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CONSTRAINING IRAN'S MISSILE CAPABILITIES

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B | Foreign Policy at BROOKINGS

TABLE OF CONTENTS

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I. INTRODUCTION AND EXECUTIVE SUMMARY

For decades, the United States has sought to constrain Iran's missile program, both because it poses a conventional military threat to regional stability and because it can provide a delivery capability for nuclear weapons should Iran acquire them. But despite the efforts of the United States and others to impede Iranian procurement of missile-related materials, equipment, and technology and a succession of U.N. Security Council (UNSC) restrictions imposed largely to prevent Iran from acquiring nuclear weapons delivery systems, Iran has managed to acquire the largest and most diverse missile force in the Middle East.

The Iranian missile threat

Relying initially on missiles, components, and technology purchased mainly from North Korea and China, but increasingly making advances through indigenous efforts, Iran maintains a force of hundreds of liquid- and solid-propellant short- and medium-range ballistic missiles (SRBMs and MRBMs), now being augmented by land-attack cruise missiles. Although claiming to limit itself to ballistic missiles with a 2000 km range by order of the supreme leader and not yet launching ballistic missiles above that range, Iran pursues at least four paths that it could use to develop intercontinental ballistic missiles (ICBMs) capable of reaching the United States, including the development of space-launch vehicles (SLVs) based on technologies directly applicable to long-range ballistic missiles. While placing priority on indigenous development, Iran remains dependent on importing key components and materials. It is working on more accurate guidance systems to improve the military utility of its missiles and has fielded road-mobile missile launchers to promote their survivability against attack.

The Iranians see their missile force as an integral and indispensable part of their national defense strategy, fulfilling key strike roles traditionally taken by manned aircraft, but beyond the capabilities of an Iranian air force hobbled by many years of

sanctions. The missile program serves key Iranian goals: deterring attacks against Iran, providing warfighting capabilities if deterrence fails or Iran decides to initiate hostilities, supporting military capabilities of regional proxies such as Hezbollah and the Houthis, enhancing national pride and regional influence, and providing a nuclear delivery hedge if Iran decides to acquire nuclear weapons. The use of Iranian ballistic missiles is not just theoretical. Iran has fired ballistic missiles against Iraq during the Iraq-Iran war and against various non-state actor adversaries in neighboring states in recent years. Moreover, Iranian proxies have fired Iranian-supplied missiles and rockets at U.S. regional partners Israel, Saudi Arabia, and the United Arab Emirates (UAE).

Iran's missile program poses a serious threat to the security interests of the United States and its partners, both in the Middle East and beyond. Key U.S. objectives with respect to that program are to deter attacks and intimidation against the United States and its friends, impede quantitative and qualitative improvement in the regional missile capabilities of Iran and its proxies, maintain military capabilities that can degrade the ability of the missile forces of Iran and its proxies to achieve their objectives, and discourage and delay the development of missile capabilities that can reach beyond the region, including to Western Europe and the U.S. homeland.

The Trump administration's approach

President Trump has cited the absence of missile constraints in the Iran nuclear deal—officially called the Joint Comprehensive Plan of Action (JCPOA)—as one of its major flaws and a key reason he decided to withdraw from the agreement. By withdrawing from the JCPOA and re-imposing sanctions against Iran that were suspended under the deal, the administration hopes to place overwhelming pressure on Tehran and compel it to accept a comprehensive "new deal" meeting the 12 highly ambitious requirements outlined by Secretary of State Mike Pompeo in May 2018, including the halt of all uranium enrichment, the end of Iranian support to Middle East terrorist groups, and the withdrawal from Syria of all forces under Iranian command.[1] On the missile issue, the requirement is that "Iran must end its proliferation of ballistic missiles and halt further launching or development of nuclear-capable missiles."

While talking about a new comprehensive deal with Iran, administration officials do not seem to be looking to negotiate separate solutions to their various concerns about Iranian behavior, including a separate missile deal. Instead, they appear to be counting on their "maximum pressure campaign" to produce either a fundamental change in Iran's outlook and policies that would be reflected in an across-the-board capitulation to U.S. demands or, what many observers assume to be their true objective, the collapse of the Iranian regime.

