possession of the Fajr-5: Mohammad-Reza Moradi, "نگاه) پایان افسانه گنبد آهنین چگونه رقم خورد؟) [How Did The End of The Iron Dome Dream Come About? (Viewpoint)]," *Kayhan* (Iran), May 11, 2019. (https://web.archive.org/web/20200112050028/http://kayhan.ir/fa/mobile/news/160086/1562)

121. Such as the Badr-3, for instance, which is assumed to be Iranian supplied or supported: "رونمایی از «بدر 3»؛ 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.ir/news/13980216000081/رونمایی-از-بدر3--موشک-جدید-جهاد-اسلامی-فلسطین)

122. Ali Javid, "Iran Soraya TV with IRGC_AS missiles chief Gen. Hajizadeh, capabilities ایران ثریا سردار حاجی زاده," *YouTube*, November 22, 2018. (https://www.youtube.com/watch?v=tCQLTI2r6kY)

Tochka SRBMs from the ousted Yemeni government,[123] 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.[124] 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,[125] 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.[126] 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."[127] Photos of the Burkan-2H contain evidence of shoddy welding, vindicating the thesis of local reassembly of larger imported components.[128]

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.[129]

In 2019, the Houthis launched their first MRBM, the Burkan-3, at targets in eastern Saudi Arabia.[130] This extended-range Burkan, which would reappear

123. Emilyn Tuomala, "Houthis," *Missile Defense Advocacy Alliance*, June 2018. (https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/non-state-actors/houthis)
124. Bel Trew, "Saudis shoot down Houthi missile fired towards Mecca," *The Times* (UK), July 29, 2017. (https://www.thetimes.co.uk/article/saudis-shoot-down-houthi-missile-fired-towards-mecca-wdcckwntj)
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.
126. "Houthis fire ballistic missile toward Mecca," *Deutsche Welle* (Germany), October 28, 2016. (https://www.dw.com/en/houthis-fire-ballistic-missile-toward-mecca/a-36181308)
127. For more, see: Ralph Savelsberg, "Houthi Missiles: The Iran Connection; Scuds Are Not Dead Yet," *Breaking Defense*, May 17, 2018. (https://breakingdefense.com/2018/05/houthi-missiles-the-iran-connection-scuds-are-not-dead-yet); United Nations Security Council, "Letter dated 26 January 2018 from the Panel of Experts on Yemen mandated by Security Council resolution 2342 (2017) addressed to the President of the Security Council," January 26, 2018, pages 27-31. (https://reliefweb.int/report/yemen/letter-dated-26-january-2018-panel-experts-yemen-mandated-security-council-resolution)
128. @EllemanIISS, *Twitter*, December 14, 2017. (https://twitter.com/EllemanIISS/status/941382431571103744)
129. U.S. Department of the Treasury, Press Release, "Treasury Targets Iranian Individuals Providing Ballistic Missile Support to Yemen's Huthis," May 22, 2018. (https://home.treasury.gov/news/press-releases/sm0392)
130. Jeremy Binnie, "Yemeni rebels claim ballistic missile attack against Dammam," *Janes* (UK), August 2, 2019. (https://www.janes.com/defence-news/news-detail/yemeni-rebels-claim-ballistic-missile-attack-against-dammam)

in 2021 as the Zolfaghar,[131] carries a narrower conical warhead than most Iranian MRBMs but has the same tail-section fins at the Qiam 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[132] and even a U.S. base in the UAE in early 2022.[133]

"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 Houthis unveiled the Badr-1P, the guided version of an older artillery rocket that has since been modified[134] and used in various missions, including against attacks on civilian targets like Aden International Airport in December 2020.[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.[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 Hatem, the Karrar, and the Falaq — 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.[137]

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, Seyyed Majid Mousavi, described Syria

131. @Yahya_Saree, *Twitter*, March 26, 2021. (https://twitter.com/Yahya_Saree/status/1375370161050488833). Note: The author used a different spelling of the word "ذوالفقار" in the text to avoid confusion with the Houthi liquid-propellant ballistic missile and the solid-propellant Iranian Zulfiqar SRBM, derived from the Fateh class of missiles.

132. Jeremy Binnie, "Houthis claim long-range cruise missile attack on UAE," *Janes* (UK), January 24, 2022. (https://www.janes.com/defence-news/news-detail/houthis-claim-long-range-cruise-missile-attack-on-uae)

133. Alexander Cornwell, Alaa Swilam, and Phil Stewart, "Yemen's Houthis fail in second missile attack on UAE," *Reuters*, January 24, 2022. (https://www.reuters.com/world/middle-east/uaes-defense-ministry-destroyed-2-houthi-ballistic-missiles-wam-2022-01-24)

134. Jeremy Binnie, "Yemen's rebels unveil air-bursting missile," *Janes* (UK), April 17, 2019. (https://www.janes.com/defence-news/news-detail/yemens-rebels-unveil-air-bursting-missile). The UN Panel of Experts believes that the Badr-1 is locally produced. See: United Nations Security Council, "Letter dated 25 January 2019 from the Panel of Experts on Yemen addressed to the President of the Security Council," January 25, 2019. (https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2019_83.pdf). Many open-source analysts believe Iran to be the likeliest supporter of the Houthi precision-strike project, an assessment with which this author concurs. See: Michael Knights, "Yemen's 'Southern Hezbollah': Implications of Houthi Missile and Drone Improvements," *The Washington Institute for Near East Policy*, April 1, 2021. (https://www.washingtoninstitute.org/policy-analysis/yemens-southern-hezbollah-implications-houthi-missile-and-drone-improvements); @fab_hinz, *Twitter*, July 13, 2020. (https://twitter.com/fab_hinz/status/1282876011588120577)

135. "UN report points to Huthis for December attack on Aden airport," *Agence France-Presse* (France), March 31, 2021. (https://www.france24.com/en/live-news/20210331-un-report-points-to-huthis-for-december-attack-on-aden-airport)

136. See projectiles in video here: "یمن| رونمایی از دستاوردهای جدید در حوزه دفاعی از پهپادهای جدید تا موشک‌های «سعیر»، «قاصم۲» و «قدس۲»+فیلم [Yemen| Unveiling of new achievements in the field of defense from new drones to the 'Sair', 'Qasim 2' and 'Quds 2' missiles + Film]," *Tasnim News Agency* (Iran), March 11, 2021. (https://tn.ai/2468309). For more on the exhibition, see: Stijn Mitzer and Joost Oliemans, "Houthi Rebels Unveil Host of Weaponry, Compounding Drone and Missile Threat," *Oryx*, March 12, 2021. (https://www.oryxspioenkop.com/2021/03/houthi-rebels-unveil-host-of-weaponry.html)

137. To be clear, it is unknown when these projectiles were transferred. For the full parade, see: الإعلام الحربي اليمني, "المشاهد الكاملة للعرض العسكري المهيب بمناسبة العيد الثامن لثورة الـ21 من سبتمبر [The Full Scenes of the Majestic Military Display on the Occasion of the Eighth Anniversary of the September 21 Revolution]," *YouTube*, September 22, 2022. (https://www.youtube.com/watch?v=Uh43AmC8dQ0)

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 War[141] 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]

138. "فاتح» موشک‌های به مقاومت دستیابی/ صهیونیستی رژیم زدن برای متری کیلو 2هزار های موشک/ شد؟ ایران موشکی سازمان وارد چگونه "69 تندر» [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)
139. For a systematic review of routes and strategies, see: David Adesnik and Behnam Ben Taleblu, "Burning Bridge: The Iranian Land Corridor to The Mediterranean," *Foundation for Defense of Democracies*, June 2019. (https://www.fdd.org/analysis/2019/06/18/burning-bridge/)
140. "فاتح» موشک‌های به مقاومت دستیابی/ صهیونیستی رژیم زدن برای متری کیلو 2هزار های موشک/ شد؟ ایران موشکی سازمان وارد چگونه "69 تندر» [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)
141. "Civilians under Assault: Hezbollah's Rocket Attacks on Israel in the 2006 War," *Human Rights Watch*, August 28, 2007. (https://www.hrw.org/report/2007/08/28/civilians-under-assault/hezbollahs-rocket-attacks-israel-2006-war)
142. Jeffrey White, "A War Like No Other: Israel vs. Hezbollah in 2015," *The Washington Institute for Near East Policy*, January 29, 2015. (https://www.washingtoninstitute.org/policy-analysis/war-no-other-israel-vs-hezbollah-2015)
143. Howard Schneider, "Hezbollah's relocation of rocket sites to Lebanon's interior poses wider threat," *The Washington Post*, January 23, 2010. (https://www.washingtonpost.com/wp-dyn/content/article/2010/01/22/AR2010012204494.html)
144. "Missiles and Rockets of Hezbollah," *Center for Strategic and International Studies*, August 10, 2021. (https://missilethreat.csis.org/country/hezbollahs-rocket-arsenal)
145. "Iranian engineer commanding Hezbollah precision missile project identified," *i24 News* (Israel), July 16, 2019. (https://www.i24news.tv/en/news/international/middle-east/1563265569-i24news-exclusive-iranian-engineer-commanding-hezbollah-precision-missile-project-identified)
146. Quote from translation/summary in tweet: @DavidADaoud, *Twitter*, February 10, 2021. (https://web.archive.org/web/20210328042615/https://twitter.com/DavidADaoud/status/1359532239483199493)
147. Erik A. Olson, "Iran's Path Dependent Military Doctrine," *Strategic Studies Quarterly*, Summer 2016, pages 75-77. (https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-10_Issue-2/Olson.pdf)
148. For an excellent report on the PGM challenge, see: "Hezbollah's Precision Missile Project," *Britain Israel Communications and Research Centre*, February 2019. (http://www.bicom.org.uk/wp-content/uploads/2019/02/Precision-Project-Paper.pdf)
149. Joe Truzman, "Israel resumes airstrikes against Iran's proxy network in Syria," *FDD's Long War Journal*, April 8, 2021. (https://www.longwarjournal.org/archives/2021/04/israel-resumes-airstrikes-against-irans-proxy-network-in-syria.php)

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.[150] Phase three, which began in 2019 and is ongoing, involves efforts to develop PGMs entirely in Lebanon.[151] In 2020, the IDF released pictures of factories in Lebanon engaging in this process.[152] 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."[153]

Should Iran's PGM project continue unimpeded, writes Jonathan Schanzer, the Israeli Iron Dome defense system's "total dominance may come to an end."[154] 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.[155] Increasingly, Iranian officials are wagering that PGMs will render Israel unable to win a war with Hezbollah.[156] 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.[157] 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.[158]

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.[159] The report further noted the presence of

150. Amos Harel, "Smuggled in Suitcases | Iran's Covert Scheme to Upgrade Hezbollah's Rocket Arsenal Revealed," *Haaretz* (Israel), February 28, 2019. (https://www.haaretz.com/middle-east-news/iran/.premium-iran-s-covert-scheme-to-upgrade-hezbollah-s-rocket-arsenal-revealed-1.6978683)

151. IDF Editorial Team, IDF Website, "Hezbollah's Precision Guided Missile Project," September 19, 2019. (https://www.idf.il/en/minisites/hezbollah/hezbollahs-precision-guided-missile-project)

152. Jacob Magid, "IDF publishes photos purporting to expose Hezbollah precision missile factory, *The Times of Israel* (Israel), September 3, 2019. (https://www.timesofisrael.com/idf-publishes-photos-purporting-to-show-hezbollah-precision-missile-factory)

153. "چگونه وارد سازمان موشکی ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی مقاومت به موشک‌های «فاتح» [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)

154. Jonathan Schanzer, "The New Rocket Threat to Israel," *Commentary*, January 2020. (https://www.commentarymagazine.com/articles/jonathan-schanzer/the-new-rocket-threat-to-israel)

155. Rubin defines Iron Dome, David's Sling, and potential future laser defenses as "active." See: Uzi Rubin, "Israel and the Precision-Guided Missile Threat," *The Begin-Sadat Center for Strategic Studies – Bar Ilan University*, June 16, 2020. (https://besacenter.org/israel-precision-guided-missiles)

156. Hajizadeh in: "سردار حاجی‌زاده: دقت موشک‌ها را مدیون تدبیر رهبر معظم انقلاب هستیم/ ناوهای هواپیمابر آمریکا برای ما یک سیبل هستند [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)

157. John Irish and Ahmed Rasheed, "Iran moves missiles to Iraq in warning to enemies," *Reuters*, August 31, 2018. (https://www.reuters.com/article/cnews-us-iran-iraq-missiles-exclusive-idCAKCN1LG0WB-OCATP).

158. Qassim Abdul-Zahra, "Recent drone attack on Saudi royal palace launched from Iraq," *Associated Press*, February 25, 2021. (https://apnews.com/article/yemen-iran-saudi-arabia-riyadh-middle-east-ab3a83c9090c31f772bad7556bd482f1)

159. John Irish and Ahmed Rasheed, "Iran moves missiles to Iraq in warning to enemies," *Reuters*, August 31, 2018. (https://www.reuters.com/article/cnews-us-iran-iraq-missiles-exclusive-idCAKCN1LG0WB-OCATP).

missile factories in at least two different parts of Iraq. In December 2019, *The New York Times* confirmed the SRBM transfers had taken place,[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.[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.[162] Reportedly, the Russians sought their improved accuracy.[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.[164]

Battlefield Use

"I am Iran's guardian,"[165] read a large billboard in Tehran's Vali Asr Square after Iranian ballistic missile strikes against ISIS in Syria in 2017.[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.[167] In the first five (which occurred between 1994 and 2001), Iran fired Scuds at

IRGC missile launch billboard in Tehran (Twitter/هواداران پرسپولیس)

160. Julian E. Barnes and Eric Schmitt, "Iran Is Secretly Moving Missiles Into Iraq, U.S. Officials Say," *The New York Times*, December 4, 2019. (https://www.nytimes.com/2019/12/04/us/politics/iran-missiles-iraq.html)
161. "Iraq delays general election to Oct. 10: state media," *Reuters*, Jan 19, 2021. (https://www.reuters.com/article/us-iraq-politics-election/iraq-delays-general-election-to-oct-10-state-media-idUSKBN29O1FK)
162. Joby Warrick, Ellen Nakashima, and Shane Harris, "Iran plans to send missiles, drones to Russia for Ukraine war, officials say," *The Washington Post*, October 16, 2022. (https://www.washingtonpost.com/national-security/2022/10/16/iran-russia-missiles-ukraine/)
163. "Iran agrees to ship missiles, more drones to Russia," *Reuters*, October 18, 2022. (https://www.reuters.com/world/exclusive-iran-agrees-ship-missiles-more-drones-russia-defying-west-sources-2022-10-18/)
164. Caitlin McFaul, "Russia seeking hundreds of ballistic missiles from Iran in 'full-fledged defense partnership': UK," *Fox News*, December 10, 2022. (https://www.foxnews.com/world/russia-seeking-hundreds-ballistic-missiles-from-iran-full-fledged-defense-partnership-uk)
165. @persepolis_news, *Twitter*, June 20, 2017. (https://twitter.com/persepolis_news/status/877059788911333376/photo/1)
166. "آخرین خبر / انجام موفقیت‌آمیز انتقام بزرگ سپاه/اصابت دقیق موشک‌ها به مواضع تروریستها" [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)
167. This figure excludes the September 2019 strike on Saudi oil installations, which featured drones and cruise missiles and is believed to have been launched from Iranian territory: David D. Kirkpatrick, Christoph Koettl, Allison McCann, Eric Schmitt, Anjali Singhvi, and Gus Wezerek, "Who Was Behind the Saudi Oil Attack? What the Evidence Shows," *The New York Times*, September 16, 2019. (https://www.nytimes.com/interactive/2019/09/16/world/middleeast/trump-saudi-arabia-oil-attack.html)

the Mujahideen-e Khalq (MEK), an Iranian dissident organization in Iraq, in retaliation for alleged MEK attacks.[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 2: Iranian Military Operations Featuring Ballistic Missiles Since the Iran-Iraq War[169]

Date	Codename	Target	Apparent Rationale	Missiles Used
November 1994[170]	N/A	MEK base in Iraq	Retaliation for MEK attacks[171]	Three Shahabs (likely Shahab-1s or Shahab-2s)
November 1994[172]	N/A	MEK base in Iraq	Retaliation for MEK attacks[173]	Three Scuds (likely Shahab-1s or Shahab-2s)
June 1999[174]	N/A	MEK base in Iraq	Unclear; likely retaliation for MEK assassination[175]	Scud-B (assumed)
November 1999[176]	N/A	MEK base in Iraq	Unclear; likely retaliation for MEK assassination[177]	Scuds (assumed)
April 2001[178]	N/A	MEK bases in Iraq (at least 3 different locations)	Unclear	44 to 77 Scuds (likely Shahab-1s or Shahab-2s)[179]

168. "U.S. Terrorism Report: MEK and Jundallah," *The Iran Primer*, August 23, 2011. (https://iranprimer.usip.org/blog/2011/aug/23/us-terrorism-report-mek-and-jundallah)
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/)
170. Gary Samore, *Iran's Strategic Weapons Programmes: A Net Assessment* (NYC: International Institute for Strategic Studies, 2005), page 98. (https://books.google.com/books?id=Ea9FAAAAQBAJ)
171. Assumedly in response to this reported attack: Safa Haeri, "Bomb kills 25 and injures 70 at Iran's holiest shrine," *The Independent* (UK), June 20, 1994. (https://www.independent.co.uk/news/world/bomb-kills-25-and-injures-70-at-iran-s-holiest-shrine-1424047.html)
172. Gary Samore, *Iran's Strategic Weapons Programmes: A Net Assessment* (NYC: International Institute for Strategic Studies, 2005), page 98. (https://books.google.com/books?id=Ea9FAAAAQBAJ)
173. See description of alleged MEK attacks in this report: U.S. Department of State, "Patterns of Global Terrorism, 1994," April 1995. (https://fas.org/irp/threat/terror_94/append.html)
174. Gary Samore, *Iran's Strategic Weapons Programmes: A Net Assessment* (NYC: International Institute for Strategic Studies, 2005), page 98. (https://books.google.com/books?id=Ea9FAAAAQBAJ)
175. Assumedly this attack: "Iran Assassination Suspect Killed," *Associated Press*, June 21, 1999. (https://apnews.com/article/b8e56f1aa3932815379d4d1aa1163ef4)
176. Gary Samore, *Iran's Strategic Weapons Programmes: A Net Assessment* (NYC: International Institute for Strategic Studies, 2005), page 98. (https://books.google.com/books?id=Ea9FAAAAQBAJ)
177. Assumedly this attack: "Iran Assassination Suspect Killed," *Associated Press*, June 21, 1999. (https://apnews.com/article/b8e56f1aa3932815379d4d1aa1163ef4)
178. Paul Iddon, "Iran Bombarded Iraq Throughout the 1990s," *War is Boring*, July 23, 2018. (https://warisboring.com/iran-bombarded-iraq-throughout-the-1990s)
179. According to Gary Samore, the number of missiles launched in this last offensive has been "exaggerated." See: Gary Samore, *Iran's Strategic Weapons Programmes: A Net Assessment* (NYC: International Institute for Strategic Studies, 2005), page 98. (https://books.google.com/books?id=Ea9FAAAAQBAJ). Instead, it is assumed rockets have formed the bulk of this attack. See: Amin Tarzi and Darby Parliament, "Missile Message: Iran Strike MKO Bases in Iraq," *The Nonproliferation Review*, Summer 2001. (https://www.nonproliferation.org/wp-content/uploads/npr/82tarzi.pdf)

Date	Codename	Target	Apparent Rationale	Missiles Used
June 2017	Operation *Laylat al-Qadr*[180]	ISIS targets in Deir ez-Zour, eastern Syria	Retaliation for ISIS terror attack on Iranian parliament and Ayatollah Ruhollah Khomeini's shrine	Six SRBMs (Zulfiqars and Qiam-1s)
September 2018[181]	N/A	Kurdish opposition parties in Iraqi Kurdistan	Uptick in tensions between Tehran and Kurdish insurgent groups[182]	Seven SRBMs (Fateh-110Bs)[183] and drones
October 2018	Operation *Zarbat al-Moharram*[184]	ISIS targets in eastern Syrian city of Hajin	Retaliation for ISIS terror attack in Ahvaz[185]	Six SRBMs (Zulfiqar and modified Qiams)[186]
January 2020	Operation *Shahid Soleimani*[187]	Bases in Ain al-Asad and Erbil housing U.S. forces	Retaliation for U.S. killing of IRGC-QF chief Qassem Soleimani and Iraqi militia leader Abu-Mahdi al-Muhandis	16 SRBMs (Fateh-313 and modified Qiams)[188]
March 2022	N/A	Alleged Israeli presence in Iraq; home of a Kurdish oil tycoon	Retaliation for alleged Israeli attack from Iraqi soil	10 SRBMs (Fateh-110)[189]
September 2022	N/A (assumed *Rabi'a 1*)	Iraqi Kurdistan; targets affiliated with Kurdish-Iranian opposition groups	Allegedly responding to Kurdish support for protests	73 SSMs reported. Assumed solid-propellant due to size and plume color.[190] Later revealed as Fath-360 CRBM.[191]

180. "ببینید | تصاویری دیده نشده از عملیات «لیلة القدر» سپاه پاسداران [See | Unseen Images of The Revolutionary Guards' 'Laylat al-Qadr' Operation]," *Khabar Online* (Iran), June 18, 2020. (https://www.khabaronline.ir/news/1400658/ببینید-تصاویری-دیده-نشده-از-عملیات-لیلة-القدر-سپاه-پاسداران)

181. "سپاه حمله موشکی به مقر تروریست‌ها در کردستان عراق را تایید کرد/ شلیک ۷ موشک به مقر تروریست‌ها [IRGC Confirms Missile Attack on Terrorist Headquarters in Iraqi Kurdistan/ 7 Missiles Fired at Terrorist Headquarters]," *Tasnim News Agency* (Iran), September 9, 2018. (https://tn.ai/1824131)

182. "Iran's IRGC confirms firing 7 missiles at Iraq-based terrorists," *Press TV* (Iran), September 9, 2018. (https://www.presstv.ir/Detail/2018/09/09/573648/Missile-IRCG-Iraq-Kurdistan-terrorists-ground-forces)

183. "گزارش اختصاصی: مستندات اصابت موشک‌های سپاه به مواضع تروریست‌های حدکا + عکس و فیلم [Special Report: Documentation of The Impact of The IRGC's Missiles at The Positions of KDPI Terrorists + Picture and Film]," *Tasnim News Agency* (Iran), September 11, 2018. (https://tn.ai/1825093). Drones were also employed, making it a combined arms operation.

184. "عملیات ضربت محرم، پاسخ موشکی سپاه به تروریست ها [Operation Muharram Strike, The IRGC's Missile Response to the Terrorists]," *Aparat* (Iran), accessed August 17, 2022. (https://www.aparat.com/v/2BWKa/عملیات_ضربت_محرم،_پاسخ_موشکی_سپاه_به_تروریست_ها)

185. "Iran's Revolutionary Guard launches missiles into Syria over attack on Ahvaz military parade," *CBS News*, October 1, 2018. (https://www.cbsnews.com/news/irans-revolutionary-guard-launches-missiles-into-syria-after-attack-on-military-parade)

186. For reference to modified warhead: "گزارش| بکارگیری موشک‌های قیام در عملیات شهید سلیمانی [Report | Use of Qiam Missiles in the Shahid Soleimani Operation]," *Tasnim News Agency* (Iran), January 8, 2020. (https://tn.ai/2177328)

187. "یکسالگی عملیات «شهید سلیمانی»/ موشکباران عین‌الاسد جهان را به تحسین واداشت [One Year of the 'Martyr Soleimani' Operation; The Ain al-Asad Missile Barrage That the World was Made to Admire]," *Defa Press* (Iran), January 8, 2021. (https://dnws.ir/436275)

188. Behnam Ben Taleblu, "Iran is increasingly using missiles in its military operations — that's a problem," *The Hill*, January 21, 2020. (https://thehill.com/opinion/international/479076-iran-is-increasingly-using-missiles-in-its-military-operations-that's-a). For Qiam-2, see: @Imammedia_org, *Twitter*, January 8, 2022. (https://twitter.com/imamedia_org/status/1479906328541859840/photo/2)

189. "جزییاتی از حمله موشکی سپاه به مقر صهیونیست‌ها/ تمام موشک‌ها به هدف اصابت کرده است [Details of IRGC Missile Attack on Zionist Headquarters/ All Missiles Hit Their Targets]," *Tasnim News Agency* (Iran), March 13, 2022. (https://tn.ai/2681703)

190. "با ۳۷ موشک بالستیک محل استقرار تروریست‌ها را منهدم کردیم [We Destroyed The Location of The Terrorists With 73 Ballistic Missiles]," *Javan Online* (Iran), September 28, 2022. (https://www.javanonline.ir/fa/news/1106559/با-۷۳-موشک-بالستیک-محل-استقرار-تروریست‌ها-را-منهدم-کردیم); "تصاویری از مرکز عملیات سپاه پاسداران علیه تروریست‌های تجزیه طلب [Images From The Operations Center of the Guard Corps Against Separatist Terrorists]," *Mehr News Agency* (Iran), September 28, 2022. (https://www.mehrnews.com/news/5598936/تصاویری-از-مرکز-عملیات-سپاه-پاسداران-علیه-تروریست-های-تجزیه-طلب)

191. "فتح ۰۶۳» مشت محکم رزمندگان اسلام به تروریست‌ها [The 'Fath-360' The Strong Fist of The Soldiers of Islam to The Terrorists]," *Javan Online* (Iran), October 3, 2022. (https://www.Javann.ir/004e7O); "گزارش تسنیم از سامانه موشکی فتح ۰۶۳ در رزمایش ارس [Tasnim's Report from the Fath-360 missile system in the Aras Exercise]," *Tasnim News Agency* (Iran), October 17, 2022. (https://tn.ai/2789526)

Date	Codename	Target	Apparent Rationale	Missiles Used
November 2022[192]	Operation *Rabi'a 2*	Iraqi Kurdistan	Allegedly responding to Kurdish support for protests	Pictures show at least 12 canisters on TELs. Assumed Fath-360 CRBM.
November 2022[193]	Operation *Rabi'a 2*	Iraqi Kurdistan	Allegedly responding to Kurdish support for protests	No clear number of projectiles fired. Assumed at least 1 Fath-360 CRBM.