Approach of other countries to Iran's missile program

The European response. While France, Germany, and the United Kingdom (the E3) have strongly opposed U.S. withdrawal from the JCPOA and have actively worked to circumvent U.S. sanctions in the interest of persuading Iran to remain in the deal, they generally share U.S. concerns about Iran's missile program. They have condemned Iranian missile launches as inconsistent with the missile restrictions of UNSC Resolution 2231, opposed Iran's missile-related assistance to its regional proxies, and encouraged negotiations aimed at placing restraints on Iran's missile capabilities and exports. But the 28 members of the European Union (EU) do not have a uniform view of the Iran missile threat and the means for dealing with it. While France and the United Kingdom

pushed hard for new EU missile sanctions against Iranian entities, the group failed to reach the consensus needed for their adoption.

The Russian response. Russia was a constructive partner in the JCPOA negotiations. But since the conclusion of the JCPOA—and the sharp deterioration in U.S.-Russian relations—the positions of Washington and Moscow on Iran issues have significantly diverged, including on the missile issue. Russia has been Iran's chief defender in the Security Council, vetoing a British draft resolution condemning Iran for supplying missiles to the Houthis in violation of the UNSC-mandated Yemen arms embargo and maintaining that Iran is respecting in good faith the call in Resolution 2231 to refrain from activities related to ballistic missiles "designed to be capable of delivering nuclear weapons."

Middle East state responses. Not surprisingly, the countries that are America's closest Middle East partners, Iran's major regional adversaries, and the most significant potential targets of Iranian and Iranian-assisted missile attacks—Israel, Saudi Arabia, and the UAE—are the strongest opponents of Tehran's missile program and the missile and rocket capabilities of Tehran's regional proxies. Unlike the Europeans, their preferred means of addressing missile threats from Iran and its proxies do not include direct negotiations with Iran. Instead, they prefer more coercive policy tools—sanctions, interdictions, and possibly pre-emptive military strikes.

Iran's opposition to missile constraints

Iran has repeatedly and adamantly rejected Western interest in constraining its missile capabilities. Notwithstanding evidence in the Iranian nuclear archive acquired by Israeli intelligence of an Iranian project to examine the integration of a nuclear payload into a re-entry vehicle for the Shahab-3 medium-range missile, Iranians argue that their missiles are designed exclusively to be armed with conventional munitions. Maintaining that their missile force is an essential part of their legitimate self-defense capabilities, they claim that their missile capabilities are needed to rectify a conventional military imbalance in the region created by the decades-old Western arms embargo against Iran and by the supply of advanced weapons systems by the United States and other Western countries to Iran's regional rivals. In response to appeals that Iran agree to missile talks, Iranian officials at all levels assert that Iran's missile capabilities are non-negotiable. They are often proud to publicly announce ballistic missile launches and other advances in indigenous missile development, as well as to acknowledge missile strikes against "terrorist" targets.

On the question of whether Iran will continue to observe a voluntary range limit of 2000 km on its ballistic missiles putatively established by Supreme Leader Ali Khamenei, Iranians have been ambiguous. On the one hand, they state that they have no need for missiles of longer range because the enemy targets they would need to strike are within 2000 km. On the other hand, they assert that they already have the scientific capability to build missiles of longer ranges, that they could build such missiles if the threat changes, and that they are under no legal obligation not to do so.

Policy tools to address the Iranian missile threat

For several reasons, reducing the Iranian missile threat is a formidable challenge. Iran already possesses extensive missile capabilities and the expertise indigenously to continue advancing those capabilities. It believes it faces major external threats

and regards its missile program as a critical means of addressing those threats and of promoting its regional political and security goals. Unlike in the case of its nuclear program, it does not consider itself under any legal obligation to limit its missile capabilities and does not face united international opposition to its missile program; it even receives support from key countries for its stance on missile issues.

Overcoming these obstacles—and promoting U.S. objectives against Iran's missile program—will require the simultaneous application and creative, rigorous implementation of a broad range of policy tools.

- National and multilateral **trade controls** (e.g., those of the Missile Technology Control Regime, or MTCR) and case-by-case, ad hoc **interdictions** (i.e., stopping specifically identified individual transfers of equipment, technology, and funds to and from Iran's missile program) will play an important role in impeding quantitative and qualitative improvement in the Iranian missile threat. The United States should continue to press key source countries (e.g., China) and transit and transshipment countries (e.g., UAE, Singapore, Malaysia) to strengthen their missile-related trade controls, and it should cooperate and share intelligence with countries in a position to interdict sensitive transactions. But these policy tools are of diminishing marginal utility in the face of the large size of Iran's force and the increasing sophistication of its indigenous missile production capability.