Iranian ballistic missile strike on Al-Asad base in Iraq, January 8, 2020. (Stripes via U.S. Central Command)

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.[194] While the strikes from 2017 onward were made possible by Iran's increasingly precise shorter-range missiles,[195] 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.[196]

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."[197] 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

192. "جزییات دومین عملیات موشکی و پهپادی نیروی زمینی سپاه در اقلیم شمال عراق +تصاویر" [Details of The Second Missile and Drone Operation of the IRGC Ground Forces in The Northern Region of Iraq + Images]," *Tabnak* (Iran), November 14, 2022. (https://www.tabnak.ir/fa/news/1150334/جزییات-دومین-عملیات-موشکی-و-پهپادی-نیروی-زمینی-سپاه-در-اقلیم-شمال-عراق-تصاویر)

193. "Iran's Revolutionary Guards hit Kurdish Iranian group in Iraqi Kurdistan - Tasnim," *Reuters*, November 22, 2022. (https://www.reuters.com/world/middle-east/irans-revolutionary-guards-hit-kurdish-iranian-group-iraqi-kurdistan-tasnim-2022-11-22)

194. "دیدار جمعی از فرماندهان سپاه با رهبر انقلاب پس از عملیات موشکی لیلةالقدر" [Group Meeting of IRGC Commanders With the Leader of The Revolution After the Laylat al-Qadr Missile Operation]," *Khamenei Website* (Iran), July 5, 2017. (https://web.archive.org/web/20170713004823/https://farsi.khamenei.ir/news-content?id=37070)

195. "سربلندی نقطه‌زن‌های سپاه در آزمون «عین‌الاسد»/ موشک‌های ایرانی چگونه نقطه‌زن شدند؟" [The Pride of the IRGC's Precision at the Test of "Ain al-Assad"/ How Did Iran's Missiles Become Precise?] *Blogh News* (Iran), January 11, 2020. (https://www.bloghnews.com/news/411187/سربلندی-نقطه-زن-های-سپاه-آزمون-عین-الاسد-موشک-های-ایرانی-چگونه-نقطه-زن-شدند)

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.

197. "عکس نوشت| "دشمن می‌داند اگر یکی بزند، دهتا می‌خورد" [The Picture Wrote: 'The Enemy Knows That if He Hits One, He Will Receive Ten']," *Tasnim News Agency* (Iran), June 4, 2018. (https://tn.ai/1742628)

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 strong[206] 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]

198. Khamenei,Ir, "رهبر انقلاب: بزنید میخورید، دوران بزن، در رو تمام شده [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)
199. "انتقام سخت به وقوع پیوست؛ سیلی موشکی سپاه به آمریکایی‌ها [A Harsh Revenge Took Place: The IRGC's Missile Slap to The Americans]," *Donya-e Eqtesad* (Iran), January 9, 2020. (https://www.donya-e-eqtesad.com/fa/tiny/news-3613500)
200. For details on those missiles as reported by U.S. officials, see: Mark T. Esper, *Remarks to the Press*, January 8, 2020. (https://www.defense.gov/Newsroom/Transcripts/Transcript/Article/2053184/press-brief-by-secretary-esper-and-general-milley)
201. " رهبری گفتند موشک‌هابه غیرنظامیان نخورد/ کلکسیون غنائم پهپادی داریم/ پایگاه‌های آمریکایی اطراف ایران زیر برد موشکی سپاه قرار دارند +فیلم [The Leader Said That Our Missiles [Must] Not Hit Civilians/ We Have a Collection of Drone Trophies/American Bases Around Iran Are Under The IRGC's Missile Ranges + Film]," *Mashregh News* (Iran), November 22, 2018. (mshrgh.ir/913323)
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. "پیام عملیات موشکی سپاه به آمریکا و متحدانش/ انبوهی از موشک‌های ۲ هزار کیلومتری نقطه‌زن در اختیار داریم [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://dnws.ir/308836)
204. "پیام عملیات موشکي سپاه براي دشمنان بسیار بزرگتر از يك حادثه براي تروریست ها بوده است [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/xjkVb3)
205. "هشدار شمخانی به بولتون [Shamkhani's Warning to Bolton]," *Hamshahri Online* (Iran), October 3, 2018. (https://newspaper.hamshahrionline.ir/id/32700/هشدار-شمخانی-بولتون.html)
206. "IRGC shoots 6 missiles to terrorists' positions in Syria," *Islamic Republic News Agency* (Iran), October 1, 2018. (https://en.irna.ir/news/83050037/IRGC-shoots-6-missiles-to-terrorists-positions-in-Syria); "شمخانی: ضعیف ترین سناریو از ۱۳ سناریوی انتقام، یک کابوس تاریخی برای آمریکاست" [Shamkhani: The Weakest of 13 Scenarios for Revenge is A Historical Nightmare For America]," *Shahrar News* (Iran), January 7, 2020. (https://shrr.ir/0003dC)
207. "سردار حاجی‌زاده: جواب ترقه‌بازی تکفیری‌ها را با موشک دادیم [Commander Hajizadeh: We Responded to The Takfiri's Firecrackers with Missiles]," *Iran's Metropolitan News Agency* (Iran), June 19, 2017. (www.imna.ir/news/307401)
208. "موشک جواب فشنگ بود[Missiles Were the Response to Bullets]," *Mizan* (Iran), October 2, 2018. (https://www.mizan.news/?p=456584)

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 Fateh-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. Objectively, the Islamic Republic lucked out by not killing any Americans in its January 2020 ballistic missile strikes in Iraq. American deaths

209. Joseph Trevithick, "Everything New We Just Learned About The 2020 Iranian Missile Attack On U.S. Forces In Iraq," *The Drive*, March 3, 2021. (https://www.thedrive.com/the-war-zone/39527/everything-new-we-just-learned-about-the-iranian-missile-attack-on-al-asad-air-base); "Iran's attack on Iraq shows how precise missiles have become," *The Economist* (UK), January 16, 2020. (https://www.economist.com/science-and-technology/2020/01/16/irans-attack-on-iraq-shows-how-precise-missiles-have-become)

210. "سردار حاجی زاده: اگر دنبال کشته بودیم در گام اول 500 آمریکایی کشته می شد/می خواستیم به مرکز کنترل فرماندهی آمریکا ضربه بزنیم [Commander Hajizadeh: If We Were Looking to Kill, in The First Step 500 Americans Would Have Been Killed/We Wanted to Strike a Blow at the Command Center of America]," *Fars News Agency* (Iran), January 9, 2020. (https://web.archive.org/web/20200131183903/https://www.farsnews.ir/news/13981019000581/سردار-حاجی-زاده-اگر-دنبال-کشته-بودیم-در-گام-اول-500-آمریکایی-کشته-می)

211. David Martin, "Inside the attack that almost sent the U.S. to war with Iran," *CBS News*, February 28, 2021. (https://www.cbsnews.com/news/iran-missle-strike-al-asad-airbase-60-minutes-2021-02-28)

212. @Elizrael, *Twitter*, June 19, 2017. (https://twitter.com/Elizrael/status/876780154353180673)

213. "گزارش اختصاصی|"ضربت محرم"؛ اولین عملیات برون‌مرزی پهپادهای سپاه با "بمب‌افکن صاعقه" + عکس [Special Report | 'Muharram Strike,' The First External Operation of the IRGC's Drones with 'The Saegheh Bomber' + Picture]," *Tasnim News Agency* (Iran), October 1, 2018. (https://tn.ai/1841607); "گزارش کامل تسنیم|سومین ضربت موشکی بر پیکر تروریست‌ها/ قیامِ بالستیک‌های سپاه با ذوالفقار ۷۰۰ کیلومتری [Tasnim's Full Report | The Third Missile Strike Against The Body of Terrorists/The Uprising of The IRGC's Missiles with The 700-kilometer Zulfiqar]," *Tasnim News Agency* (Iran), October 1, 2018. (https://tn.ai/1841329)

214. "انتشار اولین تصاویر از محل اصابت موشک‌های سپاه به مقر تروریست‌ها در سوریه + عکس [Release of the First Pictures of the Location Where the IRGC's Missiles Hit the Terrorist Headquarters in Syria + Photos]," *Tasnim News Agency* (Iran), October 2, 2018. (https://tn.ai/1842844)

215. "Iran says missile attack in Syria killed 40 'leaders' of Islamic State," *Reuters*, October 2, 2018. (https://www.reuters.com/article/us-iran-syria-attacks/iran-says-missile-attack-in-syria-killed-40-leaders-of-islamic-state-idUSKCN1MC2BB)

likely would have forced the United States to respond militarily.[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.[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.[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."[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.[220] The attack killed 13 persons, including one U.S. citizen.[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,[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

216. The strikes did lead to more than 100 American servicemembers being diagnosed with traumatic brain injuries.
217. See: Aminjarahi, "قسمت سوم (آخر | قدرت موشکی ایران - « بازدارنده » (مستند, [Documentary 'Deterrent' – Iran's Missile Power | Part Three (Final)]," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=z17xVAm7rKM)
218. Laurie Mylroie, "US sanctions Iran for missile attacks on Erbil, Saudi Aramco," *Kurdistan 24* (Iraq), March 30, 2022. (https://www.kurdistan24.net/en/story/27803-US-sanctions-Iran-for-missile-attacks-on-Erbil,-Saudi-Aramco)
219. "سردار حاجی زاده: اگر دنبال کشته بودیم در گام اول 500 آمریکایی کشته می شد/می خواستیم به مرکز کنترل فرماندهی آمریکا ضربه بزنیم [Commander Hajizadeh: If We Were Looking to Kill, in The First Step 500 Americans Would Have Been Killed/We Wanted to Strike a Blow at the Command Center of America]," *Fars News Agency* (Iran), January 9, 2020. (https://web.archive.org/web/20200131183903/https://www.farsnews.ir/news/13981019000581/سردار-حاجی-زاده-اگر-دنبال-کشته-بودیم-در-گام-اول-500-آمریکایی-کشته-می)
220. "تصاویری از مرکز عملیات سپاه پاسداران علیه تروریست‌های تجزیه طلب [Images From the IRGC's Operation Center Against Separatist Terrorists]," *Mehr News Agency* (Iran), September 28, 2022. (https://www.mehrnews.com/news/5598936/تصاویری-از-مرکز-عملیات-سپاه-پاسداران-علیه-تروریست-های-تجزیه-طلب)
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-iraq-state-department-says-rcna50056)
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.[223]

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.[224]

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.[225]

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,[226] has a CEP of 450 meters.[227] Conversely, the Fateh family of missiles used in more recent Iranian military operations reportedly has a CEP of 10 meters.[228]

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.[229]

223. 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.
224. For more, see: "سرجنگی بارانی موشک‌های ایران چگونه عمل می‌کند؟/ تخریب وسیع با کلاهک‌های ارزان و کارآمد+تصاویر [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)
225. John Pike and Steven Aftergood, "Ballistic Missile Basics," *Federation of American Scientists*, June 4, 2000. https://fas.org/nuke/intro/missile/basics.htm)
226. 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)
227. "SS-1 'Scud'," *Center for Strategic and International Studies*, August 2, 2021. (https://missilethreat.csis.org/missile/scud)
228. 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)
229. "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[230]

Name	Meaning	Class	Propellant	Reported Range (km)	Missile Diameter (cm)	Missile Length (m)
Tondar-69[231]	Thunder-69	CRBM[232]	Solid	150[233]	-	-
Fateh-110 (A/B/C/D)	Conquerer-110	SRBM	Solid	250 (A) 300 (B/C/D)[234]	61	8.8
Fateh-313	Conquerer-313	SRBM	Solid	500[235]	-	-
Zulfiqar	Lord of the Spines	SRBM	Solid	700	68	10.3
Fateh Mobin	Clear Conqueror	SRBM	Solid	700[236]	-	-
Dezful[237]	Named after city of Dezful[238]	SRBM/MRBM	Solid	~1,000[239]	~68[240]	~10.3,[241] 12[242]

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: مستند پارتیزان [Partisan Documentary], "مستند نظامی بازدارنده قسمت اول //Deterrent Part One," YouTube, January 5, 2021. (https://www.youtube.com/watch?v=fsUf2Vak4y4); مستند پارتیزان [Partisan Documentary]," مستند نظامی بازدارنده قسمت دوم //Deterrent Part 2," YouTube, January 5, 2021. (https://www.youtube.com/watch?v=VtMEzxDxvDU); and Aminjarahi, " (مستند), ☒ بازدارنده ☒ - آخر) قسمت سوم | قدرت موشکی ایران [Documentary 'Deterrent' – Iran's Missile Power | Part Three (Final)]," YouTube, January 16, 2021. (https://www.youtube.com/watch?v=z17xVAm7rKM)

231. See: "«فاتح» موشک‌های دستیابی مقاومت به/ کیلومتری 2هزار موشک‌های برای زدن رژیم صهیونیستی/ 69" چگونه وارد سازمان موشکی ایران شد؟ [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)

232. Per range categorization here: "Ballistic and Cruise Missile Threat," *National Air and Space Intelligence Center*, 2020, pages 8, 14-15, 17. (https://fas.org/irp/threat/missile/bm-2020.pdf)

233. Reportedly negotiated up from 125 kilometers by the Iranians when procuring from China, see: "تندر 69" چگونه وارد سازمان موشکی"! ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی مقاومت به موشک‌های «فاتح» [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. "تصاویر و ویژگی‌های خانواده موشک‌های فاتح که ۱۳ عضوی شد | دوربردترین موشک بالستیک تاکتیکی ایران رونمایی شد [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/تصاویر-و-ویژگی-های-خانواده-موشک-های-فاتح-که-۱۳-عضوی-شد-دوربردترین)

235. Ibid.

236. Ibid.

237. "10 10] ویژگی مهم «دزفول»؛ از بالک تا کلاهک/ موشک‌های نقطه‌زن ایرانی به اسرائیل رسیدند +عکس و نقشه Important Features of the 'Dezful'; From Finlets to The Warhead/ Iran's Precision-Strike Missiles Have Reached Israel + Photo and Map]," *Mashregh News* (Iran), February 12, 2017. (https://www.mashreghnews.ir/news/936136/ویژگی-مهم-دزفول-از-بالک-تا-کلاهک-موشک-های-نقطه-زن-ایرانی). Hajizadeh had promised that a missile would be named after the city as early as 2019. See: "سردار حاجی زاده: اولین موشک بالستیک زمین به زمین با نام دزفول آزمایش خواهد شد" [Commander Hajizadeh: The First Ballistic Missile Named Dezful Will Be Tested]," *Donya-e Eqtesad* (Iran), May 25, 2017. (https://www.donya-e-eqtesad.com/fa/tiny/news-3213048)

238. A southwestern Iranian city of importance during the Iran-Iraq War.

239. "تصاویر و ویژگی‌های خانواده موشک‌های فاتح که ۱۳ عضوی شد | دوربردترین موشک بالستیک تاکتیکی ایران رونمایی شد [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/تصاویر-و-ویژگی-های-خانواده-موشک-های-فاتح-که-۱۳-عضوی-شد-دوربردترین)

240. Estimate: @imamedia_org, January 22, 2021. (https://twitter.com/imamedia_org/status/1352671565821968384/photo/1)

241. Ibid.

242. "ویژگی موشک‌های جدید سپاه پاسداران + عکس [Features of The IRGC's New Missiles]," *Donya-e Eqtesad* (Iran), January 16, 2021. (https://www.donya-e-eqtesad.com/fa/tiny/news-3731758)

Name	Meaning	Class	Propellant	Reported Range (km)	Missile Diameter (cm)	Missile Length (m)
Ra'ad-500[243] **(a.k.a. Zouhair)**	Thunder-500 (Name of companion of Imam Hussein at Karbala)	SRBM	Solid	500	-	-
Shahid Haj Qassem[244]	Martyr Haj Qassem	MRBM	Solid	1,400[245]	~85-95	11
Fath[246] **(a.k.a BM-120; assumedly Fath-360)**	Conquest (Conquest-360)	CRBM	Solid	80-100, ~130-170,[247] or 120[248]	40-50% smaller than Fateh-110, ~30	40-50% smaller than Fateh-110, ~4
BM-250[249]	N/A	CRBM	Solid	250	45.6	7.235
Kheibar Shekan[250]	Breaker of Kheibar	MRBM	Solid	1,450	-	-
Sejjil-2[251]**/Sejjil**	Baked Clay-2	MRBM	Solid	2,000	125	17.5,18
Shahab-1	Meteor-1	SRBM	Liquid	300	88	11
Shahab-2	Meteor-2	SRBM	Liquid	500	88	11

243. "تصاویر و ویژگی‌های خانواده موشک‌های فاتح که ۱۳ عضوی شد | دوربردترین موشک بالستیک تاکتیکی ایران رونمایی شد" [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/تصاویر-و-ویژگی-های-خانواده-موشک-های-فاتح-که-۱۳-عضوی-شد-دوربردترین)

244. "گزارش تسنیم| «قاسم» برد موشک‌های تاکتیکی ایران را به اسرائیل رساند/ جدیدترین موشک بالستیک ایران چه مختصاتی دارد؟" [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)

245. "تصاویر و ویژگی‌های خانواده موشک‌های فاتح که ۱۳ عضوی شد | دوربردترین موشک بالستیک تاکتیکی ایران رونمایی شد" [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/تصاویر-و-ویژگی-های-خانواده-موشک-های-فاتح-که-۱۳-عضوی-شد-دوربردترین). Other sources allege the range can stretch up to 1,700-1,800 kilometers. "گزارش تسنیم| «قاسم» برد موشک‌های تاکتیکی ایران را به اسرائیل رساند/ جدیدترین موشک بالستیک ایران چه مختصاتی دارد؟" [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)

246. "فتح»؛ کوچکترین بالستیک ایرانی از خانواده فاتح«» ['Fath'; Iran's Smallest Ballistic From The Fateh Family]," *Tasnim News Agency* (Iran), August 24, 2020. (https://tn.ai/2334615). Other estimates of the new Fath's range, weight, and diameter can be found here: "موشک فتح»؛ کوچک اما خطرناک/ سرباز جدید موشکی ایران را بیش‌تر بشناسید" [The 'Fath' Missile; Small But Dangerous/ Know Iran's Newest Missile Soldier Better]," *Barkhat News* (Iran), August 24, 2020. (https://www.barkhat.news/political/159821124343/conquest-missile-small-but-dangerous-learn-more-about-iran-s-new-missile-soldier)

247. Range if, according to *Tasnim News Agency*, using the composite body of the Fateh-313.

248. "گزارش تسنیم از سامانه موشکی فتح ۰۶۳ در رزمایش ارس" [Tasnim's Report from the Fath-360 missile system in the Aras Exercise]," *Tasnim News Agency* (Iran), October 17, 2022. (https://tn.ai/2789526)

249. "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۰۵۲ کیلومتر+فیلم" [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)

250. "موشک بالستیک «خیبرشکن» با برد ۱۴۵۰ کیلومتر رونمایی شد+فیلم" [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)

251. Figures for length, weight, and warhead weight also come from: "موشک بالستیک سجیل؛ نماد توانمندی موشکی دور برد و دقیق ایران +فیلم" [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/موشک-بالستیک-سجیل-نماد-توانمندی-موشکی-دور-برد-و-دقیق-ایران-فیلم); Michael Elleman, "Iran's Ballistic Missile Program," *Testimony Before the U.S. Senate Committee on Banking, Housing, and Urban Affairs*, May 24, 2016, page 4. (https://www.banking.senate.gov/imo/media/doc/052416_Elleman%20Testimony.pdf)

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)[252]	88	11.5 (11.846 for Qiam-2)[253]
Shahab-3	Meteor-3	MRBM	Liquid	1,150-2,000[254]	125	15.86
Ghadr-1(101) and F/H/S	Magnitude-1(101) and F/H/S	MRBM	Liquid	1,350-1,950. 1,350 (S), 1,750 (H), and 1,950 (F)	125	15.86
Emad	Pillar	MRBM	Liquid	1,700-2,000[255]	125	15.5
Rezvan[256]	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)[257]	150	13

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.[258] Khamenei himself reportedly called for that range limit.[259] 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.

252. "برد موشک قیام به ۱۰۰۰ کیلومتر رسید, [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: "هولناک‌ترین موشک‌های بالستیک ایرانی / از شهاب ۳ تا سجیل [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)
255. U.S. government sources say 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)
256. "ویژگی‌های موشک بالستیک «رضوان» [Features of the "Rezvan" Ballistic Missile]," *Iranian Students News Agency* (Iran), September 22, 2022. (https://www.isna.ir/news/1401063122690/ویژگی-های-موشک-بالستیک-رضوان)
257. United Nations Security Council, "Letter dated 25 March 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," March 27, 2019, page 2. (https://undocs.org/S/2019/270). U.S. government sources believe the Khorramshahr-2's range cap is still 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)
258. Ariel Zirulnick, "Iran test fires 14 missiles capable of reaching Israeli, US targets," *Christian Science Monitor*, June 28, 2011. (https://www.csmonitor.com/World/terrorism-security/2011/0628/Iran-test-fires-14-missiles-capable-of-reaching-Israeli-US-targets); "Iran 'will not make longer-range missiles as Israel is already in reach'," *Associated Press*, June 28, 2011. (https://www.theguardian.com/world/2011/jun/28/iran-longer-range-missiles-israel)
259. "Iran Commanders Say Supreme Leader Limiting Ballistic Missile Range," *Radio Farda*, October 31, 2017. (https://www.rferl.org/a/iran-ballistic-missiles-range-200-km-khamenei/28826950.html)

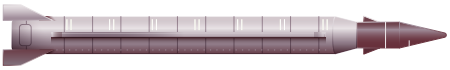
Iranian Ballistic Missile Reach

Key: Distance from Kermanshah, Iran | 300 km | 500 km | 1,000 km | 2,000 km

Fateh-110 (300 km)

Qiam-1 (700 km)

Emad (+1,700 km)



Shahab-1 (300 km)

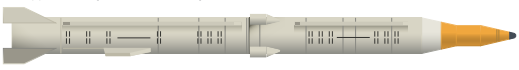
Zulfiqar (700 km)

Ghadr (~2,000 km)

Fateh-313 (500 km)

Dezful (~1,000 km)

Sejjil-2 (2,000 km)



Shahab-2 (500 km)

Shahab-3 (+1,150 km)

Khorramshahr (+2,000 km)

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."[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."[261] Likewise, a 2017 report by the U.S. National 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."[262] The 2020 version of the report reiterated that assessment.[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,[264] such as contrasting trajectories based on the engines or motors employed in each projectile.[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

260. Shahram Chubin, "Is Iran a Military Threat" *Survival*, Vol. 56, No. 2 (2014), page 77. (https://www.tandfonline.com/doi/abs/10.1080/00396338.2014.901733)
261. U.S. Defense Intelligence Agency, "Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance," 2019, pages 46-47. (https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Iran_Military_Power_LR.pdf)
262. "Ballistic and Cruise Missile Threat," *National Air and Space Intelligence Center*, 2017, page 27. (https://www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat_Final_small.pdf?ver=2017-07-21-083234-343)
263. "Ballistic and Cruise Missile Threat," *National Air and Space Intelligence Center*, 2020, page 27. (https://fas.org/irp/threat/missile/bm-2020.pdf)
264. Janne E. Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Washington, DC: The Brookings Institution, 1991), page 40.
265. Michael Elleman, "Why Iran's satellite launch does not amount to an ICBM test," *The International Institute for Strategic Studies*, January 17, 2019. (https://www.iiss.org/blogs/analysis/2019/01/iran-satellite-launch)

Ghadr-1 (which is a Shahab-3 variant) for its first stage and has a smaller second stage.[266] 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,[267] there are several earlier versions modeled on artillery rockets.[268] 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[269] to launch an orbital transfer block named the Saman, presumably to function as a tug between satellites in the future.[270]

Conversely, the Simorgh, which Iran first unveiled in 2010 but tested in 2016, has failed to put a satellite into orbit.[271] 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[272] Sarir SLV at 35 meters long and 2.4 meters in diameter,[273] which Tehran hopes will one day put a one-ton payload into a 1,000-kilometer orbit. Also under development is the Soroush SLV, with a diameter of 4 meters,[274] which will allegedly be able to put a 15-ton payload into a 300-kilometer orbit.[275]

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.[276] The U.S. Treasury Department revealed in 2016 that Iranian defense contractors from the Shahid Hemmat Industrial Group (SHIG)[277] — a subsidiary of Iran's Aerospace Industries Organization (AIO),[278] which in turn is a subsidiary of Iran's Ministry of Defense and Armed

266. United Nations Security Council, "Final report of the Panel of Experts established pursuant to resolution 1929 (2010)," June 12, 2012, page 23. (https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2012_395.pdf)
267. "Teheran claims successful launch of second rocket," *Agence France-Presse* (France), November 26, 2008. (https://www.france24.com/en/20081126-teheran-claims-successful-launch-second-rocket-iran)
268. For example, Gunter Krebs, "Kavoshgar (Type B)," *Gunter's Space Page*, accessed August 15, 2022. (https://space.skyrocket.de/doc_lau/kavoshgar-b.htm)
269. "بلوک انتقال مداری سامان» با موفقیت پرتاب و آزمایش شد+ فیلم و جزئیات«['Saman Orbital Transfer Block' Successfully Launched and Tested + Film and Details]," *Shahrara News* (Iran), October 4, 2022. (https://shahraranews.ir/fa/amp/news/128132)
270. "Iran says it launched test 'tug' into suborbital space," *Associated Press*, October 4, 2022. (https://thehill.com/homenews/ap/ap-international/ap-iran-says-it-launched-test-tug-into-suborbital-space/)
271. Nasser Karimi and Jon Gambrell, "Iran satellite fails to reach orbit in US-criticized launch," *Associated Press*, January 15, 2019. (https://apnews.com/article/a8c2f77cc86747f68c8ca3e05a52536a)
272. For more on Iran's future SLVs, see: Ali Javid, "Iran IRIB4 Zuljanah, Soroush-1-2 SLV & future launches ،ایران ماهواره بر ذوالجناح سروش-۱-۲," *YouTube*, February 1, 2021. (https://www.youtube.com/watch?v=5miDAol3Y_o)
273. Khosro Kalbasi, "Islamic Republic Working on Two Satellite Launch Vehicles," *Financial Tribune* (Iran), February 4, 2020. (https://financialtribune.com/articles/sci-tech/102021/islamic-republic-working-on-two-satellite-launch-vehicles)
274. Ibid.
275. "عضو جدید اسکادران ماهوارهبرهای ایرانی شد "ذوالجناح" ["Zuljanah" Became the Newest Member of Iran's Squadron of Satellite Carriers]," *Iranian Students News Agency* (Iran), February 2, 2021. (https://web.archive.org/web/20220424143811/https://www.isna.ir/news/99111409999/ذوالجناح-عضو-جدید-اسکادران-ماهواره-برهای-ایرانی-شد)
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-irans-simorgh-space-launcher-appear-north-korea)
277. "Shahid Hemat Industrial Group (SHIG)," *Iran Watch*, September 24, 2021. (https://www.iranwatch.org/iranian-entities/shahid-hemat-industrial-group-shig)
278. "Aerospace Industries Organization (AIO)," *Iran Watch*, October 28, 2019. (https://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio)

Forces Logistics (MODAFL)[279] — worked with Pyongyang on an 80-ton rocket booster.[280] SHIG officials previously attended the launch of the Unha rocket in North Korea in 2012.[281] The UN Panel of Experts on North Korea raised these concerns about SLV cooperation in a March 2021 report.[282]

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."[283] Open-source experts and imagery analysts continue to raise concerns over Iranian liquid-propellent 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.[284] The location of the test, a facility in Khojir, is believed to be overseen by SHIG.

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.[285]

"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."

Although Iranian officials claim that Tehran is committed to the "peaceful use of space,"[286] 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

279. "Ministry of Defense Armed Forces Logistics (MODAFL)," *Iran Watch*, November 14. 2019. (https://www.iranwatch.org/iranian-entities/ministry-defense-armed-forces-logistics-modafl)
280. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Those Involved in Ballistic Missile Procurement for Iran," January 17, 2016. (https://home.treasury.gov/news/press-releases/jl0322)
281. Jonathan McLaughlin, "North Korea Missile Milestones – 1969-2017," *Wisconsin Project on Nuclear Arms Control*, January 23, 2018. (https://www.wisconsinproject.org/north-korea-missile-milestones)
282. United Nations Security Council, "Letter dated 5 February 2021 from the Panel of Experts established pursuant to resolution 1874 (2009) addressed to the Chair of the Security Council Committee established pursuant to resolution 1718 (2006)," March 4, 2021, pages 129-131. (https://undocs.org/S/2021/211)
283. United Nations Security Council, "Identical letters dated 25 May 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 25, 2022. (https://undocs.org/en/S/2022/421)
284. @TheIntelLab, *Twitter*, June 4, 2022. (https://twitter.com/TheIntelLab/status/1533003243978215424)
285. "Indian Missiles," *Federation of American Scientists*, May 30, 1998. (https://fas.org/nuke/guide/india/missile/overview.htm); Gary Millholin, "The Link Between Space Launch and Missile Technology," *Presentation to the Asia-Pacific Center for Security Studies*, March 16, 2000. (https://www.wisconsinproject.org/the-link-between-space-launch-and-missile-technology)
286. See comments by Morteza Berari in: "'Peaceful use of space': Iran to launch observation satellite," *Al Jazeera* (Qatar), February 3, 2020. (https://www.aljazeera.com/news/2020/2/3/peaceful-use-of-space-iran-to-launch-observation-satellite)

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 diameter[293] 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

287. See comments by Mousavi in: "تندر 69" چگونه وارد سازمان موشکی ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی «مقاومت به موشک‌های «فاتح [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)
288. Ibid.
289. Mohammad Tehrani-Moghadam, cited in: "'ایران در مرحله نهایی ساخت موشک قارەپیما'؛ ادعایی که حذف شد" ['Iran in The Final Stages of Constructing an Intercontinental Ballistic Missile'; A Claim That Was Deleted]," *BBC Persian* (UK), November 19, 2011. (https://www.bbc.com/persian/iran/2011/11/111119_l10_moghadam_icbm_iran_sepah)
290. "Islamic Revolutionary Guard Corps (IRGC) Research and Self-Sufficiency Jihad Organization," *Iran Watch*, August 28, 2020. (https://www.iranwatch.org/iranian-entities/islamic-revolutionary-guard-corps-irgc-research-self-sufficiency-jihad-organization)
291. U.S. Department of the Treasury, Press Release, "Treasury Targets Iranian Individuals Providing Ballistic Missile Support to Yemen's Huthis," May 22, 2018. (https://home.treasury.gov/news/press-releases/sm0392)
292. For more on this development and why it matters, see: Behnam Ben Taleblu, "Solid-Propellant Motor Test Proves Iran's Continuing Missile Advancement," *The National Interest*, February 2, 2022. (https://nationalinterest.org/feature/solid-propellant-motor-test-proves-iran%E2%80%99s-continuing-missile-advancement-200245)
293. "'Raafe' rocket engine, the most advanced Iranian first stage solid-fueled engine (+Video)," *Ahlul Bayt News Agency* (Iran), January 22, 2022. (https://web.archive.org/web/20220309105122/https://en.abna24.com/news/%E2%80%98raafe%E2%80%99-rocket-engine-the-most-advanced-iranian-first-stage-solid-fueled-engine-video_1221255.html)
294. Noted in description box of video. See: IMA Media • ایما مدیا, "Successful test of advanced 'Raafe' solid-fueled space engine," *YouTube*, January 13, 2022. (https://www.youtube.com/watch?v=t27-sVHWp0s)
295. "5,000] موشک ۵۰۰۰ کیلومتری در دسترس‌تر از همیشه Kilometer Missiles Are More Within Reach Than Ever]," *Farhikhtegan* (Iran), January 15, 2022. (http://fdn.ir/67802)
296. Ali Javid, "Iran IRGC_AS Chief Gen Hajizadeh: Raafe solid Composite Propellant Motor, 68 tons thrust, VTC nozzle," *YouTube*, January 25, 2022. (https://web.archive.org/web/20220204014849/https://www.youtube.com/watch?v=98dDk2hnh6w)
297. Ali Javid, "Iran Iinterview IRGC_AS chief Gen. Hajizadeh: Space, SAT, SLV," *YouTube*, April 23, 2020. (https://www.youtube.com/watch?v=TGXdZ3om5-g)
298. "گزارش ویژه تسنیم| ۱۰ ویژگی شگفت‌انگیز جدیدترین ماهواره‌بر ایران/ سپاه موشک ۳مرحله‌ای قاصد را چگونه ساخت؟ [Tasnim's Special Report | 10 Amazing Features of Iran's Latest Satellite Carrier/ 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,[299] and the involvement of the IRGC-AF rather than the ISA[300] raises worries about the direction of IRGC-AF's parallel solid-propellant space program.[301]

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.[302] 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.[303]

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,[304] 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.[305]

Launch of Qa'em-100 SLV. (Photo via Qods News Agency (Iran))

299. Ali Javid, "Iran Iinterview IRGC_AS chief Gen. Hajizadeh: Space, SAT, SLV," *YouTube*, April 23, 2020. (https://www.youtube.com/watch?v=TGXdZ3om5-g)
300. "Iranian Space Agency," *Iran Watch*, June 12, 2020. (https://www.iranwatch.org/iranian-entities/iranian-space-agency)
301. The program was previously called the Qa'em project. See: "گزارش ویژه تسنیم|رمزگشایی از مهمترین پروژه فضایی شهید طهرانی مقدم/ حرکت به مدار ۱۰۰۰کیلومتری با موشک چهارمرحله‌ای قائم [Tasnim's 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)
302. "Iran Launches New Satellite-Carrying Rocket for "Research Purposes," *Agence-France Presse* (France), February 1, 2021. (https://www.i24news.tv/en/news/middle-east/1612210900-iran-launches-new-satellite-carrying-rocket-for-research-purposes)
303. "Iran tests Zuljanah indigenous satellite carrier rocket for second time," *Press TV* (Iran), June 26, 2022. (https://www.presstv.ir/Detail/2022/06/26/684573/Iran-Zoljanah-satellite-carrier-rocket-Ahmad-Hosseini-solid-liquid-fuel)
304. "Iran announces new space launch amid nuclear talks," *France 24* (France), December 30, 2021. (https://www.france24.com/en/live-news/20211230-iran-announces-new-space-launch-amid-nuclear-talks-1)
305. "پرتاب دو نمونه ماهواره ناهید یک در سال آینده [The Launch of Two Types of Nahid One Satellites in the Next Year]," *Islamic Republic of Iran Broadcasting News Agency* (Iran), February 3, 2022. (https://web.archive.org/web/20220627062540/https://www.iribnews.ir/fa/news/3352311/پرتاب-دو-نمونه-ماهواره-ناهید-یک-در-سال-آینده)

Table 4: Select SLVs Tested by Iran

Name	Meaning	First Revealed/Tested	Last Tested	Motor/Engine	Stages	Length (m)	Overseen By
Safir	Ambassador	2008[306]	August 2019[307]	Liquid	2	22[308]	ISA
Simorgh	Phoenix	2010/2016	December 2021[309]	Liquid	2	27[310]	ISA
Qased	Messenger	2020	March 2022[311]	Hybrid (currently: liquid-solid-solid)	3	17.75[312] -18.1[313]	IRGC-AF
Zuljanah	Name of Imam Hussein's horse	Assumed late 2020/ early 2021	June 2022[314]	Hybrid (currently: solid-solid-liquid)[315]	3	25.5[316]	ISA
Qa'em-100[317]	Upright-100	November 2022	November 2022	Solid	3	20[318]	IRGC-AF

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.[319] 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.[320] The successful test of the Ra'afe

306. Stephen M. McCall, "Iran's Ballistic Missile and Space Launch Programs," *Congressional Research Service*, January 9, 2020. (https://fas.org/sgp/crs/nuke/IF10938.pdf)
307. Geoff Brumfiel, "Iranian Rocket Launch Ends In Failure, Imagery Shows," *NPR*, August 29, 2019. (https://www.npr.org/2019/08/29/755406765/iranian-rocket-launch-ends-in-failure-images-show?t=1567107739452)
308. United Nations Security Council, "Final report of the Panel of Experts established pursuant to resolution 1929 (2010)," June 12, 2012, page 23. (https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2012_395.pdf)
309. United Nations Security Council, "Letter dated 3 January 2022 from the Chargé d'affaires a.i. of the United States Mission to the United Nations addressed to the President of the Security Council," January 4, 2022. (https://undocs.org/en/S/2022/3)
310. Tamir Eshel, "Simorgh First Launch – an Iranian Success or Failure?," *Defense Update* (Israel), April 24, 2016. (https://defense-update.com/20160424_simorgh.html)
311. IMA Media • ایما مدیا, "Exclusive: footage of preparation and launch of NOUR-02 satellite on board Qased SLV," *YouTube*, March 10, 2022. (https://www.youtube.com/watch?v=fRfjUYSXUxI)
312. See graphic in: "گزارش ویژه تسنیم| ۱۰ ویژگی شگفت‌انگیز جدیدترین ماهواره‌بر ایران/ سپاه موشک ۳مرحله‌ای قاصد را چگونه ساخت؟ [Tasnim's Special Report | 10 Amazing Features of Iran's Latest Satellite Carrier/ How Did the IRGC Create the Three-Stage Qased Missile?]," *Tasnim News Agency* (Iran), May 6, 2020. (https://tn.ai/2258410)
313. Ibid.
314. "دومین پرتاب ماهواره‌بر ذوالجناح انجام شد+ فیلم [The Second Launch of the Zuljanah Satellite Carrier was Completed + Film]," *Islamic Republic News Agency* (Iran), June 26, 2022. (https://irna.ir/xjJPJZ)
315. Uzi Rubin, "Iran's winged horse rocket: Another step towards global reach," *Jewish News Syndicate*, March 2, 2021. (https://www.jns.org/opinion/irans-winged-horse-rocket-another-step-towards-global-reach)
316. Jeremy Binnie, "Iran Flight Tests New Solid Rocket Motor," *Janes* (UK), February 3, 2021. (https://www.janes.com/defence-news/news-detail/iran-flight-tests-new-solid-rocket-motor)
317. "IRGC's Aerospace successfully launches Qaem 100 solid fuel suborbital carrier," *Press TV* (Iran), November 5, 2022. (https://www.presstv.ir/Detail/2022/11/05/692196/Iran-IRGC-Aerospace-Qaem-100-suborbital-carrier)
318. "قائم ۱۰۰، قاره‌پیمای ایرانی + جزئیات [The Qa'em-100, an Iranian Intercontinental + Details]," *Iran's Metropolitan News Agency* (Iran), November 8, 2022. (www.imna.ir/photo/617960/) v
319. Military Tweet, "اولین پرتاب موشک ماهواره‌بر قائم ایرانی در سال جاری, توئیت نظامی | First Lunch of Iranian Qaem SLV in this year," *YouTube,* July 24, 2022. (https://www.youtube.com/watch?v=905MYkUBTy8)
320. Ali Javid, "Iran IRGC Space Chief Gen. Jafar-Abadi: Qaem Family Propellant: Qaem-100 Qaim-105 Qaim-110 Qaim-120," *YouTube*, November 5, 2022. (https://www.youtube.com/watch?v=GgcrtPvbzKE)

— 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),[321] 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."[322] 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.[323] The TEL for the Qa'em's launch at Shahroud also bore a large poster of Tehrani-Moghadam, further linking the projects.[324] 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."[325] 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."[326]

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.[327]

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

321. "در سال جاری اولین ماهواره با ماهواره‌بر قائم ۱۰۰ در مدار قرار می‌گیرد" [This Year The First Satellite Will be Placed into Orbit by The Qa'em-100 SLV]," *Iranian Students News Agency* (Iran), November 20, 2022. (https://www.isna.ir/news/1401082920162/در-سال-جاری-اولین-ماهواره-با-ماهواره-بر-قائم-۱۰۰-در-مدار-قرار)
322. "دستیابی رسمی سپاه به موشک‌های ۱۲۵۰۰ کیلومتری میان‌برد و قاره‌پیما" [The IRGC's Official Acquisition of 12,500-kilometer medium-range and intercontinental missiles]," *Etemad Online* (Iran), November 8, 2022. (https://www.etemadonline.com/fa/tiny/news-581120)
323. @Inbarspace, *Twitter*, November 14, 2019. (https://twitter.com/inbarspace/status/1195114145475170305)
324. @AmirIGM, *Twitter*, November 5, 2022. (https://twitter.com/AmirIGM/status/1589041296924372992)
325. "فیلم/ سردار حاجی زاده: آمریکا در منطقه مثل گوشت زیر دندان ماست" [Film/ Commander Hajizadeh: America in the Region is Like Meat Under Our Teeth]," *Mashregh News* (Iran), January 4, 2020. (https://www.mashreghnews.ir/news/1026753/فیلم-سردار-حاجی-زاده-آمریکا-در-منطقه-مثل-گوشت-زیر-دندان-ماست)
326. See Abdollahian's comments in: Aminjarahi, "قسمت سوم (آخر) | قدرت موشکی ایران - « بازدارنده » (مستند" [Documentary 'Deterrent' – Iran's Missile Power | Part Three (Final)]," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=z17xVAm7rKM)
327. For an excellent assessment as to how this may foster a shift in Iranian military doctrine overtime, see: Bilaal Y. Saab and Michael Elleman, "Precision Fire: A Strategic Assessment of Iran's Conventional Missile Program," *Atlantic Council*, September 2016. (https://www.atlanticcouncil.org/wp-content/uploads/2016/09/Precision_Fire_web_0907.pdf)

missile force.[328] "I want precision from you" was how Amir-Ali Hajizadeh recalled his charge from Khamenei in 2009.[329] 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.[330] 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.[331] 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.[332] Iran's embrace of training for combined arms operations offers insight into how the regime may employ its ballistic missiles, in the future.[333]

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, Khorramshahr-2, and Emad missiles. Iranian warheads can be unitary or configured to carry submunition payloads.[334] 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,[335] documents from the seized atomic archive indicate that Iran originally planned to put a nuclear device in the Shahab-3's conical RV.[336]

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

328. "سردار حاجی‌زاده: دقت موشک‌ها را مدیون تدبیر رهبر معظم انقلاب هستیم/ ناوهای هواپیمابر آمریکا برای ما یک سیبل 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)
329. Mojtaba 68, "فرمانده هوا فضا سردار حاجی زاده دقت موشک ها [Aerospace Force Chief Commander Hajizadeh on the Precision of Missiles]," *YouTube*, September 27, 2018. (https://www.youtube.com/watch?v=UHKIXuebMS8)
330. Iranian outlets did, of course, publicize drills and military operations.
331. "1st Phase of Great Prophet 15 Drills Starts with Ballistic Missiles Mass Firing," *Fars News Agency* (Iran), January 15, 2021. (https://web.archive.org/web/20210117132819/https://www.farsnews.ir/en/news/13991026000230/s-Phase-f-Grea-Prphe-5-Drills-Sars-wih-Ballisic-Missiles-Mass-Firing); IMA Media • ایما مدیا, "Attack on the Zionist regime's weapons of mass destruction center during TheGreatProphet17 war games," *YouTube*, December 25, 2021. (https://www.youtube.com/watch?v=VcZEJ40Gt9M)
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: "سرجنگی بارانی موشک‌های ایران چگونه عمل می‌کند؟/ تخریب وسیع با کلاهک‌های ارزان و کارآمد+تصاویر [How Do Iran's Showering Warheads Work?/ Extensive Destruction With Cheap and Efficient Warheads + Pictures]," *Tasnim News Agency* (Iran), September 30, 2020. (https://tn.ai/2359270)
335. Michael Eisenstadt, "The Role of Missiles in Iran's Military Strategy," *The Washington Institute for Near East Policy*, November 2016, page 9. (https://www.washingtoninstitute.org/media/1940?disposition=inline)
336. For a picture from the atomic archive, see: "From Iran's Nuclear Archive: Schematics of Warhead in a Shahab-3 Re-entry Vehicle," *Institute for Science and International Security*, May 17, 2019. (https://isis-online.org/isis-reports/detail/from-irans-nuclear-archive-schematics-of-warhead-in-a-shahab-3-re-entry-veh)

solid-propellant missiles less susceptible to pre-emptive, or "left-of-launch," strikes.[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.[338]

Rapid underground ballistic missile launcher with Emad MRBMs (Popular Mechanics via YouTube/IMA Media)

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.[339] Iran is also developing subterranean missile production[340] and storage centers.[341] These underground missile complexes are reportedly the largest in the Middle East.[342] In June 2020, as part of the Great Prophet 14 military drill, Iran launched its first-ever ballistic missile from underground.[343]

337. See: U.S. Department of Defense, Joint Chiefs of Staff, "Unclassified Report to Congress: Declaratory Policy, Concept of Operations, and Employment Guidelines for Left-of-Launch Capability," May 10, 2017. (https://fas.org/man/eprint/left.pdf)
338. United Nations Security Council, "Letter dated 25 March 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," March 27, 2019, page 2. (https://undocs.org/S/2019/270)
339. Kyle Mizokami, "Iran's New Underground Missile Base Looks Mildly Terrifying. See for Yourself.," *Popular Mechanics*, November 5, 2020. (https://www.popularmechanics.com/military/aviation/a34576311/iran-underground-missile-base-video)
340. "دزفول یکی از محصولات کارخانه زیرزمینی موشک‌های بالستیک [The Dezful is One of the Products of the Underground Ballistic Missile Production Facility]," *Young Journalists Club* (Iran), March 21, 2019. (https://www.yjc.ir/00Sq0J)
341. Ali Javid, "Rise Fortieth, Deep depth, Iran Missile Cities, underground bases," *YouTube*, February 21, 2019, (https://www.youtube.com/watch?v=Dmjcp9-hBLg)
342. Arie Egozi, "Cyber Strike By Foreign Force Caused Iran Explosion: Israeli Experts," *Breaking Defense*, July 2, 2020. (https://breakingdefense.com/2020/07/cyber-strike-by-foreign-force-causes-iran-explosion-israeli-experts)
343. Amir Vahdat and Jon Gambrell, "Iran launches underground ballistic missiles during exercise," *Associated Press*, July 29, 2020. (https://apnews.com/article/virus-outbreak-strait-of-hormuz-ap-top-news-iran-persian-gulf-tensions-325a4cbcf313fdbb703654d627c16773)

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.[344] In 2010, the Pentagon conditioned Iran's ability to develop an ICBM by 2015 on Tehran's receipt of "sufficient foreign assistance."[345] And in 2019, a Defense Intelligence Agency report said Iran's missile program "continues to depend on foreign suppliers for critical components and technology."[346]

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,[347] 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.[348] Music,[349] books,[350] and documentaries[351] 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.[352] 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.[353] Less than a year later, Tehran tasked him with developing the IRGC's first artillery unit. Soon after, the regime dispatched

344. The timeline for the estimate was from 2001 to 2015. See: National Intelligence Council, "Foreign Missile Developments and the Ballistic Missile Threat Through 2015," December 2001. (https://fas.org/irp/nic/bmthreat-2015.htm)
345. Department of Defense, Secretary of Defense, "Unclassified Report on Military Power of Iran," April 2010, page 11. (https://fas.org/man/eprint/dod_iran_2010.pdf)
346. U.S. Defense Intelligence Agency, "Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance," 2019, page 44. (https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Iran_Military_Power_LR.pdf)
347. See education history in: " (۸۳۳۱-۰۹۳۱ زندگینامه: حسن طهرانی مقدم) [Biography: Hassan Tehrani-Moghadam (1338-1390)]," *Hamshahri* (Iran), March 1, 2013. (https://www.hamshahrionline.ir/news/203522/زندگینامه-حسن-طهرانی-مقدم-۱۳۹۰-۱۳۳۸)
348. "طرح/ به یاد پدر موشکی ایران [Plan/In Memory of the Father of Iran's Missiles]," *Mashregh News* (Iran), October 28, 2013. (https://www.mashreghnews.ir/photo/259252/طرح-به-یاد-پدر-موشکی-ایران)
349. "صوت/ ترانه ای برای پدر موشکی ایران [Audio/Song for the Father of Iran's Missiles]," *Mashregh News* (Iran), November 13, 2012. (https://www.mashreghnews.ir/photo/170549/صوت-ترانه-ای-برای-پدر-موشکی-ایران)
350. "از خط مقدم تا فاتح قدس [From the 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)
351. Bachehaye GHalam, "مستند خط مقدم (کامل) | کیفیت خوب [Frontline Documentary (Complete) | Good Quality]," *YouTube*, July 24, 2017. (https://www.youtube.com/watch?v=EEBA6G10U_Y)
352. "شهید طهرانی مقدم؛ مدیر و دانشمندی پارسا [Martyr Tehrani-Moghadam; A Pious Manager and Scientist]," *Islamic Republic News Agency* (Iran), October 27, 2020. (www.irna.ir/news/84089795/)
353. " از دِمونتاژ محرمانه و مهندسی معکوس تا ساخت موشک‌های نقطه‌زن/تلاش‌های مرد پشت‌پرده موشکی ایران برای تولید موشک‌های بومی [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/از-دمونتاژ-محرمانه-و-مهندسی-معکوس-تا-ساخت-موشک-های-نقطه-زن-تلاش-های)

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.[354] Drawing on his experiences in Syria as well as technical support from North Korea (where he later traveled),[355] 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.[356] Tehrani-Moghadam reportedly then went to Lebanon to lay the foundation for Hezbollah's missile capabilities.[357]

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.[358] Tehrani-Moghadam rose to become the IRGC-AF's deputy commander in 2005-2006 before serving as an advisor on missile affairs to the IRGC commander and as the head of the IRGC-RSSJO beginning in December 2006.[359] In 2006-2007, he reportedly led a missile and space research center that the IRGC-RSSJO later absorbed.[360]

Gravestone of Hassan Tehrani-Moghadam (Mashregh News)

354. "یک ماجرای موشکی به روایت محسن رفیق دوست [One Missile Story According to Mohsen Rafighdoost]," *Iranian Students News Agency* (Iran), September 27, 2020. (https://web.archive.org/web/20201204023037/https://www4.isna.ir/news/99070604351/یک-ماجرای-موشکی-به-روایت-محسن-رفیق-دوست)

355. "عکسی دیده نشده از دیدار نظامی شهید طهرانی مقدم با کیم ایل سونگ رهبر کره شمالی [Unseen Photo of Martyr Tehrani-Moghadam with Kim Il-Sung, Leader of North Korea]," *Donya-e Eqtesad* (Iran), May 19, 2020. (https://www.donya-e-eqtesad.com/fa/tiny/news-3655655). For commentary about procurement, see: A. Ekramian, "مستند «خط مقدم» ['Frontline' Documentary]," *YouTube*, September 30, 2015. (https://www.youtube.com/watch?v=w-LkkVw5Ol4)

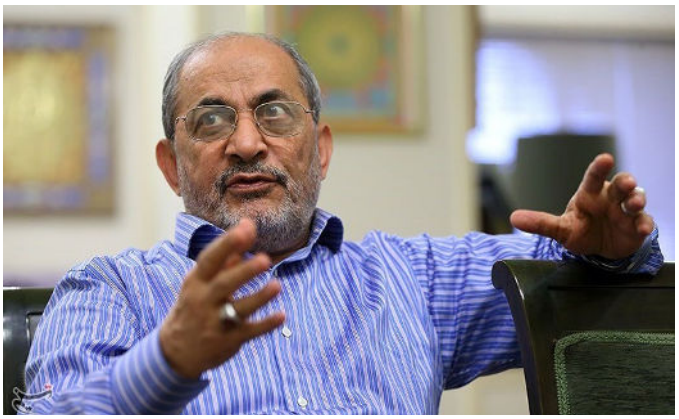
356. The missile command was the predecessor to the Aerospace Force. It was also one of the original IRGC branches that Tehran established in 1985.