- This means that there will be an increasing need to rely on military capabilities—the mutually reinforcing set of offensive **attrition**, **missile defenses**, and **passive defenses**—and **declaratory policy** to deter, defend against, and deny the objectives of Iran's missile program.

    - To deter Iranian missile attacks and limit Iran's ability to achieve its warfighting objectives, the United States and its regional partners should further develop offensive military capabilities—ranging from cyber operations to kinetic pre-emptive means—to be able to carry out counterforce strikes against Iranian missile forces and production infrastructure, both before and during conflict.

    - While ballistic and cruise missile defenses are expensive, imperfect, and can be overwhelmed by Iranian increases in offensive missiles, they can help protect against attacks involving small numbers of missiles, complicate Iranian attack planning against specific targets, and provide U.S. regional partners a measure of confidence to withstand Iranian intimidation and threats. In cooperation with its partners, Washington should seek to enhance defenses against Iranian missiles, both regionally and extra-regionally (including potential future threats to Western Europe and the American homeland).

    - Upgrading passive defenses of key regional airbases, ports, command and control facilities, and other critical nodes—through such methods as hardening, concealment, duplication, and preparations for rapid repair—can reduce the vulnerability of protected assets to missile attack and degrade Iran's ability to meet specific regional military goals.

    - Under current U.S. declaratory policy, Iran will be held accountable for any direct or proxy attack that results in injury to U.S. personnel or damage to U.S. government facilities. Washington should consider extending that policy to cover direct Iranian missile attacks on partner countries unrelated to U.S. personnel and facilities

and to warn of appropriately strong responses to such Iranian actions as the flight testing or deployment of an ICBM capable of reaching the U.S. homeland or an intermediate-range ballistic missile (IRBM) capable of reaching all of Western Europe.

- **Sanctions and diplomatic pressure** will remain important policy tools to dissuade other countries from assisting Iran's missile program and to increase the prospects that Iran can be persuaded at some point to limit aspects of its missile program.
    - Given the low probability of further UNSC sanctions against Iran, the sanctions most likely to impact Iran's missile capabilities would be U.S. sanctions on third-party entities doing business with Iran's missile program. For this to be effective, Washington must be prepared to elevate the priority of constraining Iran's missile program—and potentially to incur costs—in bilateral relationships with countries having jurisdiction over such entities, such as China (and Hong Kong), Malaysia, Russia, Singapore, Turkey, and the UAE.
    - The United States and like-minded countries should engage in active public and private diplomatic efforts to underscore the threats posed by Iran's missile force, to warn countries like Russia and China of the implications for them of a growing Iranian missile force (including possible sanctions against their entities and a build-up of U.S. and partner missile defenses), to urge countries with influence in Tehran to press for missile restraint, and to improve receptivity to Iran-related counterproliferation and trade control efforts by the United States.

Diplomacy with Iran to promote missile restraint

The final policy tool for countering the missile threat from Iran and its proxies is direct diplomacy with Iran. Although this may be the tool many governments think of first when considering the missile issue, Iran's military reliance on missiles, its related refusal to engage in negotiations on its missile capabilities, and the confrontational state of U.S.-Iranian relations render negotiated restraint unlikely to be realistic anytime soon.

The other policy tools described above will therefore be the most promising ways of addressing the Iranian missile threat in the near term. If effective, they can complicate, slow, and impede Iran's missile activities; deter Iran from using missiles; and degrade the ability of Iran's missile force to achieve its military and political objectives. But these other tools cannot prevent a determined and resourceful country like Iran from pursuing missile activities. Ultimately, it is up to Iran to restrain its missile program.

So diplomacy with Iran should remain part of the overall toolkit, both because circumstances might change in the future to make missile negotiations more promising and because U.S. readiness to negotiate could help build international support for the other measures needed to deal with the Iranian missile threat in the event that diplomacy is not feasible.

Several negotiated restraint options, which could be pursued individually or in combination, are addressed in this report and are evaluated in terms of their likely effectiveness in reducing the threat, their monitorability, and their negotiability (i.e., the likelihood Iran would agree).

A number of those analyzed fall short on one or more of these criteria and do not appear promising to pursue for the foreseeable future, including: a ban on development of nuclear-capable missile systems, a ban on launches of all nuclear-capable systems, a ban on new types of missiles, a limit on the number of missile launches, a ban on possessing nuclear-capable missiles, and Middle East regional missile constraints.

This report's evaluation does, however, suggest that two potential negotiating objectives hold more promise in terms of reducing the Iranian missile threat, monitorability, and negotiability:

- *Banning Iranian launches of long-range rockets* (e.g., greater than a range of 2000 km), if accompanied by definitions and restrictions to prevent circumvention, could substantially reduce the Iranian missile threat to the U.S. homeland with high monitorability and consistent with Iran's claimed policy and current practice, but would not affect SRBM and MRBM systems.

- *Banning Iranian launches of rockets with multiple independently targeted re-entry vehicle (MIRV) payloads and launches of nuclear-capable rockets from air, sea, and submerged platforms* would impede in a highly monitorable way new attributes that would increase the warfighting capability, ability to penetrate missile defenses, and survivability of Iran's missile force. But it would not reduce the current Iranian missile threat, or increases in that threat, using other payload types and basing modes; this same lack of current impact may mean that Iran would be more willing to accept it.

A third potential negotiating objective might have promise if there is progress in reducing regional tensions or resolving key regional disputes: banning Iranian missile-related exports. This could limit increases in the missile threat from Iran's proxies, albeit not their current inventories or the direct threat posed by Iran's own missile force. Tehran presumably would be more willing to negotiate an export ban than limits on its own forces, and an improved regional situation might reduce Tehran's interest in using missile-related exports to promote its foreign policy objectives. Over time, the fact of continuing violations of an export ban probably would be detected.

Space-launch vehicles. Because SLVs are inherently capable of delivering nuclear weapons, any negotiated limits on long-range missiles should also apply to SLVs. However, if Iran is only prepared to accept meaningful limits on ballistic missiles if SLVs are permitted, the United States would need to decide whether the constraints on ballistic missiles that Tehran is willing to accept, at the negotiating price it is asking, are worth running the risk of allowing Iran to retain SLVs inherently capable of delivering nuclear weapons and serving as a technology testbed and breakout repository for an ICBM program. If the United States decides that permitting Iran to retain SLVs is worth the risk, various collateral constraints have been proposed to limit their weapons delivery potential.

Incentivizing Iranian missile restraint. Iran can be expected to seek compensation for any negotiated missile restraints. But what carrots would be reasonable to provide Iran would depend on the constraints it is willing to accept. If, for example, Tehran is only prepared to reaffirm or codify its existing position—that it does not need missiles that exceed 2000 km—it should expect to receive little in exchange. But if it is prepared to accept more significant limits, such as restrictions on flight tests of long-range missiles or a ban on missile-related exports, it could expect to receive more, such as a relaxation or suspension of U.S. missile-related sanctions.

U.S. missile diplomacy with Iran would presumably be embedded in a broader diplomatic effort to seek modifications of Iranian behavior in several areas of concern, including Tehran's nuclear program and its destabilizing role in the Middle East. Therefore, the question of incentivizing Iranian missile restraint would have to be considered in the context of the leverage available to promote Iranian restraint across the board—and how to allocate that leverage to achieve various negotiating objectives.

Looking ahead

Iran will continue efforts to improve the accuracy and lethality of its SRBMs and MRBMs and to expand its regional ballistic and land-attack cruise missile forces. Tehran also will continue to pursue several parallel paths to develop IRBMs capable of reaching all of Western Europe and ICBMs capable of reaching the U.S. homeland, at least as a hedge.

There is much the United States can do using the full spectrum of policy tools at its disposal to impede improvements in Iran's missile force and to mitigate its threat. The United States can help partner countries strengthen their trade and transshipment controls and can cooperate with them to enhance their attrition capabilities, their defenses against ballistic missiles and land-attack cruise missiles, and their passive defenses. Washington can also coordinate closely with partners to increase diplomatic pressure against Iran's missile program, to raise international awareness of the Iranian missile threat, to remain vigilant against Iranian missile-related procurement efforts, and to complete NATO's planned defenses against any future Iranian missile attack.

Many of those policy tools would be most effective if the United States had the full cooperation of the international community. In the current contentious international environment, that cooperation will not always be forthcoming. In particular, Russia, China, and other countries that have problematic bilateral relations with the United States and are sympathetic toward Iran may often oppose U.S. efforts. But the United States should continue to press hard on the Iranian missile issue with Russia, China, and other such countries.