357. Between 1986/1987-1987/1988. See comments by his brother, in: "زندگینامه: حسن طهرانی مقدم (۱۳۳۱-۰۹۳۱) [Biography: Hassan Tehrani-Moghadam (1338-1390)]," *Hamshahri* (Iran), March 1, 2013. (https://www.hamshahrionline.ir/news/203522/زندگینامه-حسن-طهرانی-مقدم-۱۳۹۰-۱۳۳۸-)

358. "سرلشکر شهید حسن تهرانی مقدم شمشیر برون از نیام [Major General Hassan Tehrani-Moghadam, A Sword Out of the Sheath]," *Khabarban* (Iran), November 12, 2017. (https://khabarban.com/15569851/سرلشکر_شهید_حسن_تهرانی_مقدم_شمشیر_برون_از_نیام)

359. "دانشمند برجسته و بی‌ادعایی که صهیونیست‌ها و استکبار را برای همیشه وحشت‌زده کرد [The Prominent and Unassuming Scientist Who Terrified the Zionists and Arrogance Forever]," *Kayhan* (Iran), November 12, 2017. (https://www.pishkhan.com/news/201775)

360. "سرلشکر شهید حسن تهرانی مقدم شمشیر برون از نیام [Major General Hassan Tehrani-Moghadam, A Sword Out of The Sheath]," *Khabarban* (Iran), November 12, 2017. (https://khabarban.com/15569851/سرلشکر_شهید_حسن_تهرانی_مقدم_شمشیر_برون_از_نیام)



Mohsen Rafighdoost (Tasnim News Agency)

Until his death on November 12, 2011, from a reported accident on a missile base near Tehran that killed dozens,[361] Tehrani-Moghadam was developing a large solid-propellant SLV.[362] IRGC-AF Deputy Commander Majid Mousavi revealed in 2014 that Tehrani-Moghadam saw the IRGC's space efforts as a way to grow Iran's missile capabilities without overtly transgressing the supreme leader's 2,000-kilometer range cap.[363] According to Hossein Salami, a former IRGC-AF chief who now serves as an IRGC commander, Tehrani-Moghadam prioritized "precision, destructive power, range, health of missiles up until impact, radar evasion, and concealment until launching" as vectors for developing Iranian missile power.[364] "Here lies someone who wanted to destroy Israel" is etched on Tehrani-Moghadam's gravestone.[365]

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.

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361. There have been allegations of covert foreign involvement in the explosion. See: Julian Borger and Saeed Kamali Dehghan, "Iranian missile architect dies in blast. But was explosion a Mossad mission?," *The Guardian* (UK), November 14, 2011. (https://www.theguardian.com/world/2011/nov/14/iran-missile-death-mossad-mission). At least 39 died in the explosion. "شهادت سردار طهرانی مقدم و یارانش چگونه رقم خورد؟ [How Did the Martyrdom of Commander Tehrani-Moghadam and His Companions Occur?]," *Tasnim News Agency* (Iran), November 12, 2019. (https://tn.ai/2137685)

362. "طهرانی مقدم در زمان شهادت مشغول کدام پروژه مهم بود؟/ جزئیات جدید از برنامه فضایی سپاه [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. "تندر 69" چگونه وارد سازمان موشکی ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی مقاومت به موشک‌های «فاتح» [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)

364. "گزارش: آیا موشکهای ایرانی یادگار هاشمی رفسنجانی است؟ [Report: Are Iranian Missiles a Relic of Hashemi Rafsanjani?]," *Tasnim News Agency* (Iran), January 15, 2019. (https://tn.ai/1921907)

365. "تصویر سنگ مزار شهید حاج حسن تهرانی مقدم، پدر موشکی جمهوری اسلامی ایران [Picture of the Tombstone of Martyr Haj Hassan Tehrani Moghadam, the father of the Islamic Republic of Iran's Missiles]," *Jahan News* (Iran), June 19, 2017. (https://www.jahannews.com/news/527823/تصویر-سنگ-مزار-شهید-حاج-حسن-تهرانی-مقدم-پدر-موشکی-جمهوری-اسلامی-ایران)

366. A claim attributed to former IRGC Commander Yahya Rahim Safavi: " ماجرای اولین موشکی که وارد ایران شد | رحیم صفوی: محسن رفیقدوست پدربزرگ موشکی ایران است [The Story of the First Missile That Entered Iran | Rahim Safavi: Mohsen Rafighdoost is the Grandfather of Iran's Missile]," *Hamshahri* (Iran), January 26, 2020. (https://www.hamshahrionline.ir/news/480671/ماجرای-اولین-موشکی-که-وارد-ایران-شد-رحیم-صفوی-محسن-رفیقدوست)

367. Saeed Alamian, برای تاریخ می‌گویم: خاطرات محسن رفیق‌دوست [*For the Record: Memoirs of Mohsen Rafighdoost*] (Tehran: Soureh Mehr, 2012/2013), pages 186-87.

368. "یک ماجرای موشکی به روایت محسن رفیق دوست [One Missile Story According to Mohsen Rafighdoost]," *Iranian Students News Agency* (Iran), September 27, 2020. (https://web.archive.org/web/20201204023037/https://www4.isna.ir/news/99070604351/یک-ماجرای-موشکی-به-روایت-محسن-رفیق-دوست) According to Rafighdoost, Libyan leader Muammar al-Ghaddafi's only condition was that one of the Scuds be fired at Saudi Arabia. Rafighdoost promised that Iran would do so, but Tehran never complied.

IRGC-AF chief, Brigadier General Amir-Ali Hajizadeh (Khamenei Website)

Accompanying Rafighdoost on both trips was Yahya Rahim Safavi, who now holds the rank of major general and serves as a military affairs advisor to the supreme leader.[369] Safavi's support for Rafighdoost's early procurement efforts makes him an important figure in Iran's missile history, as does the fact that he was the officer who tasked Tehrani-Moghadam with developing a list of personnel to go to Syria for Scud training.[370] Safavi also held numerous IRGC positions in the past. These include commander of IRGC Ground Forces (IRGC-GF), a decade-long stint as a deputy IRGC commander, and another decade-long stint as an IRGC commander.[371]

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,[372] 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[373] and to serve as deputy commander of Tehrani-Moghadam's newly formed IRGC missile unit, Hadid.[374] Hajizadeh also took a procurement trip to North Korea.[375] 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."[376]

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

369. "زندگینامه: سیدیحیی صفوی-(۱۳۳۱ [Biography: Seyyed Rahim Safavi (1331-)]," *Hamshahri* (Iran), May 29, 2010. (https://www.hamshahrionline.ir/news/108501/زندگینامه-سیدیحیی-صفوی-۱۳۳۱)

370. "اینگونه بود که تیپ موشکی «حدید» تشکیل شد [This Was How The 'Hadid' Missile Brigade Was Formed]," *Tabnak* (Iran), August 11, 2012. (https://www.tabnak.ir/fa/news/264602/اینگونه-بود-که-تیپ-موشکی-حدید-تشکیل-شد)

371. "در مورد رحیم صفوی در ویکی تابناک بیشتر بخوانید [Read More About Rahim Safavi on Wiki Tabnak]," *Tabnak* (Iran), accessed August 17, 2022. (https://www.tabnak.ir/fa/tags/10728/1/رحیم-صفوی)

372. For example: "حاجی زاده: اگر می توانستند جلوی موشکهایمان را می گرفتند [Hajizadeh: If They Could Have, They Would Have Blocked Our Missile [Progress],]" *Mashregh News* (Iran), November 10, 2014. (https://www.mashreghnews.ir/news/361423/حاجی-زاده-اگر-می-توانستند-جلوی-موشکهایمان-را-می-گرفتند); Ali Javid, "Iran Soraya TV with IRGC_AS missiles chief Gen. Hajizadeh, capabilities ایران ثریا سردار حاجی زاده," *YouTube*, November 22, 2018. (https://www.youtube.com/watch?v=tCQLTI2r6kY)

373. "اینگونه بود که تیپ موشکی «حدید» تشکیل شد [This Was How The 'Hadid' Missile Brigade Was Formed]," *Tabnak* (Iran), August 11, 2012. (https://www.tabnak.ir/fa/news/264602/اینگونه-بود-که-تیپ-موشکی-حدید-تشکیل-شد)

374. A. Ekramian, "مستند «خط مقدم» ['Frontline' Documentary]," *YouTube*, September 30, 2015. (https://www.youtube.com/watch?v=w-LkkVw5Ol4)

375. "گزارش: آیا موشکهای ایرانی یادگار هاشمی رفسنجانی است؟ [Report: Are Iranian Missiles A Relic of Hashemi Rafsanjani?]," *Tasnim News Agency* (Iran), January 15, 2019. (https://tn.ai/1921907)

376. David Albright, Olli Heinonen, Frank Pabian, and Andrea Stricker, "A Key Missing Piece of the Amad Puzzle: The Shahid Boroujerdi Project for Production of Uranium Metal & Nuclear Weapons Components," *Institute for Science and International Security*, January 11, 2019. (https://isis-online.org/uploads/isis-reports/documents/Shahid_Borourjerdi_Project_Key_Piece_of_Amad_Puzzle_10Jan2019_Final.pdf)

representative on Iran's Supreme Defense Council,[377] and briefly as acting commander-in-chief of Iran's Armed Forces.[378] 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.[379] Rafsanjani visited North Korea on a procurement trip in the 1980s while serving as parliament speaker.[380]

Rafsanjani also visited Libya during the war with another influential Iranian politician, Iran's then president and current supreme leader, Ayatollah Ali Khamenei.[381] 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.[382] 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.[383]

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[384] — the former head of AIO's Shahid Bagheri Industrial Group (SBIG)[385] — as well as Seyyed Mehdi Farhi[386] and Ahmad Vahid Dastjerdi.[387]

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377. "حکم انتصاب آقای هاشمی رفسنجانی به نمایندگی امام در شورای عالی دفاع" [Order appointing Mr. Hashemi Rafsanjani as The Imam's Representative on the Supreme Defense Council]," *Imam Khomeini Website* (Iran), October 13, 1981. (http://webcache.googleusercontent.com/search?q=cache:YvKbPsaVPGwJ:www.imam-khomeini.ir/fa/C207_43581/+&cd=2&hl=en&ct=clnk&gl=us)

378. "Rafsanjani to Head Iran Armed Forces: Khomeini Move Follows Serious Iranian Losses in War With Iraq," *Associated Press*, June 2, 1988. (https://www.latimes.com/archives/la-xpm-1988-06-02-mn-5911-story.html)

379. Akbar Hashemi Rafsanjani and Sara Lahooti, 1364 امید و دلواپسی (کارنامه و خاطرات هاشمی رفسنجانی سال) [Hope and Concern: Hashemi Rafsanjani's career and memoirs; Year 1364] (Tehran: Ma'aref Enghelab, 2008/2009), page 47. Accessible in part via Google Books: (https://www.google.com/books/edition/امید_و_دلواپسی/mcBQxUcvvzgC?hl=en&gbpv=0)

380. "اولین سفر یک مقام بلندپایه ایرانی به کره شمالی پس از تحریم جهانی" [The First Trip of a High-Ranking Iranian Official to North Korea After Global Sanctions," *BBC Persian* (UK), September 1, 2011. (https://www.bbc.com/persian/iran/2011/09/110901_l23_iran_nkorea_larijani)

381. "گزارش: آیا موشکهای ایرانی یادگار هاشمی رفسنجانی است؟" [Report: Are Iranian Missiles a Relic of Hashemi Rafsanjani?]," *Tasnim News Agency* (Iran), January 15, 2019. (https://tn.ai/1921907)

382. "از دِمونتاژ محرمانه و مهندسی معکوس تا ساخت موشک‌های نقطه‌زن/تلاش‌های مرد پشت‌پرده موشکی ایران برای تولید موشک‌های بومی" [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/از-دمونتاژ-محرمانه-و-مهندسی-معکوس-تا-ساخت-موشک-های-نقطه-زن-تلاش-های)

383. "سردار حاجی‌زاده: دقت موشک‌ها را مدیون تدبیر رهبر معظم انقلاب هستیم/ ناوهای هواپیمابر آمریکا برای ما یک سیبل هستند" [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.news/fa/tiny/news-1059629)

384. "مدیر عامل سازمان صنایع هوافضا و معاون امور صنعتی وزارت دفاع منصوب شدند" [The Managing Director of the Aerospace Industries Institute and the Ministry of Defense's Deputy for Industrial Affairs Were Appointed]," *Iranian Labour News Agency* (Iran), November 12, 2014. (https://www.ilna.news/fa/tiny/news-222500)

385. "Mehrdada Akhlaghi Ketabachi," *Iran Watch*, September 24, 2021. (https://www.iranwatch.org/iranian-entities/mehrdada-akhlaghi-ketabachi)

386. "رئیس سازمان صنایع هوافضا وزارت دفاع: برد متغیر و رادارگریزی؛دو ویژگی مهم موشک بالستیک قیام است" [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)

387. "Ahmad Vahid Dastjerdi," *Iran Watch*, September 24, 2021. (https://www.iranwatch.org/iranian-entities/ahmad-vahid-dastjerdi)

Pictured left to right: Logos of IRGC, MODAFL, and AIO (Iranwatch.org)

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,"[388] 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.[389]

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."[390] 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

388. "قالیباف باعث گسترش صنعت موشکی شد اما تاکنون اسمی از وی آورده نشده است" [Qalibaf Expanded the Missile Industry But His Name Has Not Been Mentioned Thus Far]," *Tasnim News Agency* (Iran), September 14, 2017. (https://tn.ai/1518684)
389. Fabian Hinz, "Why Is Iran Talking About Intercontinental Ballistic Missiles Now?," *Radio Farda*, November 17, 2020. (https://en.radiofarda.com/a/30955019.html)
390. "موشک‌های ما از ایده تا محصول کاملاً ایرانی هستند/ در بخش تأمین تسلیحات وابستگی نداریم" [Our Missiles Are Completely Iranian From Idea to Product/ We Have No Dependency in the Area of Arms Supplies]," *Islamic Republic News Agency* (Iran), February 14, 2016. (www.irna.ir/news/81963631)

specialized subsidiaries contributing to Iran's domestic missile supply chain.[391]

For example, AIO's Shahid Hemmat Industrial Group (SHIG) and Shahid Bagheri Industrial Group (SBIG) specialize in the development of liquid-propellant and solid-propellant missiles, respectively. SHIG's network of subsidiaries include Shahid Movahed Industries, which previously worked with North Korea, and Shahid Rastegar Industries, which reportedly develops missile engines.[392] Similarly, SBIG subsidiaries include Shahid Moghaddam Industries, which helps to develop motor casings for missiles, and Shahid Kharrazi Industries, which develops guidance technology for missiles.[393] The United Nations and the European Union have not sanctioned these AIO subsidiary networks. The Trump administration sanctioned them only after the United States left the 2015 nuclear deal.

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."[394] 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.[395] For example, the mining sector provides materials that can be refined for military use, such as developing aluminum powder from bauxite.[396] 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.[397]

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.

391. "Aerospace Industries Organization (AIO)," *Iran Watch*, October 28, 2019. (https://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio)
392. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Key Ballistic Missile Entities in Iran," July 28, 2017. (https://home.treasury.gov/news/press-releases/sm0136)
393. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Iranian Entities," January 4, 2018. (https://home.treasury.gov/news/press-releases/sm0246)
394. مستند پارتیزان [Partisan Documentary], "مستند نظامی بازدارنده قسمت دوم//Deterrent Part 2," *YouTube*, January 5, 2021. (https://www.youtube.com/watch?v=VtMEzxDxvDU)
395. For an excellent analysis of sectors of relevance, see: Saeed Ghasseminejad, "Iran's Ballistic Missile Program and Economic Sanctions," *Foundation for Defense of Democracies*, March 2016. (https://www.fdd.org/analysis/2016/03/16/irans-ballistic-missile-program-and-economic-sanctions/)
396. Bozorgmehr Sharafedin and Pratima Desai, "Special Report: Inside Iran's secret project to produce aluminum powder for missiles," *Reuters*, June 24, 2020. (https://www.reuters.com/article/us-iran-missiles-programme-specialreport/special-report-inside-irans-secret-project-to-produce-aluminium-powder-for-missiles-idUSKBN23V1K1)
397. "New York CEO gets prison for Iran conspiracy plea," *Associated Press*, September 8, 2017. (https://www.timesofisrael.com/new-york-ceo-gets-prison-for-iran-conspiracy-plea)

American Policy Aims Towards Tehran's Missiles		Iran's Missile Policy Aims
Prevent Iran from developing means to deliver a nuclear weapon		Retain option for delivering a potential nuclear weapon
Impede Iranian missile production		Continue producing missiles and other projectiles
Impede qualitative missile advances		Continue drive for more precise, longer-range, and more reliable missile systems
Thwart foreign procurement of parts and systems		Continue illicit foreign procurement
Intercept, expose, and deter Iranian missile and missile-related technology transfers to other actors		Continue missile and missile-related technology transfers to proxies and partners
Deploy missile defenses to offset Iranian missile advances through deterrence by denial		Use missiles to bolster deterrence by punishment
Get Iran to address missiles in talks		Reject including missiles in talks
Be able to hold Iran's missile assets and infrastructure at risk militarily		Develop a more mobile, dispersed, and survivable missile force
Minimize the political impact of Iran's missile systems in its coercive diplomacy in the region		Maximize the impact of missiles on regional coercive diplomacy

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.[398] 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,[399] 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

398. Janne E. Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Washington, DC: The Brookings Institution, 1991), page 60.
399. David Patrikarakos, *Nuclear Iran: The Birth of An Atomic State* (London: I.B. Tauris, 2012).

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,[403] whichever is earlier."[404]

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."[405] 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.[406]

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

400. Noted political scientist Hans J. Morgenthau cautioned against this very framing. See: Hans J. Morgenthau, *Scientific Man Vs. Power Politics*. (Chicago: The University of Chicago Press, 1946)
401. "Iran Nuclear Negotiations: From Extension to Final Agreement?" *Hearing Before the U.S. House Committee on Foreign Affairs*, July 29, 2014. (https://www.govinfo.gov/content/pkg/CHRG-113hhrg88915/html/CHRG-113hhrg88915.htm)
402. For more on Iran deal related sunsets, see: Behnam Ben Taleblu and Andrea Stricker, "Key Sunsets Under the JCPOA and UNSC Resolution 2231," *Foundation for Defense of Democracies*, February 24, 2021. (https://www.fdd.org/analysis/2021/02/19/key-sunsets-under-the-jcpoa-and-unsc-resolution-2231)
403. Such an affirmation is known as a broader conclusion. For IAEA history on this, see: International Atomic Energy Agency, "IAEA Safeguards: Serving Nuclear Non-Proliferation," 2021, page 14. (https://www.iaea.org/sites/default/files/18/09/sg-serving-nuclear-non-proliferation.pdf)
404. United Nations Security Council, Resolution 2231, July 20, 2015, page 99. (https://undocs.org/S/RES/2231(2015))
405. United Nations Security Council, Resolution 1929, June 9, 2010, page 5. (https://www.iaea.org/sites/default/files/unsc_res1929-2010.pdf)
406. For example: Rod McGuirk, "Iran foreign minister denies missile test breached UN rules," *Associated Press*, March 15, 2016. (https://apnews.com/article/8616fe4776654437900eebcf7c4c33ff)

Iranian violations of UNSCR 2231, such as missile tests or transfers.[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,[408] America's transatlantic partners plan to go one step further. By October 2023, according to the JCPOA's implementation timeline,[409] the European Union will delist much of the brain trust behind Iran's missile program, including entities with ties to MODAFL.[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),[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.[412] Initially, the Trump administration tried to "fix" the JCPOA with its transatlantic partners,[413] with a focus on missiles.[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?"[415]

Between the JCPOA's finalization in 2015 and May 2018, when the Trump administration left the

407. Valerie Lincy and Behnam Ben Taleblu, "Iran's Compliance with UNSCR 2231Alleged Violations Must Be Addressed," *Wisconsin Project on Nuclear Arms Control*, August 2017. (https://www.wisconsinproject.org/wp-content/uploads/2017/08/Irans-Compliance-with-UNSCR-2231-Alleged-Violations-Must-Be-Addressed.pdf)
408. For exact JCPOA penalties waived, see: Joint Comprehensive Plan of Action, Vienna, July 14, 2015, Annex II, pages 8-15. (https://2009-2017.state.gov/documents/organization/245320.pdf). For U.S. delistings, see: Joint Comprehensive Plan of Action, Vienna, July 14, 2015, Annex II, Attachments 3-4. (https://2009-2017.state.gov/documents/organization/245319.pdf)
409. See: Joint Comprehensive Plan of Action, Vienna, July 14, 2015, Annex V. (https://2009-2017.state.gov/documents/organization/245324.pdf)
410. This also applies to the United Kingdom, which post-Brexit mirrors much of the existing EU sanctions architecture and political timelines for sanctions lifting on Iran per the JCPOA.
411. See: U.S. Department of the Treasury, Press Release, "Treasury Sanctions Those Involved in Ballistic Missile Procurement for Iran," January 17, 2016. (https://home.treasury.gov/news/press-releases/jl0322); Dan Roberts, "US imposes new sanctions on Iranian firms over ballistic missile test," *The Guardian* (UK), March 24, 2016. (https://www.theguardian.com/world/2016/mar/24/us-treasury-new-sanctions-iran-ballistic-missile-test)
412. The White House, Office of the Press Secretary, "President Donald J. Trump's New Strategy On Iran," October 13, 2017. (https://ir.usembassy.gov/president-donald-j-trumps-new-strategy-iran)
413. Steve Holland, "Trump issues ultimatum to 'fix' Iran nuclear deal," *Reuters*, January 11, 2018. (https://www.reuters.com/article/us-iran-nuclear-decision/trump-issues-ultimatum-to-fix-iran-nuclear-deal-idUSKBN1F108F)
414. Felicia Schwartz and Laurence Norman, "Macron, Merkel Set to Visit Trump With Iran Deal Hanging in the Balance," *The Wall Street Journal*, April 19, 2018. (https://www.wsj.com/articles/macron-merkel-set-to-visit-trump-with-iran-deal-hanging-in-the-balance-1524176332)
415. Donald Trump, in "U.S.-France Relations," *C-SPAN*, April 24, 2018. (https://www.c-span.org/video/?444586-1/presidents-trump-macron-speak-iran-nuclear-deal)

accord, Iran tested at least 27 ballistic missiles.[416] 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.

"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."

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.

416. For launch calculation (23+2+2), see: Behnam Ben Taleblu, "Iranian Ballistic Missile Tests Since the Nuclear Deal – 2.0," *Foundation for Defense of Democracies*, January 25, 2018. (https://www.fdd.org/analysis/2018/01/24/iranian-ballistic-missile-tests-since-the-nuclear-deal-2-0); United Nations Security Council, "Identical letters dated 23 May 2018 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 24, 2018. (https://undocs.org/S/2018/495); United Nations Security Council, "Identical letters dated 23 November 2018 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," November 26, 2018. (https://undocs.org/S/2018/1047)

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

417. On the imperative of these restraints, see: Mark Dubowitz, Reuel Marc Gerecht, and Behnam Ben Taleblu, "What "Yes" With Iran Looks Like," *Foundation for Defense of Democracies*, June 26, 2019. (https://www.fdd.org/wp-content/uploads/2019/06/fdd-report-what-yes-with-iran-looks-like.pdf)
418. For a primer on U.S missile sanctions on Iran, see: Richard Goldberg, Matthew Zweig, Behnam Ben Taleblu, and Saeed Ghasseminejad, "Biden, Congress Should Defend Missile Sanctions Imposed on Iran," *Foundation for Defense of Democracies*, April 27, 2021. (https://www.fdd.org/analysis/2021/04/27/biden-congress-should-defend-missile-sanctions-imposed-on-iran)
419. This creative idea is mentioned in passing here: Anthony H. Cordesman, "The Other Sides of Renegotiating the JCPOA Iran Nuclear Agreement," *Center for Strategic and International Studies*, April 15, 2021. (https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210407_Cordesman_JCPOA_Agreement.pdf?MiDtABPoD7YyAewI9DjNIa_kYMvYW65Z)

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.[420] 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."[421]
- **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.[422] 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.

IRGC members test ballistic missiles during a military drill on January 16, 2021, in Iran. (Photo by Sepahnews/Handout/ Anadolu Agency via Getty Images)

- **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

420. "Indian Missiles," *Federation of American Scientists*, May 30, 1998. (https://fas.org/nuke/guide/india/missile/overview.htm); Richard Spier, "U.S. Space Aid to India: On a 'Glide Path' to ICBM Trouble?," *Arms Control Today*, March 2006. (https://www.armscontrol.org/act/2006-03/features/us-space-aid-india-glide-path-icbm-trouble); Janne E. Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Washington, DC: The Brookings Institution, 1991), pages 41-48.

421. Michael Elleman, "How can we stop Iran's space programme threatening the West?," *The International Institute for Strategic Studies*, August 1, 2018. (https://www.iiss.org/blogs/research-paper/2018/07/reduce-risk-iran-develop-icbm-nuclear)

422. Tehran released the latest variant, dubbed the Kheibar Shekan, in February 2022. See: Jamie McIntyre, "As US and Iran nuclear talks come down to the wire, Tehran touts new missile capable of reaching Israel," *Washington Examiner*, February 10, 2022. (https://www.washingtonexaminer.com/policy/defense-national-security/as-us-and-iran-nuclear-talks-come-down-to-the-wire-tehran-touts-new-missile-capable-of-reaching-israel)

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,"[423] 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.[424] 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.[425]

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.[426] 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.[427]

Policy Recommendations

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

Diplomatic:[428]

- **Enforce all UNSCRs related to Iranian weapons proliferation.** Although multilateral enforcement of UNSCR 2231 prohibitions on Iranian arms transfers

423. "IRGC Deputy Commander Salami: We Have a 'Jungle' of Missiles Ready to Be Launched at Any Enemy Far Away," *Middle East Media Research Institute*, September 21, 2016. (https://www.memri.org/tv/irgc-deputy-commander-salami-we-have-jungle-missiles-ready-be-launched-any-enemy-far-away)

424. For example: "Range limit to 2,000km for Iranian missiles not everlasting," *Mehr News Agency* (Iran), January 3, 2021. (https://en.mehrnews.com/news/168004/Range-limit-to-2-000km-for-Iranian-missiles-not-everlasting)

425. Both of which no longer exist. Discussions with Valerie Lincy, 2018.

426. "آمریکا و اسرائیل ۵ بار قصد حمله به ایران داشتند؛ توان موشکی ایران مانع حمله شد/ آمریکا می‌خواهد موشک را از ما بگیرد [The United States and Israel Tried to Attack Iran Five Times; Iran's Missile Power Thwarted the Attack/ America Wants to Take the Missile From Us]," *Tasnim News Agency* (Iran), April 2, 2015. (https://tn.ai/1038012)

427. An excellent report by the Wisconsin Project on Nuclear Arms Control provides starting points for how to apply these lessons with respect to the Iranian missile program. See: "More Eyes on More Data: Prospects for Restricting Iran's Missile Program Using Open Sources," *Wisconsin Project on Nuclear Arms Control*, February 2019. (https://www.iranwatch.org/sites/default/files/more-eyes-on-more-data-prospects-for-restricting-iran-missile-program-using-open-sources.pdf)

428. Fortunately, there is a consensus among analysts over the range of existing multilateral tools and policies available to impede Iran's missile program. For example, many of the diplomatic recommendations listed below can also be found in the excellent report: Robert Einhorn and Vann H. Van Diepen, "Constraining Iran's Missile Capabilities," *The Brookings Institution*, March 2019. (https://www.brookings.edu/wp-content/uploads/2019/03/FP_20190321_missile_program_WEB.pdf)

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.[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.[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.[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.[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.[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.[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,[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.[436] Notably, Iran has twice voted against HCOC-related resolutions at the United Nations.[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

429. "Yemen (NGF)," *Stockholm International Peace Research Institute*, June 13, 2019. (https://www.sipri.org/databases/embargoes/un_arms_embargoes/yemen/yemen)
430. C.I. Bosley, "Iran Allegedly Skirts Hezbollah Arms Ban," *Arms Control Today*, September 2007. (https://www.armscontrol.org/act/2007-09/iran-nuclear-briefs/iran-allegedly-skirts-hezbollah-arms-ban)
431. "Arms-related transfers," *United Nations Security Council*, accessed August 17, 2022. (https://www.un.org/securitycouncil/content/2231/arms-related-transfers)
432. Michael Lipin, "US Tries to Extend UN Arms Embargo on Iran Despite Obstacles," *Voice of America*, July 30, 2020. (https://www.voanews.com/middle-east/voa-news-iran/us-tries-extend-un-arms-embargo-iran-despite-obstacles). The EU basis for creating this can be found in "Criterion Six" of the 1998 EU Code of Conduct for Arms Exports. See: Council of the European Union, "European Union Code of Conduct On Arms Exports," June 5, 1998. (https://www.sipri.org/sites/default/files/research/disarmament/dualuse/pdf-archive-att/pdfs/eu-code-of-conduct-on-arms-exports.pdf)
433. For more background, see: Kay C. Georgi, "Evaluating the Iran Section of CAATSA: More Secondary Sanctions Codified, More Congressional Oversight, But Not Much Real Change," *Arent Fox Schiff*, August 15, 2017. (https://www.arentfox.com/perspectives/alerts/evaluating-the-iran-section-caatsa-more-secondary-sanctions-codified-more)
434. "Missile Technology Control Regime (MTCR) Frequently Asked Questions," *U.S. Department of State*, accessed August 17, 2022. (https://www.state.gov/remarks-and-releases-bureau-of-international-security-and-nonproliferation/missile-technology-control-regime-mtcr-frequently-asked-questions)
435. Mark Fitzpatrick, "Israel's ballistic-missile programme: an overview," *The International Institute for Strategic Studies*, August 25, 2021. (https://www.iiss.org/blogs/analysis/2021/08/israel-ballistic-missile-programme)
436. HCOC members voluntarily adhere to a series of "principles," which can be of value when designing a potential missile deal with Iran. See: "Text of The HCoC," *The Hague Code of Conduct Website*, November 2012. (https://www.hcoc.at/?tab=background_documents&page=text_of_the_hcoc)
437. "The Hague Code of Conduct (HCOC)," *Nuclear Threat Initiative*, November 30, 2020. (https://www.nti.org/learn/treaties-and-regimes/hague-code-conduct-against-ballistic-missile-proliferation-hcoc)

vehicles.[438] The UN Register of Conventional Arms calls on states to submit "relevant data on imports and exports of conventional arms."[439]

- **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.[440] 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,[441] which is geared toward WMD and associated delivery vehicles.[442] 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.**[443] 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.[444] 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.

438. United Nations Security Council, Resolution 1540, April 28, 2004. (https://documents-dds-ny.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement

439. U.S. Department of State, "United Nations Register of Conventional Arms," March 3, 2004. (https://web.archive.org/web/20201105125932/https://fas.org/asmp/resources/govern/DoS_UNarmsregister_factsheet2004.htm)

440. U.S. Department of State, "About the Proliferation Security Initiative," March 19, 2019. (https://www.state.gov/about-the-proliferation-security-initiative/

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/

442. This executive order has a global reach and is not narrowly tailored to Iran. See: Executive Order 13382, "Blocking Property of Weapons of Mass Destruction Proliferators and Their Supporters," July 1, 2005. (https://2009-2017.state.gov/documents/organization/135435.pdf)

443. For more on snapback, see: Richard Goldberg, "FAQ: The 'Snapback' of UN Sanctions on Iran," *Foundation for Defense of Democracies*, July 9, 2020. (https://www.fdd.org/in-the-news/2020/07/09/faq-the-snapback-of-un-sanctions-on-iran)

444. "Biden Withdraws Trump's Restoration of UN Sanctions on Iran," *Associated Press*, February 18, 2021. (https://www.usnews.com/news/world/articles/2021-02-18/biden-withdraws-trumps-restoration-of-un-sanctions-on-iran)

- **Continue to prosecute persons who export U.S.-origin goods to Iran.**[445] 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.[446]
- **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,"[447] a directory of Iran-based entities of proliferation concern.[448] 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.[449] Yet those officials also stress the limitation is subject to change.[450] 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

445. For example: U.S. Department of Justice, Press Release, "Three Charged with Illegally Exporting Goods to Iran," January 12, 2021. (https://www.justice.gov/opa/pr/three-charged-illegally-exporting-goods-iran)
446. *Missile Defense Cooperation in the Gulf*, Eds. Michael Elleman, Toby Dodge, Andrew Kelly, and Douglas Barrie (London: The International Institute for Strategic Studies, 2016), pages 102-103.
447. For previous iterations, see: "WMD End-Use Control: Licence Applications for Iran," *Iran Watch*, October 31, 2015. (https://www.iranwatch.org/library/governments/united-kingdom/department-business-innovation-skills/iran-list)
448. For more: "Notice to exporters 2017/08: Iran list removed from GOV.UK," *Iran Watch*, March 22, 2017. (https://www.iranwatch.org/library/governments/united-kingdom/notice-exporters-201708-iran-list-removed-govuk)
449. Jon Gambrell, "Iran says supreme leader limiting ballistic missile range," *Associated Press*, October 31, 2017. (https://apnews.com/article/a9b9ff80f4424ce5be3a4a81e04dc8dc)
450. Bozorgmehr Sharafedin, "Iran warns it would increase missile range if threatened by Europe," *Reuters*, November 25, 2017. (https://www.reuters.com/article/us-iran-missiles-europe-idUSKBN1DQ007); "Iranian general says nation can extend missile range beyond 2,000 kilometers," *The Times of Israel* (Israel), December 10, 2018. (https://www.timesofisrael.com/iranian-general-says-nation-can-extend-missile-range-beyond-2000-kilometers)

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.**[451] While there is open-source material on this cooperation,[452] it is primarily historical in nature, and the directions of future technology flows are debated by experts.[453] 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."[454] 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

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)

452. "The Iran – North Korea Strategic Alliance," *Joint Hearing Before the U.S. House Foreign Affairs Subcommittees on Terrorism, Nonproliferation, and Trade; Asia and the Pacific; and Middle East and North Africa*, July 28, 2015. (https://www.govinfo.gov/content/pkg/CHRG-114hhrg95694/html/CHRG-114hhrg95694.htm); Ali Alfoneh and Scott Modell, "The Iran-North Korea Nuclear Nexus: Unanswered Questions," *Foundation for Defense of Democracies*, January 2016. (https://www.fdd.org/analysis/2016/01/27/the-iran-north-korea-nuclear-nexus-unanswered-questions)

453. For instance: Michael Elleman, "North Korea-Iran Missile Cooperation," *38 North*, September 22, 2016. (https://www.38north.org/2016/09/melleman092216); Anthony Ruggiero and Behnam Ben Taleblu, "The danger of North Korea and Iran — and how Trump should tackle it," *The Hill*, July 6, 2017. (https://thehill.com/blogs/pundits-blog/foreign-policy/340832-the-great-danger-of-north-korea-and-iran-and-what-trump-can)

454. David E. Sanger and William J. Broad, "U.S. Revives Secret Program to Sabotage Iranian Missiles and Rockets," *The New York Times*, February 13, 2019. (https://www.nytimes.com/2019/02/13/us/politics/iran-missile-launch-failures.html)

to Iran's nuclear program,[455] including cyber-enabled sabotage against a gas storage facility tied to Iran's missile program.[456] 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,[457] and Bahrain to acquire the S-400 SAM system.[458] 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.[459]
- **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.[460]
- **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.[461]

455. Andrea Stricker, "Iran Could Face a Summer of Nuclear Sabotage," *Foundation for Defense of Democracies*, July 13, 2020. (https://www.fdd.org/analysis/2020/07/13/iran-could-face-a-summer-of-nuclear-sabotage)
456. Arie Egozi, "Cyber Strike By Foreign Force Caused Iran Explosion: Israeli Experts," *Breaking Defense*, July 2, 2020. (https://breakingdefense.com/2020/07/cyber-strike-by-foreign-force-causes-iran-explosion-israeli-experts)
457. Bradley Bowman and Andrew Gabel, "Russia's S-400: An offer US partners should refuse," *Defense News*, July 22, 2019. (https://www.defensenews.com/opinion/commentary/2019/07/22/russias-s-400-an-offer-us-partners-should-refuse/
458. "Bahrain," *Missile Defense Advocacy Alliance*, October 3, 2018. (https://missiledefenseadvocacy.org/intl_cooperation/bahrain)
459. Bradley Bowman and Jacob Nagel, "Why not add Israel to this year's US-UAE Iron Union exercise?," *Defense News*, September 10, 2020. (https://www.defensenews.com/opinion/commentary/2020/09/10/why-not-add-israel-to-this-years-us-uae-iron-union-exercise)
460. Note the reference to early aerial warning with a different Arab state here:: Ronen Bergman and Patrick Kingsley, "Israel Works With Arab Allies to Down Drones, in Sign of Growing Ties," *The New York Times*, July 13, 2022. (https://www.nytimes.com/2022/07/13/world/middleeast/israel-arab-allies-drones-biden.html)
461. Bradley Bowman and Katherine Zimmerman, "Biden Can't Bring Peace to Yemen While Iran Keeps Sending Weapons," *Foreign Policy*, March 4, 2021. (https://foreignpolicy.com/2021/03/04/biden-yemen-peace-saudi-arabia-houthis-iran-weapons)

- **Support base hardening.**[462] 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.**[467] 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).**[468] 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.**[470] 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

462. Ian Williams, "Uncomfortable Lessons: Reassessing Iran's Missile Attack," *Center for Strategic and International Studies*, February 6, 2020. (https://www.csis.org/analysis/uncomfortable-lessons-reassessing-irans-missile-attack)
463. See Hajizadeh comments in: Ali Javid, "Iran Soraya TV with IRGC_AS missiles chief Gen. Hajizadeh, capabilities," *YouTube*, November 22, 2018. (https://www.youtube.com/watch?v=tCQLTI2r6kY)
464. Bradley Bowman, Andrew Gabel, and Mikhael Smits, "Iran attack highlights US missile defense vulnerability," *Defense News*, January 13, 2020. (https://www.defensenews.com/opinion/commentary/2020/01/13/iran-attack-highlights-us-missile-defense-vulnerability)
465. Caroline Houck, "Left-of-Launch Missile Defense: 'You Don't Want to Have Just One Solution to the Threat,'" *Defense One*, January 24, 2018. (https://www.defenseone.com/threats/2018/01/left-launch-missile-defense-you-dont-want-have-just-one-solution-threat/145438)
466. Bradley Bowman and Maj. Jared Thompson, "We Must Work to Prevent a 'Space Pearl Harbor,'" *The Dispatch*, February 18, 2021. (https://thedispatch.com/p/we-must-work-to-prevent-a-space-pearl)
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)
468. The list of projects is mentioned in a transcript of an FDD event: "The Sprint to Field the Army Force of the Future," *Foundation for Defense of Democracies*, March 18, 2021. (https://www.fdd.org/events/2021/03/18/the-sprint-to-field-the-army-force-of-the-future/#downloads)
469. Bradley Bowman and Behnam Ben Taleblu, "Attacks in Iraq underscore need for indirect fire protection capability," *Defense News*, March 16, 2020. (https://www.defensenews.com/opinion/commentary/2020/03/16/attacks-in-iraq-underscore-need-for-indirect-fire-protection-capability)
470. "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress," *Congressional Research Service*, August 29, 2022. (https://crsreports.congress.gov/product/pdf/RL/RL33745)

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

471. "Elements – Sea-Based Weapons Systems," *U.S. Missile Defense Agency*, accessed August 17, 2022. (https://www.mda.mil/system/aegis_bmd.html)
472. For more, see: Bradley Bowman and Behnam Ben Taleblu, "Successful SM-3 weapons test offers missile defense opportunity," *Defense News*, November 21, 2020. (https://www.defensenews.com/opinion/commentary/2020/11/21/successful-sm-3-weapons-test-offers-missile-defense-opportunity)
473. See: Michael Eisenstadt, "Deterring Iran's Next Attack," *The Washington Institute for Near East Policy*, December 11, 2019. (https://www.washingtoninstitute.org/policy-analysis/deterring-irans-next-attack). As early as 1987, the CIA assessed, "Tehran has never been made to pay a significant price for the use of terrorist tactics as a political weapon, a factor that reinforces its willingness to use them." See: U.S. Central Intelligence Agency, Director of Central Intelligence, "Iran's Use of Terrorism," September 1987. (https://www.cia.gov/reading-room/docs/CIA-RDP91T00498R000800100002-2.pdf)
474. This recommendation emerged from conversations with Bradley Bowman in early 2021. See also: "U.S. Army Long-Range Precision Fires: Background and Issues for Congress," *Congressional Research Service*, March 16, 2021. (https://crsreports.congress.gov/product/pdf/R/R46721)
475. For example: @SGhasseminejad, *Twitter*, March 17, 2021. (https://twitter.com/SGhasseminejad/status/1372307091877212162)

used to support Tehran's missile efforts.[476] 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.**[477] 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,[478] Abdollah Asgharzadeh, and Kambiz Rostamian,[479] 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. 13428: Blocking Property of Persons Who Threaten Stabilization Efforts in Iraq.[480]
  - E.O. 13611: Blocking Property of Persons Threatening the Peace, Security, or Stability of Yemen.[481]
  - E.O. 13949: Blocking Property of Persons with Respect to the Conventional Arms Activities of Iran.[482]
- **Consider sanctions against Iranian missile commanders.** The United States has yet to employ counterproliferation designations against Hajizadeh,[483] 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-

476. Saeed Ghasseminejad, "Iran's Ballistic Missile Program and Economic Sanctions," *Foundation for Defense of Democracies*, March 2016. (https://www.fdd.org/analysis/2016/03/16/irans-ballistic-missile-program-and-economic-sanctions)
477. For example, see: "Pompeo says U.S. has expanded scope of Iran metals sanctions," *Reuters*, July 30, 2020. (https://www.reuters.com/article/us-usa-iran-sanctions/pompeo-says-u-s-has-expanded-scope-of-iran-metals-sanctions-idUSKCN24V3P5)
478. See: U.S. Department of Justice, Press Release, "Li Fangwei Charged In Manhattan Federal Court With Using A Web Of Front Companies To Evade U.S. Sanctions," April 29, 2014. (https://www.justice.gov/usao-sdny/pr/li-fangwei-charged-manhattan-federal-court-using-web-front-companies-evade-us-sanctions)
479. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Supporters of Iran's Ballistic Missile Program and Iran's Islamic Revolutionary Guard Corps – Qods Force," February 3, 2017. (https://home.treasury.gov/news/press-releases/as0004)
480. Executive Order 13438, "Blocking Property of Certain Persons Who Threaten Stabilization Efforts in Iraq," July 17, 2007. (https://fas.org/irp/offdocs/eo/eo-13438.htm)
481. Executive Order 13611, "Blocking Property of Persons Threatening the Peace, Security, or Stability of Yemen," May 16, 2012. (https://home.treasury.gov/system/files/126/yemen_eo.pdf)
482. Executive Order 13949, "Blocking Property of Persons with Respect to the Conventional Arms Activities of Iran," September 23, 2020. (https://www.federalregister.gov/documents/2020/09/23/2020-21160/blocking-property-of-certain-persons-with-respect-to-the-conventional-arms-activities-of-iran)
483. Interestingly enough, the United States sanctioned Hajizadeh under counterterrorism authorities in 2019 even though there is a stronger case for his designation under Executive Order 13382. See: Matthew Zweig and Behnam Ben Taleblu, "No Accountability for Iran's Nuclear Violators," *The National Interest*, March 3, 2019. (https://nationalinterest.org/feature/no-accountability-iran%E2%80%99s-nuclear-violators-45882)

AF's space division as well as its commander, Second Brigadier General Ali Jafarabadi.[484]

- **Investigate the applicability of counterproliferation sanctions to entities like the Iran Alumina Company.**[485] According to a 2020 investigation by Reuters, Iran Alumina Company[486] is helping the IRGC and Iran's solid-propellant missile program by providing aluminum powder from bauxite mining operations.[487] 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,[488] as well as using its Self-Sufficiency Organization to aid Tehran's conversion of rockets into missiles.[489] 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.

484. "IRGC planning to place satellite in geostationary orbit: cmdr." *Mehr News Agency* (Iran), May 10, 2020. (https://en.mehrnews.com/news/158530/IRGC-planning-to-place-satellite-in-geostationary-orbit-cmdr)
485. The Iran Alumina Company should not be confused with the Iran Aluminum Company (IRALCO), which the United States sanctioned in January 2020. Reuters Staff, "Factbox: Iran's metals under new U.S. sanctions," *Reuters*, January 14, 2020. (https://www.reuters.com/article/us-usa-iran-metals-factbox-idINKBN1ZD223)
486. For more: "Iran Alumina Company (IAC)," *Iran Watch*, September 28, 2021. (https://www.iranwatch.org/iranian-entities/iran-alumina-company); "درباره ما [About Us]," *Iran Alumina*, accessed August 17, 2022. (http://iranalumina.ir/392_درباره-ما.html)
487. Bozorgmehr Sharafedin and Pratima Desai, "Special Report: Inside Iran's secret project to produce aluminum powder for missiles," *Reuters*, June 24, 2020. (https://www.reuters.com/article/us-iran-missiles-programme-specialreport/special-report-inside-irans-secret-project-to-produce-aluminium-powder-for-missiles-idUSKBN23V1K1)
488. "یگان موشکی نیروی زمینی ارتش تشکیل شد [The Missile Unit of the Army's Ground Forces Was Formed]," *Tasnim News Agency* (Iran), February 13, 2022. (https://tn.ai/2662142)
489. "گزارش تسنیم از دستاورد جدید ارتش/ قدیمی‌ترین راکت‌های ایرانی«نقطه‌زن» شدند[Tasnim Report of the Artesh's Latest Attainment/ Iran's Oldest Rockets Became Precision-Strike]," *Tasnim News Agency* (Iran), October 5, 2019. (https://tn.ai/2111200)

Appendix A: Iran's Ballistic Missile Launches Since July 2015 (Post-JCPOA)[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,[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[492] to become guided rockets.[493]

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
August 2015	Test	1	Fateh-313[494]	SRBM	Solid
October 2015	Test	1	Emad[495]	MRBM	Liquid
November 2015	Test	1	Ghadr-110 (a.k.a. Ghadr-1/101)[496]	MRBM	Liquid
March 2016	Test/Drill	1	Ghadr-F[497]	MRBM	Liquid
March 2016	Test/Drill	2	Ghadr-H[498]	MRBM	Liquid

490. Behnam Ben Taleblu, "Iranian Ballistic Missile Tests Since the Nuclear Deal – 2.0," *Foundation for Defense of Democracies*, January 25, 2018. (https://www.fdd.org/analysis/2018/01/24/iranian-ballistic-missile-tests-since-the-nuclear-deal-2-0)

491. Such as the Khalij-e Fars, Hormuz 1 and 2, and the Zulfiqar-e Basir, "شعاع دایره خطر برای شناورهای آمریکایی بیشتر شد/ «ذوالفقار بصیر» را بیشتر بشناسید [The Radius of the Circle of Danger for American Vessels has Grown/ Get to Know The "Zulfiqar Basir" Better]," *Tasnim News Agency* (Iran), September 28, 2020. (https://tn.ai/2357961). All four derive from the Fateh family of SRBMs.

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?," *The Uncommon Defense*, May 20, 2020. (https://theuncommondefense.com/2020/05/20/did-iran-convert-a-dumb-rocket-into-a-guided-aeroballistic-missile)

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): "روایتی از قدرت بالستیک ایران/مقایسه توان موشکی قبل وبعد از انقلاب [A Story From Iran's Ballistic Power/Comparing Missile Capabilities From Before and After The Revolution]," *Mehr News Agency* (Iran), March 23, 2020. (https://www.mehrnews.com/news/4843936/روایتی-از-قدرت-بالستیک-ایران-مقایسه-توان-موشکی-قبل-وبعد-از-انقلاب). The list further includes the Labaik, which is a guided Nazeat rocket. See: "گزارش تسنیم از دستاورد جدید ارتش/ قدیمی‌ترین راکت‌های ایرانی«نقطه‌زن» شدند [Tasnim Report of the Artesh's Latest Attainment/ Iran's Oldest Rockets Became Precision-Strike]," *Tasnim News Agency* (Iran), October 5, 2019. (https://tn.ai/2111200).