While seeking international support for addressing the Iranian missile threat, the United States will also need to act unilaterally—including by further developing and deploying missile defenses, imposing U.S. sanctions when UNSC and other multilateral sanctions are not possible, using public diplomacy to raise awareness of the missile threat from Iran, developing attrition capabilities potentially applicable in Iran, and announcing declaratory policy regarding how the United States may respond to Iranian missile-related provocations.

But the above types of measures can only go so far in impeding and countering the Iranian missile threat. At the end of the day, it is Iran's choice whether to restrain its missile program. This is why the United States must be prepared, if the opportunity arises, to engage in direct diplomacy with Iran to seek restraint in its missile program.

That said, the near-term outlook for directly engaging Iran and negotiating meaningful missile limitations is poor. The Trump administration's maximum pressure campaign is putting great stress on the Iranian economy, but it is unlikely to force Iran to capitulate to U.S. demands that Tehran considers extreme and unjustified and that it believes are motivated by a desire to undermine the regime. Indeed, far from compelling Iran to rein in its missile capabilities, the administration's anti-Iran campaign may convince Iran's leaders that they should strengthen those capabilities against a growing American threat.

And if Iran decides to withdraw from the JCPOA and build up its nuclear program, the U.S.-Iranian confrontation could escalate—and conditions for Iranian missile restraint would deteriorate further.

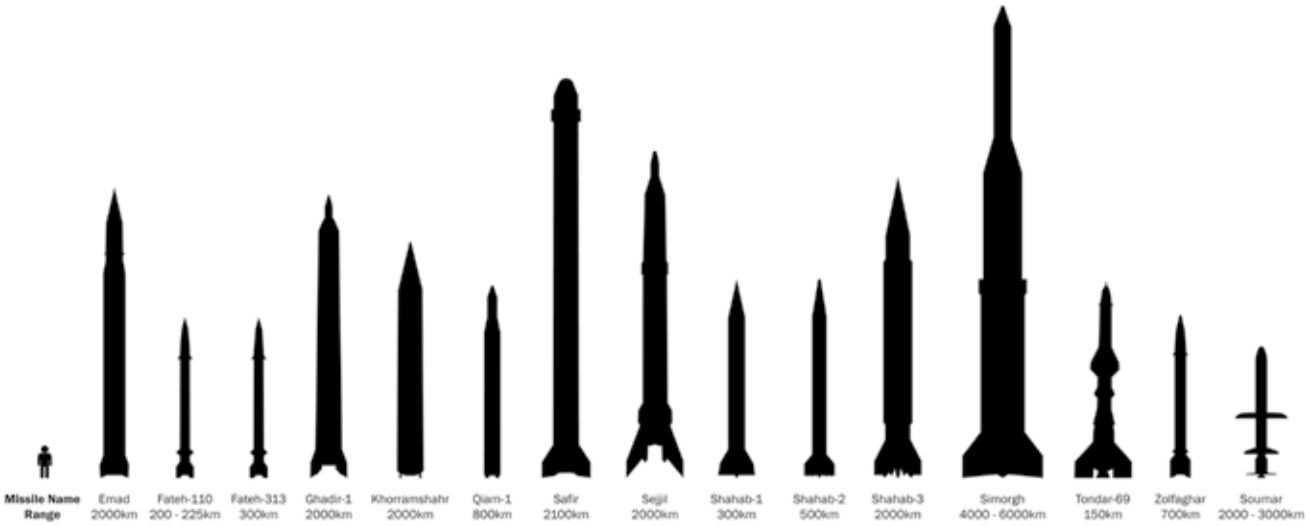
In these circumstances, it is hard to imagine productive engagement with Iran on its missile program in the next two years. Whether a successor U.S. administration will be in a better position to pursue negotiated limitations on Iran's missile activities will depend on a variety of factors, including whether the current U.S.-Iranian confrontation can be eased and whether talks on other issues, mainly on updating and extending the nuclear deal, can begin.