494. "تصاویر + ۳۱۳ فاتح موشک شلیک لحظه [The Moment of Firing Fateh-313 Missile + Images]," *Tasnim News Agency* (Iran), August 22, 2015. (https://tn.ai/836241)

495. Sam Wilkin, "Iran tests new precision-guided ballistic missile," *Reuters*, October 11, 2015. (https://www.reuters.com/article/us-iran-military-missiles/iran-tests-new-precision-guided-ballistic-missile-idUSKCN0S505L20151011)

496. Louis Charbonneau and Michelle Nichols, "U.S. conducting 'serious review' of alleged Iran missile test," *Reuters*, December 8, 2015. (http://www.reuters.com/article/us-iran-missiles-usa-idUSKBN0TR2G920151208)

497. "First Missile Test after Nuclear Deal," *Iranian Diplomacy* (Iran), March 9, 2016. (http://irdiplomacy.ir/en/page/1957075/First+Missile+Test+after+Nuclear+Deal.html)

498. "Iran test-fires two ballistic missiles during large-scale drills," *Press TV* (Iran), March 9, 2016. (https://www.presstv.ir/Detail/2016/03/09/454681/iran-irgc-ballistic-missile-); "پیام موشکی سپاه به زبان «عبری» مخابره شد: ישראל צריכה להימחק מעל+تصویر [The IRGC's Missile Message Was Transmitted in 'Hebrew': Israel Should Be Wiped Out + Image]," *Fars News Agency* (Iran), March 9, 2016. (https://web.archive.org/web/20160322204149/http://www.farsnews.com/newstext.php?nn=13941219000316)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
March 2016	Test/Drill	1	Qiam-1[499]	SRBM	Liquid
March 2016	Test/Drill	1	Shahab-3[500]	MRBM	Liquid
April 2016	Test	1	Simorgh[501]	SLV	Liquid
April 2016	Test	1	Unknown[502]	Likely MRBM	Liquid (assumed)
July 2016	Test	1	BM-25 Musudan (later assumed Khorramshahr)[503]	MRBM (assumed; possibly IRBM)	Liquid
September 2016	Test	1	Zulfiqar[504]	SRBM	Solid
November 2016	Test	1	Qiam-1[505]	SRBM	Liquid
December 2016	Test	1	Shahab-3[506]	MRBM	Liquid
January 2017	Test	1	Khorramshahr[507]	MRBM	Liquid
June 2017[508]	Operation	<5	Zulfiqar[509]	SRBM	Solid
June 2017	Operation	>1	Qiam-1[510]	SRBM	Liquid
July 2017	Test	1	Unknown[511]	MRBM	Liquid (assumed)
July 2017	Test	1	Simorgh[512]	SLV	Liquid

499. United Nations Security Council, "Report of the Secretary-General on the implementation of Security Council resolution 2231 (2015)," July 12, 2016, page 6. (https://www.undocs.org/S/2016/589)
500. Ibid.
501. Tamir Eshel, "Simorgh First Launch – an Iranian Success or Failure?" *Defense Update* (Israel), April 24, 2016. (http://defense-update.com/20160424_simorgh.html)
502. "Iran tests missile capable of reaching Israel," *Associated Press*, May 9, 2016. (http://www.cbsnews.com/news/iran-ballistic-missile-test-launch-nuclear-deal-israel-middle-east)
503. Lucas Y. Tomlinson, "Iran conducts 4th missile test since signing nuke deal," *Fox News*, July 21, 2016. (https://www.foxnews.com/world/exclusive-iran-conducts-4th-missile-test-since-signing-nuke-deal)
504. "هدف به ذوالفقار موشک دقیق اصابت و شلیک لحظه/ فیلم) [Film/ The Zulfiqar Missile's Moment of Firing and Precisely Hitting the Target]," *Mashregh News* (Iran), September 25, 2016. (https://www.mashreghnews.ir/news/635200/فیلم-لحظه-شلیک-و-اصابت-دقیق-موشک-ذوالفقار-به-هدف)
505. United Nations Security Council, "Identical letters dated 28 June 2017 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," June 28, 2017. (https://undocs.org/S/2017/555)
506. Lucas Tomlinson and Jennifer Griffin, "Iran launched another ballistic missile in secret last month, US officials say," *Fox News*, January 31, 2017. (http://www.foxnews.com/world/2017/01/31/iran-launched-another-ballistic-missile-in-secret-last-month-us-officials-say.html)
507. Idrees Ali, "Iran tested medium-range ballistic missile: U.S. official," *Reuters*, January 30, 2017. (https://www.reuters.com/article/us-usa-iran-missiles/iran-tested-medium-range-ballistic-missile-u-s-official-idUSKBN15E2EZ)
508. Contrary to Western and Iranian press reporting, Israel believes Iran fired seven ballistic missiles during the operation, not six. See: United Nations, Security Council, "Identical letters dated 28 June 2017 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," June 28, 2017. (https://undocs.org/S/2017/555)
509. "قیام» سپاه با «ذوالفقار» بر سر تروریست‌ها فرود آمد" ['The Uprising' of the IRGC with the 'Zulfiqar' Landed on the Terrorists' Head]," *Fars News Agency* (Iran), June 19, 2017. (https://web.archive.org/web/20170623070056/http://www.farsnews.com/newstext.php?nn=13960329000517)
510. Ibid.
511. U.S. Department of State, Press Release, "Iran's Space Launch Vehicle Inconsistent With UNSCR 2231 Joint Statement by France, Germany, the United Kingdom and United States," July 28, 2017. (https://2017-2021.state.gov/irans-space-launch-vehicle-inconsistent-with-unscr-2231-joint-statement-by-france-germany-the-united-kingdom-and-united-states/index.html)
512. "Iran says it has launched a satellite-carrying rocket into space," *Associated Press*, July 27, 2017. (https://www.latimes.com/world/la-fg-iran-satellite-20170727-story.html)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
January 2018	Test	1	Shahab-3 variant (likely Ghadr or Emad)[513]	MRBM	Liquid
January 2018	Test	1	Scud variant (assumed Qiam-1 or Shahab-1/2)[514]	SRBM	Liquid
February 2018	Test	1	Zulfiqar[515]	SRBM	Solid
April 2018	Test	1	Khorramshahr[516]	MRBM	Liquid
May 2018	Test	1	Shahab-3 variant (likely Ghadr or Emad)[517]	MRBM	Liquid
May 2018	Test	1	Zulfiqar[518]	SRBM	Solid
June 2018	Test	1	Shahab-3 variant (assumed Ghadr or Emad)[519]	MRBM	Liquid
August 2018	Test	1	Qiam-1[520]	SRBM	Liquid
August 2018	Test	1	Zulfiqar[521]	SRBM	Solid
August 2018 (assumed)	Test	1	Fateh-Mobin[522]	SRBM	Solid
September 2018	Operation	7	Fateh-110 B[523]	SRBM	Solid
October 2018[524]	Operation	>2-3	Qiam[525] (modified warhead)	SRBM	Liquid

513. United Nations Security Council, "Identical letters dated 23 May 2018 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 24, 2018. (https://undocs.org/S/2018/495); United Nations Security Council, "Sixth report of the Secretary-General on the implementation of Security Council resolution 2231 (2015)," December 6, 2018. (https://undocs.org/S/2018/1089). Contrast with reporting here: Daniel-Dylan Böhmer, "Iran significantly expands missile testing," *Die Welt* (Germany), December 8, 2018. (https://www.welt.de/politik/ausland/article185208076/Nuclear-threat-Iran-significantly-expands-missile-testing.html)
514. Ibid.
515. United Nations Security Council, "Identical letters dated 23 May 2018 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 24, 2018. (https://undocs.org/S/2018/495); United Nations, Security Council, "Sixth report of the Secretary-General on the implementation of Security Council resolution 2231 (2015)," December 6, 2018. (https://undocs.org/S/2018/1089)
516. Ibid.
517. Ibid.
518. Ibid.
519. Ibid.
520. United Nations Security Council, "Identical letters dated 23 November 2018 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," November 26, 2018. (https://undocs.org/S/2018/1047)
521. Ibid.
522. "لحظه اصابت دقیق موشک بالستیک "فاتح مبین" 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)
523. Behnam Ben Taleblu, "Analysis: Iranian Missile Strikes Against Kurdish Dissidents in Iraq," *FDD's Long War Journal*, September 14, 2018. (https://www.longwarjournal.org/archives/2018/09/analysis-iranian-missile-strikes-against-kurdish-dissidents-in-iraq.php)
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.
525. "قیام» سپاه با «ذوالفقار» بر سر تروریست‌ها فرود آمد [The IRGC'S 'Uprising' with the 'Zulfiqar' Landed on the Head of The Terrorists]," *Fars News Agency* (Iran), June 19, 2017. (https://web.archive.org/web/20190414212716/https://www.farsnews.com/news/13960329000517/قیام-سپاه-با-ذوالفقار-بر-سر-تروریست-ها-فرود-آمد%E2%80%8C)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
October 2018	Operation	>3-4	Zulfiqar[526]	SRBM	Solid
December 2018	Test	1	Unknown[527] (possibly Khorramshahr "variant")[528]	MRBM (possibly IRBM)	Liquid (assumed)
December 2018	Test	1	Zulfiqar[529]	SRBM	Solid
January 2019	Test	1	Scud variant[530]	SRBM (assumed)	Liquid
January 2019	Test	1	Qiam-1[531]	SRBM	Liquid
January 2019	Test	1	Zulfiqar[532]	SRBM	Solid
January 2019	Test	1	Simorgh[533]	SLV	Liquid
February 2019	Test	1	Safir[534]	SLV	Liquid
February 2019	Test	1	Zulfiqar[535]	SRBM	Solid
February 2019	Test	1	Shahab-3 variant[536]	MRBM	Liquid
February 2019	Test	1	Shahab-3[537]	MRBM	Liquid
February 2019 (assumed)	Test	1	Dezful[538]	SRBM	Solid

526. Ibid.
527. Iran did not specify the MRBM. See: "Iran's latest ballistic missile test significant: Senior IRGC commander," *Press TV* (Iran), December 11, 2018. (https://web.archive.org/web/20190321161935/https://www.presstv.com/Detail/2018/12/11/582612/Iran-commander-Hajizadeh-missile-test-US-Secretary-of-State-Pompeo); United Nations Security Council, "Letter dated 7 March 2019 from the Chargé d'affaires a.i. of the Permanent Mission of the United States of America to the United Nations addressed to the President of the Security Council," March 15, 2019. (https://undocs.org/S/2019/216)
528. Jeremy Binnie, "Israel says Iran continues ballistic missile launches," *Janes* (UK), June 5, 2019. (https://www.janes.com/defence-news/news-detail/israel-says-iran-continues-ballistic-missile-launches)
529. United Nations, Security Council, "Identical letters dated 31 May 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 31, 2019. (https://undocs.org/S/2019/452)
530. Ibid.
531. Ibid.
532. Ibid.
533. United Nations Security Council, "Letter dated 7 March 2019 from the Chargé d'affaires a.i. of the Permanent Mission of the United States of America to the United Nations addressed to the President of the Security Council," March 15, 2019. (https://undocs.org/S/2019/216); Joseph Trevithick, "Iran's Satellite Launch Fails Amid News That Trump Admin Wanted Options To Strike Iran Last Year," *The Drive*, January 15, 2019. (https://www.thedrive.com/the-war-zone/25980/irans-satellite-launch-fails-amid-news-that-trump-admin-wanted-options-to-strike-iran-last-year)
534. United Nations Security Council, "Letter dated 7 March 2019 from the Chargé d'affaires a.i. of the Permanent Mission of the United States of America to the United Nations addressed to the President of the Security Council," March 15, 2019. (https://undocs.org/S/2019/216); Geoff Brumfiel, "Satellite Imagery Suggests 2nd Iranian Space Launch Has Failed," *NPR*, February 6, 2019. (https://www.npr.org/2019/02/06/692071812/satellite-imagery-suggests-second-iranian-space-launch-has-failed)
535. United Nations, Security Council, "Identical letters dated 31 May 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 31, 2019. (https://undocs.org/S/2019/452)
536. United Nations, Security Council, "Identical letters dated 2 April 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," April 3, 2019. (https://undocs.org/S/2019/288)
537. United Nations, Security Council, "Identical letters dated 31 May 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 31, 2019. (https://undocs.org/S/2019/452)
538. Persian_boy, "Iran Dezful ballistic missile 1000Km range, Underground missile plant موشك بالستيك دزفول," *YouTube*, February 7, 2019. (https://www.youtube.com/watch?v=wBVOJhY-QsA).

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
March 2019	Test	1	Unknown[539]	Unknown	Unknown
April 2019	Test	1	Fateh-110 variant[540]	SRBM	Solid
April 2019 (assumed)	Test	1	Shahab-3 with maneuvering RV[541] (potentially Emad)	MRBM	Liquid
May 2019	Test	1	Zulfiqar[542]	SRBM	Solid
July 2019	Test	1	Unknown[543] (E3 claimed Shahab-3)[544]	MRBM (assumed)	Liquid (assumed)
August 2019	Test	1	Unknown[545]	MRBM (assumed)	Unknown
August 2019	Test	1	Safir[546]	SLV	Liquid
January 2020[547]	Operation	>8[548]	Qiam (modified warhead a.k.a Qiam-2)[549]	SRBM	Liquid
January 2020	Operation	<8	Fateh-313[550]	SRBM	Solid

539. United Nations Security Council, "Identical letters dated 19 November 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," November 19, 2019. (https://undocs.org/en/S/2019/895)
540. Ibid.
541. United Nations Security Council, "Letter dated 21 November 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," November 27, 2019. (https://undocs.org/en/S/2019/911). The reference to a MaRV and Shahab-3 body likely means this was the Emad MRBM.
542. United Nations Security Council, "Identical letters dated 19 November 2019 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," November 19, 2019. (https://undocs.org/en/S/2019/895)
543. United Nations Security Council, "Identical letters dated 29 August 2019 from the Chargé d'affaires a.i. of the United States Mission to the United Nations addressed to the Secretary-General and the President of the Security Council," September 3, 2019. (https://undocs.org/en/S/2019/705)
544. United Nations Security Council, "Letter dated 21 November 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," November 27, 2019. (https://undocs.org/en/S/2019/911)
545. United Nations Security Council, "Identical letters dated 29 August 2019 from the Chargé d'affaires a.i. of the United States Mission to the United Nations addressed to the Secretary-General and the President of the Security Council," September 3, 2019. (https://undocs.org/en/S/2019/705)
546. United Nations Security Council, "Letter dated 21 November 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," November 27, 2019. (https://undocs.org/en/S/2019/911)
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)
548. However, U.S. government sources, which omit any reference to the Fateh-313, claim 11 Qiams were fired. See: Joseph Trevithick, "Everything New We Just Learned About The 2020 Iranian Missile Attack On U.S. Forces In Iraq," *The Drive*, March 3, 2021. (https://www.thedrive.com/the-war-zone/39527/everything-new-we-just-learned-about-the-iranian-missile-attack-on-al-asad-air-base)
549. Behnam Ben Taleblu, "Iran is increasingly using missiles in its military operations — that's a problem," *The Hill*, January 21, 2020. (https://thehill.com/opinion/international/479076-iran-is-increasingly-using-missiles-in-its-military-operations-thats-a)
550. "گزارش| استفاده از موشک‌های خانواده فاتح در عملیات انتقام سخت" [Report | The Use of Fateh Family Missiles in the Hard Revenge Operation]," *Tasnim News Agency* (Iran), January 8, 2020. (https://tn.ai/2177323); David S. Cloud and Chris Megerian, "Did Iran deliberately avoid U.S. casualties?," *Los Angeles Times*, January 8, 2020. (https://www.latimes.com/world-nation/story/2020-01-08/did-iran-deliberately-avoid-u-s-casualties)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
February 2020	Test	1	Simorgh[551]	SLV	Liquid
February 2020	Test	1	Ra'ad-500[552]	SRBM	Solid
April 2020	Test	1	Qased[553]	SLV	Mixed: One liquid, two solid[554]
July 2020[555]	Test/Drill	>1	Unknown[556] (alleged new, likely Fath)	Unknown (likely CRBM)	Unknown
July 2020	Test/Drill	>1	Fateh-110[557]	SRBM	Solid
August 2020 (assumed)	Test	1	Khorramshahr-2[558]	MRBM (possibly IRBM)	Liquid
August 2020	Test	1	Shahid Haj Qassem[559]	MRBM	Solid

551. United Nations Security Council, "Letter dated 20 February 2020 from the Permanent Representative of the United States of America to the United Nations addressed to the President of the Security Council," February 26, 2020. (https://undocs.org/en/S/2020/138)
552. "رونمایی از موشک رعد و موتور فوق پیشرفته سلمان در بهار انقلاب اسلامی + فیلم [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)
553. United Nations Security Council, "Letter dated 20 May 2020 from the Permanent Representative of the United States of America to the United Nations addressed to the President of the Security Council," May 21, 2020. (https://undocs.org/en/S/2020/428); Loren Grush, "Iran claims it has successfully launched a military satellite," *The Verge*, April 22, 2020. (https://www.theverge.com/2020/4/22/21230847/iran-military-satellite-rocket-launch-islamic-revolutionary-guard-corps)
554. "جزییات مهم از مرحله سوم ماهوارمبرهای سپاه+عکس [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)
555. Part of Great Prophet 14 military drill. At least one Fath missile. See: "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۲۵۰ کیلومتر+فیلم [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)
556. See comments by Amir-Ali Hajizadeh in: Joseph Trevithick, "Iran Touts Buried 'Missile Farms' Like Ones The United States Explored During The Cold War," *The Drive*, August 10, 2020. (https://www.thedrive.com/the-war-zone/35546/iran-touts-buried-missile-farms-like-ones-the-united-states-explored-during-the-cold-war); @Hajizadeh_org, *Twitter*, July 29, 2020. (https://twitter.com/Hajizadeh_org/status/1288398979592593408)
557. "شلیک موشک‌های سپاه از اعماق زمین / رونمایی از جدیدترین پهپاد رزمی سپاه پاسداران [Firing the IRGC's Missile From Deep Underground / Unveiling The Latest Military Drone of the IRGC]," *Khabar Online* (Iran), July 29, 2020. (https://www.khabaronline.ir/news/1415581/شلیک-موشک-های-سپاه-از-اعماق-زمین-رونمایی-از-جدیدترین-پهپاد)
558. "لحظه اصابت موشک خرمشهر-۲ به مرکز هدف + عکس [The Moment of Impact of the Khorramshahr-2 to the Center of the Target + Picture]," *Khabar Online* (Iran), August 16, 2020. (https://www.khabaronline.ir/news/1422418/لحظه-اصابت-موشک-خرمشهر۲--به-مرکز-هدف-عکس); Jeremy Binnie, "New footage of Iran's Khorramshahr missile test released," *Janes* (UK), August 17, 2020. (https://www.janes.com/defence-news/news-detail/new-footage-of-irans-khorramshahr-missile-test-released)
559. "تصاویر تست و شلیک موشک بالستیک «حاج قاسم» با برد ۱۴۰۰ کیلومتر [Images of the Test and Launch of the 'Haj Qassem' Ballistic Missile with a Range of 1,400 Kilometers]," *Barkhat* (Iran), August 20, 2020. (https://www.barkhat.news/political/159790908214/images-of-testing-and-firing-of-haj-qasem-ballistic-missile-with-a-range-of-1400-km)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
January 2021[560]	Test/Drill	~4[561]	Dezful[562]	SRBM	Solid
January 2021	Test/Drill	~4 [563]	Zulfiqar[564]	SRBM	Solid
January 2021[565]	Test/Drill	~2	Emad[566]	MRBM	Liquid
January 2021	Test/Drill	>1	Ghadr-F[567]	MRBM	Liquid
January 2021	Test/Drill	>2[568]	Sejjil[569]	MRBM	Solid

560. This test was part of the Great Prophet 15 military drill, whose first day featured Dezful and Zulfiqar solid-propellant ballistic missiles and Zelzal rockets. See: "IRGC stages drill by firing ballistic missiles (+video)," *Mehr News Agency* (Iran), January 15, 2021. (https://en.mehrnews.com/news/168560/IRGC-stages-drill-by-firing-ballistic-missiles-video). Day 2 featured at least six MRBMs. See: @inbarspace, *Twitter*, January 26, 2021. (https://twitter.com/inbarspace/status/1350540728108199937). Israel's report to the United Nations did not mention the exact number of each missile fired, contrary to previous practices. 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). Note that while E3 reporting to the United Nations declared that Iran had fired 13 SRBMs, including the Zulfiqar and Dezful, only eight could be verified via video. It is likely that the E3 conflated the Zelzal with one of these systems, which was also launched in the early part of this drill. Compare: @Auroraintel, *Twitter*, January 15, 2021. (https://twitter.com/i/web/status/1349996708038631425) with United Nations Security Council, "Letter dated 18 February 2021 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," February 19, 2021, page 2. (https://undocs.org/en/S/2021/163)

561. See line-up in: IMA Media • ایما مدیا, "Exclusive | IRGC Aerospace Force Missile and UAV Offensive drill, codenamed Prophet Mohammad 15.," *YouTube*, January 15, 2021. (https://www.youtube.com/watch?v=AyNxK3Zt3WA). Compare this drill with: "پهپاد انتحاری؛ تدبیر سپاه برای عبور از سپرهای دفاع موشکی/ رد بالستیک‌های ایران در اقیانوس هند| گزارش تسنیم از رزمایش پیامبر اعظم۵۱ [Suicide Drones; The IRGC's Prudence to Surpass Missile Defense Shields/ Traces of Iran's Ballistic [Missiles] in The Indian Ocean | Tasnim's Report]," *Tasnim News Agency* (Iran), January 16, 2021. (https://tn.ai/2433771)

562. "ببینید | غرش غرورآفرین موشک‌های بالستیک ذوالفقار، دزفول و زلزال [Watch | The Pride-Inspiring Roar of the Zulfiqar, Dezful, and Zelzal Ballistic [Missiles]]," *Khabar Online* (Iran), January 15, 2021. (https://www.khabaronline.ir/news/1476569/ببینید-غرش-غرورآفرین-موشک-های-بالستیک-ذوالفقار-دزفول-و-زلزال)

563. See line-up in: IMA Media • ایما مدیا, "Exclusive | IRGC Aerospace Force Missile and UAV Offensive drill, codenamed Prophet Mohammad 15.," *YouTube*, January 15, 2021. (https://www.youtube.com/watch?v=AyNxK3Zt3WA)

564. " ببینید | غرش غرورآفرین موشک‌های بالستیک ذوالفقار، دزفول و زلزال [Watch | The Pride-Inspiring Roar of the Zulfiqar, Dezful, and Zelzal Ballistic [Missiles]]," *Khabar Online* (Iran), January 15, 2021. (https://www.khabaronline.ir/news/1476569/-ببینید-غرش-غرورآفرین-موشک-های-بالستیک-ذوالفقار-دزفول-و-زلزال). There are at least 8 TELs for the Dezful and Zulfiqar seen in the video.

565. Note: While the E3 report to the UN identified at least 3 MRBMs, it is possible to detect more in the videos below. United Nations Security Council, "Letter dated 18 February 2021 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," February 19, 2021, page 2. (https://undocs.org/en/S/2021/163)

566. @inbarspace, *Twitter*, January 16, 2021. (https://twitter.com/inbarspace/status/1350540728108199937); IMA Media • ایما مدیا, "The second phase of the offensive drill of IRGC Aerospace force, code name the Prophet Mohammad 15.," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=tvCcvN8ww-4)

567. IMA Media • ایما مدیا, "The second phase of the offensive drill of IRGC Aerospace force, code name the Prophet Mohammad 15.," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=tvCcvN8ww-4); United Nations Security Council, "Letter dated 18 February 2021 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," February 19, 2021, page 2. (https://undocs.org/en/S/2021/163)

568. 3 Sejjil MRBMs are pictured, but one full launch and at least two solid-fuel plumes are detectable. @inbarspace, *Twitter*, January 16, 2021. (https://twitter.com/inbarspace/status/1350540728108199937?lang=en); IMA Media • ایما مدیا, "The second phase of the offensive drill of IRGC Aerospace force, code name the Prophet Mohammad 15.," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=tvCcvN8ww-4)

569. IMA Media • ایما مدیا, "The second phase of the offensive drill of IRGC Aerospace force, code name the Prophet Mohammad 15.," *YouTube*, January 16, 2021. (https://www.youtube.com/watch?v=tvCcvN8ww-4)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
(Revealed)[570] February 2021	Test	1	Zuljanah[571]	SLV	Mixed: Two solid, one liquid[572]
May 2021[573]	Test	1	Khorramshahr	MRBM	Liquid
June 2021[574]	Test	1	(Assumed) Simorgh	SLV	Assumed Liquid
June 2021[575]	Test	1	(Assumed) Simorgh	SLV	Assumed Liquid
November 2021[576]	Test	1	Khorramshahr (unclear if original or variant)	MRBM (possibly IRBM)	Liquid
November 2021[577]	Test	1	Fateh "type" missile	SRBM (possibly even CRBM)	Solid
December 2021[578]	Test	1	Zulfiqar	SRBM	Solid

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. "پرتاب تحقیقاتی ماهوارهبر ذوالجناح وزارت دفاع انجام شد + 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)
572. Some sources specify the order of this staging as solid-solid-liquid: @AmirIGM, *Twitter*, February 21, 2021. (https://twitter.com/amirigm/status/1356266728196628483); David Axe, "Iran's New Space Rocket Could Double As A Nuclear Missile," *Forbes*, February 1, 2021. (https://www.forbes.com/sites/davidaxe/2021/02/01/irans-new-space-rocket-could-double-as-a-weapon/?sh=17a968102d40). Other sources do not. See: "Iran's Home-Made 'Zoljanah' Satellite Carrier under Launch Tests," *Fars News Agency* (Iran), June 16, 2022. (http://fna.ir/1ph85x)
573. United Nations Security Council, "Identical letters dated 12 November 2021 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," November 12, 2021. (https://undocs.org/en/S/2021/949)
574. United Nations Security Council, "Letter dated 25 August 2021 from the Permanent Representative of the United States of America to the United Nations addressed to the President of the Security Council," August 26, 2021. (https://undocs.org/en/S/2021/753); Zachary Cohen and Oren Liebermann, "Pentagon tracked failed Iranian satellite launch and new images reveal Tehran is set to try again," *CNN*, June 22, 2021. (https://edition.cnn.com/2021/06/22/politics/iran-failed-satellite-launch/index.html)
575. United Nations Security Council, "Letter dated 25 August 2021 from the Permanent Representative of the United States of America to the United Nations addressed to the President of the Security Council," August 26, 2021. (https://undocs.org/en/S/2021/753)
576. United Nations Security Council, "Identical letters dated 25 May 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 25, 2022. (https://undocs.org/en/S/2022/421)
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.

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
December 2021[579]	Test/Drill	~8	Zulfiqar and Dezful (unknown what exact combination)[580]	SRBM	Solid
December 2021[581]	Test/Drill	~1	Sejjil[582]	MRBM	Solid
December 2021[583]	Test/Drill	~3	Ghadr and Emad (unknown what exact combination)[584]	MRBM	Solid

579. Iranian reports do not mention the number of each type of ballistic missile fired during the Great Prophet 17 drill, only the total, which they put at 16: "مرحله نهایی رزمایش پیامبر اعظم ۷۱ / از هشدار فرمانده کل سپاه به صهیونیست‌ها تا موشک‌باران اهداف [The Final Stage of the Great Prophet 17 Exercise / From a Warning of the IRGC Commander to the Zionists Until Missiles Rain Down on Targets]," *Bayanema* (Iran), December 24, 2021. (https://www.farsnews.ir/news/14001003000292;مرحله-نهایی-رزمایش-پیامبر-اعظم--۱۷-هشدار-فرمانده-کل-سپاه-به) "رزمایش پیامبر اعظم(ص)۷۱| تمرین عملیات موشکی بالستیک علیه اهداف ثابت و متحرک دشمن فرضی [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). The Zulfiqar and Dezful are pictured and reported, but Israeli reports to the UN secretary general assume the Ra'ad was also fired. See: United Nations Security Council, "Identical letters dated 2 March 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," March 2, 2022. (https://undocs.org/en/S/2022/177). By contrast, the E3 believes eight Zulfiqars and no Dezfuls were fired. See: United Nations Security Council, "Letter dated 31 January 2022 from the representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General and the President of the Security Council," January 31, 2022. (https://undocs.org/en/S/2022/73). For videos to cross-compare, see: @imamedia_org, *Twitter*, December 27, 2021. (https://twitter.com/imamedia_org/status/1475517866971742215); IRAN Military Power, "Great Prophet 17 Exercise - Missile and Drone Attack - Simulation of attack on Dimona nuclear base," *YouTube*, December 25, 2021. (https://www.youtube.com/watch?v=lf6S0YKDtHU). See also: "اصابت ۶۱ موشک به یک هدف / آخرین مرحله رزمایش پیامبر اعظم ۷۱ [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.mehrnews.com/news/5382931/اصابت-۱۶-موشک-به-یک-هدف-آخرین-مرحله-رزمایش-پیامبر-اعظم۱۷-)

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 • ایما مدیا, "Practicing attack on Weapons of Mass Destruction (WMD) facilities," *YouTube*, December 27, 2021. (https://www.youtube.com/watch?v=CHc72QEoyAY)

581. United Nations Security Council, "Letter dated 31 January 2022 from the representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General and the President of the Security Council," January 31, 2022. (https://undocs.org/en/S/2022/73)

582. See video and images here: "اصابت ۶۱ موشک به یک هدف / آخرین مرحله رزمایش پیامبر اعظم ۷۱ [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.mehrnews.com/news/5382931/اصابت-۱۶-موشک-به-یک-هدف-آخرین-مرحله-رزمایش-پیامبر-اعظم۱۷-); "مرحله نهایی رزمایش پیامبر اعظم ۷۱ / از هشدار فرمانده کل سپاه به صهیونیست‌ها تا موشک‌باران اهداف [The Final Stage of the Great Prophet 17 Exercise / From a Warning of the IRGC Commander to the Zionists Until Missiles Rain Down on Targets]," *Bayanema* (Iran), December 24, 2021. (https://www.bayanema.ir/news/92725/مرحله-نهایی-رزمایش-پیامبر-اعظم-۱۷-هشدار-فرمانده-کل-سپاه-صهیونیست-ها-موشک-باران-اهداف)

583. Compare E3 with Israeli reporting here: United Nations Security Council, "Identical letters dated 2 March 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," March 2, 2022. (https://undocs.org/en/S/2022/177); United Nations Security Council, "Letter dated 31 January 2022 from the representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General and the President of the Security Council," January 31, 2022. (https://undocs.org/en/S/2022/73)

584. Note that the video shows more MRBMs than media reports said were fired. Compare both E3 and Israeli estimates with: IRAN Military Power, "Great Prophet 17 Exercise - Missile and Drone Attack - Simulation of attack on Dimona nuclear base," *YouTube*, December 25, 2021. (https://www.youtube.com/watch?v=lf6S0YKDtHU). Compare with observable tests (one Sejjil, one Emad, and two Ghadrs) here: IMA Media • ایما مدیا, "Practicing attack on Weapons of Mass Destruction (WMD) facilities," *YouTube*, December 27, 2021. (https://www.youtube.com/watch?v=CHc72QEoyAY)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
December 2021[585]	Test/Drill	>2	Fath	CRBM	Solid
December 2021[586]	Test	1	Fateh-110 variant (of greater range)	SRBM	Solid
December 2021[587]	Test	1	Simorgh	SLV	Liquid
January 2022[588]	Test	1	Emad	MRBM	Liquid
February 2022[589]	Test	1	Kheibar Shekan	MRBM	Solid
February 2022[590]	Test	1	(Assumed) Zuljanah	SLV	Assumed mixed: Two solid, one liquid
March 2022[591]	Test	1	Qased[592]	SLV	Mixed: One liquid, two solid
March 2022[593]	Operation	10	Fateh family (likely Fateh-110)	SRBM	Solid

585. This test was also part of the Great Prophet 17 drill. See video of what appears to be the Fath here: "شلیک موشک‌های بالستیک و کروز دریایی توسط سپاه پاسداران [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 تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۲۵۰ کیلومتر+فیلم [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, "فیلم بخش‌های موشکی رزمایش پیامبر اعظم ۱۷ سپاه [Film of the Missile Parts of the IRGC's Great Prophet 17 Exercise]," *YouTube*, December 21, 2021. (https://www.youtube.com/watch?v=6YPkHc4mZRY)

586. See video: Hossein Daliran, "فیلم بخش‌های موشکی رزمایش پیامبر اعظم ۱۷ سپاه [Film of the Missile Parts of the IRGC's Great Prophet 17 Exercise]," *YouTube*, December 21, 2021. (https://www.youtube.com/watch?v=6YPkHc4mZRY). 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: "رزمایش پیامبر اعظم(ص) ۷۱| تمرین عملیات موشکی بالستیک علیه اهداف ثابت و متحرک دشمن فرضی [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)

587. United Nations Security Council, "Letter dated 3 January 2022 from the Chargé d'affaires a.i. of the United States Mission to the United Nations addressed to the President of the Security Council," January 4, 2022. (https://undocs.org/en/S/2022/3)

588. United Nations Security Council, "Identical letters dated 25 May 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 25, 2022. (https://undocs.org/en/S/2022/421)

589. Military Iran, "لحظه شلیک و اصابت به هدف موشک خیبر شکن [The Kheibar Shekan Missile's Moment of Launch and Impact Upon Target]," *YouTube*, February 10, 2022. (https://www.youtube.com/watch?v=qKToT8ly5uw)

590. @Inbarspace, *Twitter*, March 1, 2022. (https://twitter.com/inbarspace/status/1498793663861772294?)

591. United Nations, Security Council, "Letter dated 24 May 2022 from the representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General and the President of the Security Council," May 24, 2022. (https://undocs.org/en/S/2022/415). Note that this is only the second known or reported test of the Qased SLV, but Israeli reports appear to have conflated this SLV with a few others when reporting its launch to the secretary-general in 2022. The reports allege (incorrectly, in the view of this author) that there have been five. See: United Nations Security Council, "Identical letters dated 25 May 2022 from the Permanent Representative of Israel to the United Nations addressed to the Secretary-General and the President of the Security Council," May 25, 2022. (https://undocs.org/en/S/2022/421)

592. IMA Media • ایما مدیا, "Exclusive: footage of preparation and launch of NOUR-02 satellite on board Qased SLV," *YouTube*, March 10, 2022. (https://www.youtube.com/watch?v=fRfjUYSXUxI)

593. "Heavy Toll on Zionists Very Likely in IRGC Missile Attack on Erbil: Source," *Tasnim News Agency* (Iran), March 14, 2022. (https://www.tasnimnews.com/en/news/2022/03/14/2682015/heavy-toll-on-zionists-very-likely-in-irgc-missile-attack-on-erbil-source)

Date	Type of Launch	Number of Missiles	Missile Name	Missile Type	Propellant
June 2022[594]	Test	1	Zuljanah	SLV	Mixed: Two solid, one liquid
September 2022	Test/Drill	2[595]	Fath-360	CRBM	Solid
September 2022	Military Operation	73[596]	Fath-360	CRBM	Solid
October 2022	Test	1	Kavoshgar	SLV	(Assumed) liquid[597]
November 2022	Test	1	Qaem-100[598]	SLV	Solid
November 2022	Military Operation	>12[599]	(Assumed Fath family; Fath-360)	(Assumed CRBM)	Solid
November 2022	Military Operation	>1[600]	(Assumed Fath family; Fath-360)	(Assumed CRBM)	Solid

594. "دومین پرتاب ماهواره‌بر ذوالجناح انجام شد+ فیلم" [The Second Launch of The Zuljanah Satellite Carrier was Completed + Film]," *Islamic Republic News Agency*, June 26, 2022. (https://irna.ir/xjJPJZ)

595. At least one was tested. See: "نخستین پرتاب موشک راهبردی فتح ۳۶۰ + عکس ها" [The First Launch of the Fath-360 Strategic Missile + Pictures]," *Khabar Online* (Iran), September 9, 2022. (https://www.khabaronline.ir/news/1671914/نخستین-پرتاب-موشک-راهبردی-فتح-۳۶۰-عکس-ها); رصدکده, "موشک بردبلند فتح 360 برای اولین بار در رزمایش اقتدار ارتش عملیاتی شد" [The Fath-360 Long-Range Missile Was Operationalized for the First Time in the Army's Authority Exercise]," *YouTube*, September 8, 2022. (https://www.youtube.com/watch?v=RXr0R4of3WU). For video source, see: "رزمایش اقتدار 1401/ پرتاب موشک فتح ۳۶۰ برای اولین‌بار + فیلم" [Authority 1401 Exercise / Launch of the Fath-360 Missile for The First Time + Film]," *Fars News Agency* (Iran), September 8, 2022. (https://www.farsnews.ir/news/14010617000739/رزمایش-اقتدار-40-پرتاب-موشک-فتح-۳۶۰-برای-اولین‌بار--فیلم)

596. Assumes IRGC Hamzeh Sayyid al-Shohada Base Commander Mohammad-Taqi Osanloo incorrectly said 72 missiles used, when IRGC-GF Commander Mohammad Pakpour said 73. Compare: "تصاویری از مرکز عملیات سپاه پاسداران علیه تروریست‌های تجزیه طلب" [Images From the IRGC's Operation Center Against Separatist Terrorists]," *Mehr News Agency* (Iran), September 28, 2022. (https://www.mehrnews.com/news/5598936/تصاویری-از-مرکز-عملیات-سپاه-پاسداران-علیه-تروریست-های-تجزیه-طلب) with: "انهدام مواضع تروریست‌ها با ۳۷ فروند موشک بالستیک" [Destruction of Terrorist Positions with 73 Ballistic Missiles], *Mehr News Agency* (Iran), September 28, 2022. (https://www.mehrnews.com/news/5598901/انهدام-مواضع-تروریست-ها-با-۷۳-فروند-موشک-بالستیک)

597. Depending on how old the variant was, it may have employed solid-propellant instead.

598. "فیلم مراحل آمادسازی و پرتاب ماهواره‌بر قائم ۱۰۰" [Film of The Preparation and Launch of The Qaem-100 Satellite-Launch Vehicle]," *Mehr News Agency* (Iran), November 8, 2022. (https://www.mehrnews.com/news/5627757/فیلم-مراحل-آماده-سازی-و-پرتاب-ماهواره-بر-قائم-۱۰۰-)

599. Note: See canisters for missile estimate in photos. "جزییات دومین عملیات موشکی و پهپادی نیروی زمینی سپاه در اقلیم شمال عراق +تصاویر" [Details of The Second Missile and Drone Operation of the IRGC Ground Forces in The Northern Region of Iraq + Images]," *Tabnak* (Iran), November 14, 2022. (https://www.tabnak.ir/fa/news/1150334/جزییات-دومین-عملیات-موشکی-و-پهپادی-نیروی-زمینی-سپاه-در-اقلیم-شمال-عراق-تصاویر)

600. Note: since no accurate number of launches could be ascertained, the datapoint of "greater than or equal to one" serves a placeholder, and one is counted in the tally. "پاکپور: حملات سپاه تا خلع سلاح گروهک‌ها ادامه دارد" [Pakpour: The IRGC's Attack Continues Until The Disarming of The Groups]," *Tasnim News Agency* (Iran), November 22, 2022. (https://tn.ai/2808474)

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.[601] 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.[602] According to estimates, the Tondar-69 can carry a 190 kilogram high-explosive warhead for 150 kilometers.[603] 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).[604] 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.[605] 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.[606] 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.[607] 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.[608]

601. This assessment is shared here: Kenneth Katzman, "Iran's Long Range Missile Capabilities: Appendix III to the Report of the Commission to Assess the Ballistic Missile Threat to the United States," available at *Iran Watch*, July 15, 1998. (https://www.iranwatch.org/library/government/united-states/congress/legislation-reports/irans-long-range-missile-capabilities)

602. "چگونه وارد سازمان موشکی ایران شد؟/ موشک‌های 2هزار کیلومتری برای زدن رژیم صهیونیستی/ دستیابی مقاومت به موشک‌های «فاتح» تندر 69" [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 "69" suffix is assumedly a reference to the Persian procurement year, 1369, which corresponds with the year after the Iran-Iraq War's termination, 1989.

603. "Tondar-69 (M7, CSS-8)," *Missile Defense Advocacy Alliance*, June 5, 2018. (https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/iran/css-8-m-7)

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

605. *Missile Defense Cooperation in the Gulf*, Eds. Michael Elleman, Toby Dodge, Andrew Kelly, and Douglas Barrie (London: The International Institute for Strategic Studies, 2016), pages 20-21.

606. Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), page 51.

607. Behnam Ben Taleblu, "Analysis: Iranian Missile Strikes Against Kurdish Dissidents in Iraq," *FDD's Long War Journal*, September 14, 2018. (https://www.longwarjournal.org/archives/2018/09/analysis-iranian-missile-strikes-against-kurdish-dissidents-in-iraq.php)

608. Behnam Ben Taleblu, "Strikes on Iraq Reveal Iran's Embrace of Missile Operations," *The National Interest*, March 27, 2022. (https://nationalinterest.org/feature/strikes-iraq-reveal-iran%E2%80%99s-embrace-missile-operations-201431)

- **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

609. "تصاویر + ۳۱۳ فاتح موشک شلیک لحظه" [The Moment of Firing Fateh-313 Missile + Images]," *Tasnim News Agency* (Iran), August 22, 2015. (https://tn.ai/836241)
610. "بررسی عملکرد موشك فاتح 110 و 313+عکس" [Investigating the Performance of the Fateh-110 and 313 Missiles + Pictures]," *Islamic Revolution Documentation Center* (Iran), October 25, 2016. (https://irdc.ir/fa/news/329/بررسی-عملکرد-موشك-فاتح-110-و-313-عکس)
611. For more on the importance of this fuel, see: Roshan Sho, "جهشی عجیب در موشک های ایرانی با سوخت جامد مرکب ! [A Strange Leap in Iranian Missiles with Composite Solid Fuel]," *YouTube*, February 9, 2021. (https://www.youtube.com/watch?v=nY81WArVPZM); Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), pages 46-47.
612. "فتح قله‌های موشکی با «فاتح 313»/ تفاوت نقطه‌زن جدید با «شهاب 2" [Conquest of Missile Castles with The 'Fateh-313' / Differences of The New Precision-Strike and The 'Shahab-2']," *Defa Press* (Iran), August 24, 2015. (https://dnws.ir/51675)
613. "همه‌چیز درباره «فاتح و قیام» موشک‌های مورد استفاده در انتقام ایران از آمریکا + تصاویر"[Everything About The "Fateh" and "Qiam" Missiles That Were Used in Iran's Revenge Against America + Images]," *Young Journalists Club* (Iran), January 9, 2020. (https://www.yjc.ir/00UDfN)
614. "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۰۵۲ کیلومتر+فیلم" [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)
615. Behnam Ben Taleblu, "Assessing the Latest Iranian Ballistic Missile: The Zulfiqar," *Military Edge*, September 29, 2016. (https://web.archive.org/web/20161103023119/https://militaryedge.org/analysis-articles/assessing-latest-iranian-ballistic-missile-zulfiqar)
616. "گزارش: "خانواده موشک‌های فاتح" / "مبین" دومین موشک با مأموریت دوگانه + عکس" [Report: 'The Fateh Missile Family' Became 10 Members / The 'Mobin' is the Second Missile with a Dual Mission + Pictures]," *Tasnim News Agency* (Iran), August 14, 2018. (https://tn.ai/1801607)
617. One example: "قیام» سپاه با «ذوالفقار» بر سر تروریست‌ها فرود آمد" [The IRGC'S 'Uprising' with the 'Zulfiqar' Landed on The Head of The Terrorists]," *Fars News Agency* (Iran), June 19, 2017. (https://web.archive.org/web/20190414212716/https://www.farsnews.com/news/13960329000517/-ها-فرود-آمد%E2%80%8Cقیام-سپاه-با-ذوالفقار-بر-سر-تروریست)
618. " ببینید | غرش غرورآفرین موشک‌های بالستیک ذوالفقار، دزفول و زلزال" [Watch | The Pride-Inspiring Roar of the Zulfiqar, Dezful, and Zelzal Ballistic [Missiles]]," *Khabar Online* (Iran), January 15, 2021. (https://www.khabaronline.ir/news/1476569/ببینید-غرش-غرورآفرین-موشک-های-بالستیک-ذوالفقار-دزفول-و-زلزال)
619. "Iran Says it Fired 16 Ballistic Missiles During Annual Drill," *Associated Press*, December 24, 2021. (https://www.military.com/daily-news/2021/12/24/iran-says-it-fired-16-ballistic-missiles-during-annual-drill.html)
620. "ویژگی مهم «دزفول»؛ از بالک تا کلاهک/ موشک‌های نقطه‌زن ایرانی به اسرائیل رسیدند +عکس و نقشه [10 Important Features of the 'Dezful'; From Finlets to the Warhead/ Iran's Precision-Strike Missiles Have Reached Israel + Photo and Map]," *Mashregh News* (Iran), February 12, 2017. (https://www.mashreghnews.ir/news/936136/10-ویژگی-مهم-دزفول-از-بالک-تا-کلاهک-موشک-های-نقطه-زن-ایرانی)

operation. There is also no consensus on the Fateh Mobin's range in Persian-language sources.[621]

- **Dezful:** Unveiled in an underground missile production facility[622] 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 motor[627] 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

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: "ویژگی مهم «دزفول»؛ از بالک تا کلاهک/ موشک‌های 10 نقطه‌زن ایرانی به اسرائیل رسیدند +عکس و نقشه [Important Features of the 'Dezful'; From Finlets to the Warhead/ Iran's Precision-Strike Missiles Have Reached Israel + Photo and Map]," *Mashregh News* (Iran), February 12, 2017. (https://www.mashreghnews.ir/news/936136/10-ویژگی-مهم-دزفول-از-بالک-تا-کلاهک-موشک-های-نقطه-زن-ایرانی)

622. Persian_boy, "Iran Dezful ballistic missile 1000Km range, Underground missile bunker," *YouTube*, February 8, 2019. (https://www.youtube.com/watch?v=KaRDFAi3C1Q)

623. Persian_boy, "Iran Dezful ballistic missile 1000Km range, Underground missile plant موشك بالستيك دزفول," *YouTube*, February 7, 2019. (https://www.youtube.com/watch?v=wBVOJhY-QsA)

624. That assessment is also shared here: "ویژگی مهم «دزفول»؛ از بالک تا کلاهک/ موشک‌های نقطه‌زن ایرانی به اسرائیل رسیدند +عکس و نقشه [10 Important Features of the 'Dezful'; From Finlets to The Warhead/Iran's Precision-Strike Missiles Have Reached Israel + Photo and Map]," *Mashregh News* (Iran), Februrary 12, 2017. (https://www.mashreghnews.ir/news/936136/10-ویژگی-مهم-دزفول-از-بالک-تا-کلاهک-موشک-های-نقطه-زن-ایرانی)

625. "غرش غرورآفرین موشک‌های بالستیک ذوالفقار، دزفول و زلزال | ببینید [Watch | The Pride-Inspiring Roar of the Zulfiqar, Dezful, and Zelzal Ballistic [Missiles]]," *Khabar Online* (Iran), January 15, 2021. (https://www.khabaronline.ir/news/1476569/ببینید-غرش-غرورآفرین-موشک-های-بالستیک-ذوالفقار-دزفول-و-زلزال)

626. "Iran unveils "Raad 500" missile," *Iranian Students News Agency* (Iran), February 9, 2020. (https://web.archive.org/web/20200926131531/https://en.isna.ir/news/98112014837/Iran-unveils-Raad-500-missile)

627. For more, see: "زهیر»؛ جدیدترین موشک عملیاتی سپاه با برد ۰۰۵ کیلومتر + تصاویر» ['Zouhair': the IRGC's latest operational missile with a range of 500 km + images]," *Young Journalists Club* (Iran), September 28, 2022. (https://www.yjc.news/00Ybfe)

628. "تصاویر تست و شلیک موشک بالستیک «حاج قاسم» با برد ۱۰۴۰ کیلومتر [Picture of the Test and Launch of the "Haj Qassem" Ballistic Missile with a Range of 1,400 Kilometers]," *Fars News Agency* (Iran), August 20, 2020. (http://fna.ir/eyzq7f)

629. "گزارش تسنیم| «قاسم» برد موشک‌های تاکتیکی ایران را به اسرائیل رساند/ جدیدترین موشک بالستیک ایران چه مختصاتی دارد؟ [Tasnim's report | 'Qassem' Brought the Range of Iran's Tacticial Missiles to Israel/ What Peculiarities Does Iran's Newest Ballistic Missile Have?]," *Tasnim News Agency* (Iran), August 22, 2020. (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.[630] 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 launched[633] 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 17[636] 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] This 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

630. "۱۰ ویژگی مهم «دزفول»؛ از بالک تا کلاهک/ موشک‌های نقطه‌زن ایرانی به اسرائیل رسیدند +عکس و نقشه" [10 Important Features of the 'Dezful'; From Finlets to the Warhead/ Iran's Precision-Strike Missiles Have Reached Israel + Photo and Map]," *Mashregh News* (Iran), February 12, 2017. (https://www.mashreghnews.ir/news/936136/10-ویژگی-مهم-دزفول-از-بالک-تا-کلاهک-موشک-های-نقطه-زن-ایرانی)

631. "تصویر، مشخصات و ویژگی‌های موشک «شهید حاج قاسم» [Image, Specifications, and Features of the 'Shahid Haj Qassem' Missile]," *Hamshahri Online* (Iran), August 20, 2020. (https://www.hamshahrionline.ir/news/542055/تصویر-مشخصات-و-ویژگی-های-موشک-شهید-حاج-قاسم). For background on the technical critique, see the following section from Robert W. Buchheim's *Space Handbook: Astronautics and Its Applications* (Santa Monica, CA: RAND Corporation, 1958). Available online here: Robert W. Buchheim, "9. Flight Path And Orientation Control," *NASA*, accessed August 17, 2022. (https://history.nasa.gov/conghand/orient.htm)

632. "موشک فتح»؛ کوچک اما خطرناک/ سرباز جدید موشکی ایران را بیشتر بشناسید" [The 'Fath' Missile; Small But Dangerous/ Know Iran's Newest Missile Soldier Better]," *Fars News Agency* (Iran), August 24, 2020. (http://fna.ir/ezf6cy)

633. "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۰۵۲ کیلومتر+فیلم" [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)

634. For videos: "VIDEO: 'Great Prophet-14' military drill in south of Iran," *Mehr News Agency* (Iran), July 28, 2020. (https://en.mehrnews.com/news/161583/VIDEO-Great-Prophet-14-military-drill-in-south-of-Iran); Goorkan, "Iran IRGC Great Prophet 14 military drill In Persian Gullf and Strait Of Hormuz," *YouTube*, July 28, 2020. (https://www.youtube.com/watch?v=VTnhkJhuRCc)

635. "IRGC launches underground ballistic missiles in military exercise," *Tehran Times* (Iran), July 29, 2020. (https://www.tehrantimes.com/news/450649/IRGC-launches-underground-ballistic-missiles-in-military-exercise)

636. Videos and pictures of the drill have appeared online considerably later. See: @Pataramesh, *Twitter*, May 13, 2022. (https://twitter.com/Pataramesh/status/1525156948936691720)

637. "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۰۵۲ کیلومتر+فیلم" [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)

638. Ibid.

639. "Iranian Army Ground Force Test-Fires Strategic 'Fath 360' Missile," *Fars News Agency* (Iran), September 9, 2022. (https://web.archive.org/web/20220909163721/https://www.farsnews.ir/en/news/14010618000205/Iranian-Army-Grnd-Frce-Tes-Fires-Sraegic-'Fah-360'-Missile)

640. "گزارش تسنیم از سامانه موشکی فتح ۳۶۰ در رزمایش ارس" [Tasnim's Report from the Fath-360 missile system in the Aras Exercise]," *Tasnim News Agency* (Iran), October 17, 2022. (https://tn.ai/2789526)

2020.[641] The IRGC-GF used the Fath-360 in cross-border ballistic missile operations in 2022 against Iraqi Kurdistan.

- **BM-250:** This missile, both in range and size, is between the Fath CRBM and Fateh-110 SRBM. It contains several similar features as the early Fateh-family to include composite fuel and similarly shaped control and stabilization fins. While Iranian sources allege the BM-250 has been tested, the regime has not provided any video evidence or date for the test.[642]
- **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[643] 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.[644] The Kheibar Shekan was unveiled and tested[645] 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,[646] 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.[647] 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,[648] 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.[649] The Sejjil's stage-separation motors are easily identifiable,

641. One source even alleges that the Fath or BM-120 is also called the "Missile 360," further cementing that the Fath-360 is the Fath CRBM. See: "گزارش تسنیم از عضو جدید خانواده فاتح/ موشک ناشناخته ایرانی با برد ۲۵۰ کیلومتر+فیلم" [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)

642. "Iranian Army Ground Force Test-Fires Strategic 'Fath 360' Missile," *Fars News Agency* (Iran), September 9, 2022. (https://web.archive.org/web/20220909163721/https://www.farsnews.ir/en/news/14010618000205/Iranian-Army-Grnd-Frce-Tes-Fires-Sraegic-'Fah-360'-Missile)

643. Parisa Hafezi, "Iran unveils long-range missile as Vienna nuclear talks resume," *Reuters*, February 9, 2022. (https://www.reuters.com/world/middle-east/iran-unveils-missile-with-range-1450km-tasnim-2022-02-09)

644. "سردارحاجی زاده: موشک خیبرشکن دارای مانورپذیری برای عبور از سپر موشکی است" [Commander Hajizadeh: The Kheibar Shekan Missile Has Maneuverability to Surpass Missile [Defense] Shield[s]]," *Islamic Republic News Agency* (Iran), February 9, 2022. (https://irna.ir/xjHtXW)

645. Military Iran, "لحظه شلیک و اصابت به هدف موشک خیبر شکن" [The Kheibar Shekan Missile's Moment of Launch and Impact Upon Target]," *YouTube*, February 10, 2022. (https://www.youtube.com/watch?v=qKToT8ly5uw)

646. "سردار حاجی‌زاده: یک موشک راهبردی به زودی رونمایی می شود" [Commander Hajizadeh: A Strategic Missile Will Be Unveiled Soon]," *Islamic Republic News Agency* (Iran), February 7, 2022. (https://irna.ir/xjHt7N)

647. *Missile Defense Cooperation in the Gulf*, Eds. Michael Elleman, Toby Dodge, Andrew Kelly, and Douglas Barrie (London: The International Institute for Strategic Studies, 2016), page 22.

648. David E. Sanger and Nazila Fathi, "Iran Test-Fires Missile With 1,200-Mile Range," *The New York Times*, May 20, 2009. (https://www.nytimes.com/2009/05/21/world/middleeast/21iran.html)

649. "سردار حاجی‌زاده: اعزام نیرو به سوریه متوقف نشده/ موشک‌های ۲۰۰۰کیلومتری سپاه مخصوص زدن اسرائیل است" [Commander Hajizadeh: The Deployment of Troops to Syria Has Not Stopped/ The IRGC's 2,000-kilometer Missiles Are for Striking Israel]," *Tasnim News Agency* (Iran), March 9, 2016. (https://tn.ai/1023309)

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 MTCR'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

650. "موشک بالستیک سجیل؛ نماد توانمندی موشکی دور برد و دقیق ایران +فیلم[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/موشک-بالستیک-سجیل-نماد-توانمندی-موشکی-دور-برد-و-دقیق-ایران-فیلم)
651. "Missile Technology Control Regime (MTCR) Frequently Asked Questions," *U.S. Department of State*, accessed August 17, 2022. (https://www.state.gov/remarks-and-releases-bureau-of-international-security-and-nonproliferation/missile-technology-control-regime-mtcr-frequently-asked-questions)
652. "Iran Missile Milestones: 1985-2022," *Iran Watch*, June 29, 2022. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2020)
653. "پروژه شهاب ۱، نقطه آغازِ قدرت موشکی ایران + فیلم و تصاویر [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)
654. Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), pages 15-16.
655. "۱۶ موشک بالستیک ایرانی را بشناسید [Know 16 Iranian Ballistic Missiles]," *Borna* (Iran), March 24, 2020. (https://www.borna.news/fa/tiny/news-980774)
656. Michael Elleman, *Iran's Ballistic Missile Capabilities: A Net Assessment* (London: The International Institute for Strategic Studies, 2010), page 16.
657. "تولید موشک شهاب 1 و 2 متوقف شد/ هیچ یک از موفقیت‌های ایران با سازش بدست نیامده است [The Production of Shahab 1 and 2 Missiles Has Ceased/ Not a Single One of Iran's Successes Have Come About Through Compromise]," *Mashregh News* (Iran), November 23, 2016. (https://www.mashreghnews.ir/news/658451/تولید-موشک-شهاب-1-و2--متوقف-شد-هیچ-یک-از-موفقیت-های-ایران-با)
658. "موشکی که مخصوص هدف قرار دادن پایگاه‌های آمریکا است!+تصاویر [The Missile That Specializes in Targeting American Bases! + Images]," *Afkar News* (Iran), September 4, 2016. (https://www.afkarnews.com/بخش-سیاسی-3/547327-موشکی-که-مخصوص-هدف-قرار-دادن-پایگاه-های-آمریکا-است-تصاویر)
659. Michael Elleman, "Iran's Ballistic Missile Program," *Testimony Before the U.S. Senate Committee on Banking, Housing, and Urban Affairs*, May 24, 2016, page 3. (https://www.banking.senate.gov/imo/media/doc/052416_Elleman%20Testimony.pdf)
660. The jet vanes can be seen in most pictures of the missile's aft section.
661. "۱۶ موشک بالستیک ایرانی را بشناسید [Know 16 Iranian Ballistic Missiles]," *Borna* (Iran), March 24, 2020. (https://www.borna.news/fa/tiny/news-980774)

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-3[665] 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 tests[670] 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 range[671] 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

662. Joshua Pollack, "Iran's New Missile," *Arms Control Wonk*, August 23, 2010. (https://www.armscontrolwonk.com/archive/503101/irans-new-missile)
663. Behnam Ben Taleblu, "Analysis: Reported link between Houthi and Iranian ballistic missiles," *FDD's Long War Journal*, December 5, 2017. (https://www.longwarjournal.org/archives/2017/12/analysis-reported-link-between-houthi-and-iranian-ballistic-missiles.php)
664. Behnam Ben Taleblu, "A peek inside Houthi Rebel's recent missile strikes in Saudi Arabia," *FDD's Long War Journal*, March 28, 2018. (https://www.longwarjournal.org/archives/2018/03/a-peek-inside-houthi-rebels-recent-missile-strikes-in-saudi-arabia.php)
665. United Nations Security Council, "Letter dated 21 November 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," November 27, 2019, page 2. (https://undocs.org/en/S/2019/911)
666. See pictures: "همه‌چیز درباره «فاتح و قیام» موشک‌های مورد استفاده در انتقام ایران از آمریکا + تصاویر [Everything About the 'Fateh' and 'Qiam' Missiles That Were Used in Iran's Revenge Against America + Images]," *Young Journalists Club* (Iran), January 9, 2020. (https://www.yjc.ir/00UDfN); Ralph Savelsberg, "'Massive Improvement' In Accuracy Of Iran Missiles Over Scud-B," *Breaking Defense*, January 15, 2020. (https://breakingdefense.com/2020/01/massive-improvement-in-accuracy-of-iran-missiles-over-scud-b)
667. Charles P. Vick, "North Korean Missiles," *Federation of American Scientists*, October 20, 2016. (https://fas.org/nuke/guide/dprk/missile/nd-1.htm)
668. *Missile Defense Cooperation in the Gulf*, Eds. Michael Elleman, Toby Dodge, Andrew Kelly, and Douglas Barrie (London: The International Institute for Strategic Studies, 2016), page 18.
669. Michael Eisenstadt, *Iranian Military Power, Capabilities and Intentions* (Washington, DC: The Washington Institute for Near East Policy, 1996), page 28.
670. "Iran Missile Milestones: 1985-2022," *Iran Watch*, June 29, 2022. (https://www.iranwatch.org/our-publications/weapon-program-background-report/iran-missile-milestones-1985-2020)
671. "ویژه نامه قیام موشکی [Special Issue Missile Uprising]," *Islamic Revolution Documentation Center*, October/November 2016, pages 13-14. (http://94.182.131.132/files/fa/news/1395/10/27/872_436.pdf)
672. See Akbar Torkan's comments in: مستند پارتیزان [Partisan Documentary], "مستند نظامی بازدارنده قسمت اول//Deterrent Part One," *YouTube*, January 5, 2021. (https://www.youtube.com/watch?v=fsUf2Vak4y4). For more on the Iraqi project at Tuwaitha, see: David Albright, Corey Gay, and Khidhir Hamza, "Development of the Al-Tuwaitha Site: What If the Public or the IAEA had Overhead Imagery?," *Institute for Science and International Security*, April 26, 1999. (https://www.isis-online.org/publications/iraq/tuwaitha.html)

payload would remain safe until the re-entry vehicle reached its designated target, and that the payload would then function correctly."[673]

- **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.[674] Successive Ghadr variants have increased Iran's overall missile range, leading hardline Iranian media to classify the Ghadr-F as an "Israel-hitting missile."[675] The Ghadr, like the Shahab, can be retrofitted with different warheads and can deliver submunition payloads.[676] The Ghadr has featured prominently in Iranian missile drills and flight-tests that involve liquid-propellant systems.
- **Emad:** Debuted and tested by Tehran in 2015,[677] 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.[678] Iran launched the Emad during several military drills in 2021 known as Great Prophet 15[679] and Great Prophet 17.[680]

Rezvan: Tehran paraded a new single-stage MRBM called the Rezvan during a military parade in September 2022.[681] 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.[682]

673. International Atomic Energy Agency, Board of Governors, "Final Assessment on Past and Present Outstanding Issues regarding Iran's Nuclear Programme," December 2, 2015, page 13. (https://www.iaea.org/sites/default/files/gov-2015-68.pdf)
674. See categorization in: "Emad, Ghadr (Shahab-3 Variants)," *Center for Strategic and International Studies*, July 31, 2021. (https://missilethreat.csis.org/missile/emad)
675. Alongside other platforms. See: "موشک‌های اسرائیل‌زن"؛ سپاه از کجا می‌تواند تل‌آویو را هدف قرار دهد + تصاویر و نقشه" ['Israel Hitting Missiles'; From Where Can the IRGC Target Tel-Aviv + Image and Map]," *Tasnim News Agency* (Iran), September 23, 2017. (https://tn.ai/1527018); "موشک های «اسرائیل زن» ایران [Iran's 'Israel Hitting' Missiles]," *Nasim Online* (Iran), September 3, 2015. (https://www.nasim.news/fa/tiny/news-2018328)
676. "ویژه نامه قیام موشکی [Special Issue Missile Uprising]," *Islamic Revolution Documentation Center*, October/November 2016, page 17. (http://94.182.131.132/files/fa/news/1395/10/27/872_436.pdf)
677. Sam Wilkin, "Iran tests new precision-guided ballistic missile," *Reuters*, October 11, 2015. (https://www.reuters.com/article/us-iran-military-missiles/iran-tests-new-precision-guided-ballistic-missile-idUSKCN0S505L20151011)
678. See: Kyle Mizokami, "Iran's New Underground Missile Base Looks Mildly Terrifying. See for Yourself.," *Popular Mechanics*, November 5, 2020. (https://www.popularmechanics.com/military/aviation/a34576311/iran-underground-missile-base-video); Thomas Newdick, "Iran Now Has Mobile Ballistic Missile Launching 'Magazines' For Its Underground Bases," *The Drive*, November 4, 2020. (https://www.thedrive.com/the-war-zone/37440/iran-now-has-automated-missile-launching-magazines-for-its-underground-bases)
679. @AuroraIntel, *Twitter*, January 16, 2021. (https://twitter.com/auroraintel/status/1350363729947471872)
680. @inbarspace, *Twitter*, December 25, 2021. (https://twitter.com/inbarspace/status/1474838064446988288)
681. "رونمایی از موشک بالستیک «رضوان» [Unveiling of the 'Rezvan' Ballistic Missile]," *Fararu* (Iran), September 22, 2022. (https://fararu.com/fa/news/576381/رونمایی-از-موشک-بالستیک-رضوان); "ویژگی‌های موشک بالستیک «رضوان» [Features of the "Rezvan" Ballistic Missile]," *Iranian Students News Agency* (Iran), September 22, 2022. (https://www.isna.ir/news/1401063122690/ویژگی-های-موشک-بالستیک-رضوان)
682. Note: UN sources only refer to "unveiling." United Nations, Security Council, "Letter dated 22 November 2022 from the representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General and the President of the Security Council," November 23, 2022. (https://undocs.org/S/2022/878). This is corroborated by extant Persian-language reporting.

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.[683] The Musudan is a North Korean copy of a nuclear-capable Soviet submarine-launched ballistic missile. Iran likely tested the Khorramshahr[684] before publicly revealing and naming it in 2017.[685] 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.[686] 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.[687] In September 2019, Iranian outlets revealed that the Khorramshahr had a different, slenderer conical warhead than it did in 2017.[688]

683. Uzi Rubin, "The Global Reach of Iran's Ballistic Missiles," *Institute for National Security Studies*, November 2006. (https://www.inss.org.il/he/wp-content/uploads/sites/2/systemfiles/(FILE)1188302022.pdf)
684. Lucas Y. Tomlinson, "Iran conducts 4th missile test since signing nuke deal," *Fox News*, July 21, 2016. (https://www.foxnews.com/world/exclusive-iran-conducts-4th-missile-test-since-signing-nuke-deal)
685. Behnam Ben Taleblu, "FAQ after allegations of another ballistic missile test by Tehran," *FDD's Long War Journal*, September 28, 2017, (https://www.longwarjournal.org/archives/2017/09/faq-after-allegations-of-another-ballistic-missile-test-by-tehran.php)
686. "لحظه اصابت موشک خرمشهر-۲ به مرکز هدف" [The Moment of Impact of the Khorramshahr-2 to the Center of the Target]," *Alef* (Iran), August 16, 2020. (https://web.archive.org/web/20200817023413/https://www.alef.ir/news/3990526153.html)
687. United Nations Security Council, "Letter dated 25 March 2019 from the Permanent Representatives of France, Germany and the United Kingdom of Great Britain and Northern Ireland to the United Nations addressed to the Secretary-General," March 27, 2019, page 2. (https://undocs.org/S/2019/270)
688. "گزارش| تجهیز مهلک‌ترین موشک بالستیک ایران به کلاهک جدید/ سومین سر جنگی خرمشهر چه ویژگی‌هایی دارد؟" [Report | Equipping Iran's Most Deadly Ballistic Missile with a New Warhead/ What Traits Does the Khorramshahr's Third Warhead Have?]," *Tasnim News Agency* (Iran), September 22, 2019. (https://tn.ai/2101898)

Appendix C: Entities Supporting Iran's Ballistic Missile Program

Name	Type	U.S. Sanctions?[689]	EU Sanctions?[690]	Description[691]
Artesh (National military/ AJA) Ground-Forces (NEZAJA)	Military	No	No	Ground forces of Iran's national military. Recipient of shorter-range systems from Iranian military contractors. Recently developed a missile unit.[692]
IRGC[693]	Military	Yes	No	Iran's ideological military, tasked with safeguarding the revolution. Engages in terrorism and asymmetric warfare. Both supports and benefits from the missile program.
IRGC-AF[694]	Military	Yes	Yes, until October 2023	IRGC branch that employs missile and other long-range strike capabilities and oversees at least five different missile brigades.
IRGC-AF Al-Ghadir Missile Command[695]	Military	Yes	Yes, until October 2023	Unit of the IRGC-AF with operational control over Iran's missiles.
IRGC-AF Space Division[696]	Military	No, unless a broad definition of the IRGC-AF is applied[697]	No	IRGC-AF subunit in charge of space program.

689. Each entity that is on the Specially Designated Nationals (SDN) list can be found here: "Sanctions List Search," *U.S. Department of the Treasury, Office of Foreign Assets Control*, accessed August 17, 2022. (https://sanctionssearch.ofac.treas.gov)

690. Unless otherwise noted in footnotes, these entities can be found in Attachment 2 of Annex 2 of the JCPOA. See: Joint Comprehensive Plan of Action, Vienna, July 14, 2015, Annex 2, Attachment 2. (https://2009-2017.state.gov/documents/organization/245319.pdf). The date is derived from the implementation timeline found in Annex 5. See: Joint Comprehensive Plan of Action, Vienna, July 14, 2015, Annex 5. (https://2009-2017.state.gov/documents/organization/245324.pdf). The EU category applies to the UK, which was party to all EU sanctions on Iran until Brexit. Post-Brexit, the UK retains an autonomous sanctions regime but continues to adhere to the JCPOA implementation timeline. See: UK Foreign, Commonwealth, & Development Office, "The UK Sanctions List," July 20, 2022. (https://www.gov.uk/government/publications/the-uk-sanctions-list)

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.

692. "یگان موشکی نیروی زمینی ارتش تشکیل شد [The Missile Unit of the Army's Ground Forces Was Formed]," *Tasnim News Agency* (Iran), February 13, 2022. (https://tn.ai/2662142)

693. U.S. Department of Treasury, Press Release, "Fact Sheet: Designation of Iranian Entities and Individuals for Proliferation Activities and Support for Terrorism," October 25, 2007. (https://home.treasury.gov/news/press-releases/hp644)

694. "Islamic Revolutionary Guard Corps (IRGC) Aerospace Force," *Iran Watch*, August 24, 2020. (https://www.iranwatch.org/iranian-entities/islamic-revolutionary-guard-corps-irgc-aerospace-force)

695. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Supporters of Iran's Ballistic Missile Program and Terrorism-Designated Mahan Air," March 24, 2016. (https://home.treasury.gov/news/press-releases/jl0395)

696. See reference to this division in: "Iran utilizes satellite 'Noor' to track oil tankers to Venezuela: IRGC cmdr.," *Mehr News Agency* (Iran), June 8, 2020. (https://en.mehrnews.com/news/159574/Iran-utilizes-satellite-Noor-to-track-oil-tankers-to-Venezuela)

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.

Name	Type	U.S. Sanctions?	EU Sanctions?	Description
IRGC-QF	Military	Yes	Yes, until October 2023	Foreign and special operations branch of the IRGC. Has supported missile proliferation to militias in Iraq.[698] Members have engaged in the PGM project to bolster Hezbollah's missile capabilities.[699]
Artesh Research and Self-Sufficiency Jihad Research Organization (Artesh-RSSJO)[700]	Military affiliate	No	No	Artesh research entity that has helped turn the outdated Nazeat rocket into a guided system called the Labaik-1.
IRGC-AF Self-Sufficiency Jihad Organization (IRGC-AF-SSJO)[701]	Military affiliate	Yes	No	Research entity serving IRGC-AF. Engaged in missile research and flight testing.
IRGC Research and Self-Sufficiency Jihad Organization (IRGC-RSSJO)[702]	Military affiliate	Yes	No	IRGC research entity active in ballistic missile testing and production. Has supported Houthi ballistic missile capabilities.[703]
Iran Space Agency (ISA)	Government	Yes	No	Coordinates national space program and develops satellites and SLV technology.
Iran's Aerospace Research Institute (ARI)[704]	Government affiliate	Yes	No	Overseen by ISA and has ties to MODAFL. Develops rocket systems for Iran's SLV program.
Iran Space Research Center (ISRC)[705]	Government affiliate	Yes	No	ISA subordinate research entity involved in past SLV production.

698. John Irish and Ahmed Rasheed, "Iran moves missiles to Iraq in warning to enemies," *Reuters*, August 31, 2018. (https://www.reuters.com/article/us-iran-iraq-missiles-exclusive/exclusive-iran-moves-missiles-to-iraq-in-warning-to-enemies-idUSKCN1LG0WB)
699. IDF Editorial Team, "Hezbollah's Precision-Guided Missile Project," *Israel Defense Forces Website*, September 19, 2019. (https://www.idf.il/en/minisites/hezbollah/hezbollahs-precision-guided-missile-project)
700. "گزارش تسنیم از دستاورد جدید ارتش/ قدیمی‌ترین راکت‌های ایرانی«نقطه‌زن» شدند [Tasnim Report of the Artesh's Latest Attainment/ Iran's Oldest Rockets Became Precision-Strike]," *Tasnim News Agency* (Iran), October 5, 2019. (https://tn.ai/2111200)
701. U.S. Department of State, Press Statement, "U.S. Announces New Iran-related Sanctions," July 18, 2017. (https://2017-2021.state.gov/u-s-announces-new-iran-related-sanctions/index.html)
702. Ibid.
703. U.S. Department of the Treasury, Press Release, "Treasury Targets Iranian Individuals Providing Ballistic Missile Support to Yemen's Huthis," May 22, 2018. (https://home.treasury.gov/news/press-releases/sm0392)
704. This entity is also known as the Astronautics Research Institute. See: U.S. Department of State, Press Release, "New Sanctions Designations on Iran's Space Program," September 3, 2019. (https://2017-2021.state.gov/new-sanctions-designations-on-irans-space-program/index.html); "Aerospace Research Institute," *Iran Watch*, December 18, 2019. (https://www.iranwatch.org/iranian-entities/aerospace-research-institute)
705. U.S. Department of State, Press Release, "New Sanctions Designations on Iran's Space Program," September 3, 2019. (https://2017-2021.state.gov/new-sanctions-designations-on-irans-space-program/index.html); "Iran Space Research Center," *Iran Watch*, October 31, 2019. (https://www.iranwatch.org/iranian-entities/iran-space-research-center)

Name	Type	U.S. Sanctions?	EU Sanctions?	Description
Aerospace Industries Organization (AIO)[706]	Government affiliate	Yes	Yes, until October 2023	MODAFL subsidiary responsible for Iranian missile development. AIO logo can be found on most Iranian missiles and SLVs.
Amir Al Mo'menin Industries[707]	Government affiliate (contractor)	Yes	No	SHIG subsidiary that engages in missile research and production.
Defense Industries Organization (DIO)[708]	Government affiliate	Yes	Yes, until October 2023	MODAFL subsidiary responsible for weapons development. Has reportedly received missile guidance technology from China.
Fajr Industries Group[709]	Government affiliate (contractor)	Yes	Yes, until October 2023	AIO subsidiary developing precision-guidance systems and control technology. Has procured high-strength steel for missile components.
M. Babaie Industries[710]	Government affiliate (contractor)	Yes	Yes, until October 2023	Works on behalf of AIO for missile-related procurement.
Mizan Machine Manufacturing Group[711]	Government affiliate (contractor)	Yes	Yes, until October 2023	AIO front company used to procure machinery to transport missiles. Reportedly procured precision-guidance equipment for SHIG.
Sanam Industries Group[712]	Government affiliate (contractor)	Yes	Yes, until October 2023[713]	AIO subsidiary engaged in missile-related procurement.
Shahid Ahmad Kazemi Industries Group[714]	Government affiliate (contractor)	Yes	Yes, until October 2023	AIO subsidiary engaged in missile collaboration with North Korea and missile technology procurement.
Shahid Bagheri Industrial Group (SBIG)[715]	Government affiliate	Yes	Yes, until October 2023	AIO subsidiary overseeing Iran's solid-propellant program. SBIG has procured metals and materials from Chinese firm and oversees multiple affiliates.

706. "Aerospace Industries Organization (AIO)," *Iran Watch*, October 28, 2019. (https://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio)
707. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Key Ballistic Missile Entities in Iran," July 28, 2017. (https://home.treasury.gov/news/press-releases/sm0136)
708. "Defense Industries Organization (DIO)," *Iran Watch*, July 23, 2019. (https://www.iranwatch.org/iranian-entities/defense-industries-organization-dio)
709. U.S. Department of the Treasury, Press Release, "Treasury Takes Additional Measures to Combat Iranian WMD Proliferation Iranian Nuclear & Missile Firms Targeted," June 8, 2007. (https://home.treasury.gov/news/press-releases/hp447)
710. U.S. Department of the Treasury, Press Release, "Treasury Designates 24 Shipping Companies Affiliated with IRISL, Two Entities Tied to Iran's Aerospace Industries Organization," July 13, 2011. (https://home.treasury.gov/news/press-releases/tg1022)
711. U.S. Department of the Treasury, Press Release, "Treasury Takes Additional Measures to Combat Iranian WMD Proliferation Iranian Nuclear & Missile Firms Targeted," June 8, 2007. (https://home.treasury.gov/news/press-releases/hp447)
712. U.S. Department of the Treasury, Press Release, "Treasury Adds Two Entities to the List of Iranian Weapons Proliferators," June 18, 2006. (https://home.treasury.gov/news/press-releases/hp17)
713. Listed as Sanam Industrial Group.
714. U.S. Department of the Treasury, Press Release, "Treasury Designates 24 Shipping Companies Affiliated with IRISL, Two Entities Tied to Iran's Aerospace Industries Organization," July 13, 2011. (https://home.treasury.gov/news/press-releases/tg1022)
715. "Shahid Bagheri Industrial Group (SBIG)," *Iran Watch*, September 12, 2018. (https://www.iranwatch.org/iranian-entities/shahid-bagheri-industrial-group-sbig)

Name	Type	U.S. Sanctions?	EU Sanctions?	Description
Shahid Cheraghi Industries[716]	Government affiliate (contractor)	Yes	No	SHIG subsidiary that produces liquid propellant.
Shahid Hemmat Industrial Group (SHIG)[717]	Government affiliate	Yes	Yes, until October 2023	AIO subsidiary overseeing production of Iran's liquid-propellant missile program.
Shahid Eslami Research Center[718]	Government affiliate (contractor)	Yes	No	SBIG subsidiary functioning as an in-house research center.
Shahid Kalhor Industries[719]	Government affiliate (contractor)	Yes	No	SHIG subsidiary that produces missile launcher and other ground-support equipment.
Shahid Kharrazi Industries[720]	Government affiliate (contractor)	Yes	No	SBIG subsidiary that helps create missile guidance technology.
Shahid Moghaddam Industries[721]	Government affiliate (contractor)	Yes	No	SBIG subsidiary that produces motor casings.
Shahid Movahed Industries[722]	Government affiliate (contractor)	Yes	No	SHIG subsidiary that has facilitated Iran-DPRK missile ties.[723]
Shahid Nuri Industries[724]	Government affiliate (contractor)	Yes	No	SHIG subsidiary.
Shahid Sanikhani Industries[725]	Government affiliate (contractor)	Yes	No	SBIG subsidiary that helps cast and develop solid-propellant for missiles.

716. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Key Ballistic Missile Entities in Iran," July 28, 2017. (https://home.treasury.gov/news/press-releases/sm0136)
717. "Shahid Hemmat Industrial Group," *Iran Watch*, September 24, 2021. (https://www.iranwatch.org/iranian-entities/shahid-hemat-industrial-group-shig)
718. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Iranian Entities," January 4, 2018. (https://home.treasury.gov/news/press-releases/sm0246)
719. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Key Ballistic Missile Entities in Iran," July 28, 2017. (https://home.treasury.gov/news/press-releases/sm0136)
720. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Iranian Entities," January 4, 2018. (https://home.treasury.gov/news/press-releases/sm0246)
721. Ibid.
722. This entity is also known as Shahid Haj Ali Movahed Research Center. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Supporters of Iran's Ballistic Missile Program and Terrorism-Designated Mahan Air," March 24, 2016. (https://home.treasury.gov/news/press-releases/jl0395); U.S. Department of the Treasury, Office of Foreign Assets Control, 85 Federal Register 60520, "Notice of OFAC Sanctions Action," September 25, 2020. (https://www.federalregister.gov/documents/2020/09/25/2020-21154/notice-of-ofac-sanctions-action)
723. "UN Report Says Iran And North Korea Resumed Missile Cooperation," *Radio Free Europe/Radio Liberty*, February 9, 2021. (https://www.rferl.org/a/un-report-says-iran-and-north-korea-resumed-missile-cooperation/31093315.html)
724. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Supporters of Iran's Ballistic Missile Program and Terrorism-Designated Mahan Air," March 24, 2016. (https://home.treasury.gov/news/press-releases/jl0395)
725. U.S. Department of the Treasury, Press Release, "Treasury Sanctions Iranian Entities," January 4, 2018. (https://home.treasury.gov/news/press-releases/sm0246)

Name	Type	U.S. Sanctions?	EU Sanctions?	Description
Shahid Sattari Industries[726]	Government affiliate (contractor)	Yes	No	SBIG subsidiary that produces missile ground-support gear.
Shahid Shustari Industries[727]	Government affiliate (contractor)	Yes	No	SBIG subsidiary.
Shahid Varamini Industries[728]	Government affiliate (contractor)	Yes	No	SHIG subsidiary that produces guidance and control platforms.
Ya Mahdi Industries Group[729]	Government affiliate (contractor)	Yes	Yes, until October 2023	AIO subsidiary engaged in missile technology procurement.
Malek Ashtar University[730]	University	Yes	Yes, until October 2023	Reportedly has ties to IRGC, supports MODAFL research requirements, and has developed a missile instruction program with AIO.
Sharif University of Technology[731]	University	Yes	Yes, until October 2023	Provides research and development support to sanctioned missile-related entities such as MODAFL, IRGC, IRGC-AF, and AIO.

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