So, at least for the time being, the United States should focus its efforts to counter the Iranian missile threat on policy tools that do not require direct engagement with Iran or Iranian consent. Many of these efforts are already being pursued to varying degrees, and indeed have been pursued under several previous U.S. administrations. The United States should intensify these efforts, better integrate them, and elevate their priority in dealing with the overall Iranian challenge—and their priority in U.S. bilateral relations with key states. There is still much work the United States can do at present to address the Iranian missile threat.

II. IRAN'S MISSILE PROGRAM

Iran has worked since the mid-1980s along several tracks to acquire and develop a large and diversified force of SRBMs and MRBMs. It has produced a family of liquid-propellant missiles based on former Soviet Scud technology that was reverse engineered by North Korea, and a family of indigenously designed solid-propellant missiles based on Chinese propellant and guidance technology. It also has acquired more advanced liquid- and solid-propellant technologies (mostly from North Korea) that provide Iran with four major paths to IRBMs and ICBMs if it wishes to pursue them, and has reverse engineered a former Soviet long-range land-attack cruise missile (LACM). Iran has made substantial progress in developing the capability to produce these missiles indigenously, but remains dependent on foreign supply of key components and materials. It has, however, advanced to become a significant exporter of missiles, missile production capability, and missile technologies. Iran's missile programs have been assembled into a large, capable, well-exercised missile force integral to Iran's military strategy.

IRAN'S CURRENT MISSILE CAPABILITIES



Scud-based liquid-propellant missiles. The Islamic Republic began to acquire ballistic missiles to counter Iraqi attacks on Iranian cities in the Iran-Iraq War (1980-88).[2] It purchased 20 Soviet-origin Scud-B SRBMs with a 300 km range and two road-mobile launchers from Libya in 1985, at least 12 of these missiles from Syria in 1986, 120 Scud-B missiles reverse engineered by North Korea in 1987, and another 150-200 such missiles and four launchers from Pyongyang between 1988 and 1994.[3]

- This last deal included the transfer of production technology to permit Iran to begin producing indigenously its own North Korean Scud-B's, which it named Shahab-(Meteor-) 1s.

- As North Korea extended the range of its missiles, it offered them to Iran and its other export customers. Pyongyang created the 500 km range Scud-C SRBM by reducing the payload weight and making other modifications to the Scud-B. Iran purchased 100-170 Scud-Cs from North Korea in 1997, as well as the technology to produce what it termed the "Shahab-2" missile itself.[4] In 2010, Iran developed an improved version of the Shahab-2 called the "Qiam-1," with an 800 km range,

better accuracy, and a separating re-entry vehicle.[5] These systems can strike Iran's immediate neighbors, including the Gulf Arab states.

- In 1993, Iran purchased North Korean No Dong MRBMs with a 1300 km range—essentially having an enlarged Scud-B airframe and engine—and their production technology. The system allowed Iran to target Israel. But instead of deploying the No Dong outright, Iran performed its own improvement work on the missile system, conducting engine testing in 1997 and not deploying what it called the "Shahab-3" until 2003.[6] This shows how Iran has advanced its missile research, development, and production capabilities since the mid-1980s and has been able to build on missiles and missile technology acquired from North Korea and other countries.

- Since the early 2000s, Iran has been making further indigenous improvements to the Shahab-3 system to increase accuracy, lethality, and its range to up to 2000 km (both to strike targets at greater distances and to strike Israel from more secure positions within the Iranian interior).[7] These improvements include using aluminum instead of steel to reduce structure weight (and thus increase range), lengthening the airframe to accommodate additional propellant, and using improved guidance components for better accuracy. The improved versions include the Ghadr-1, with improved all-inertial accuracy, and the Emad, reportedly equipped with a terminally guided maneuvering re-entry vehicle (MaRV).[8]

Indigenous solid-propellant missiles based on imported technology. Liquid-propellant systems offer more energy (and thus range/payload performance) per unit of propellant. But they are difficult for troops to handle in the field, have a slower reaction time, and require a large number of propellant handling vehicles to accompany units when field-deployed, which reduces concealability. Solid-propellant missile systems have the potential to avoid these shortcomings, and thus it is no surprise that Iran has joined most other missile-reliant countries in developing them.

Instead of importing complete foreign solid-propellant missiles, however, Iran imported relevant production equipment and technology from China in the 1990s.[9] Using this technology, it developed, tested, and deployed through the 1990s and 2000s indigenously designed battlefield rockets—scaling up from small multiple launched bombardment rockets that are relatively easy to produce, through progressively larger systems, to rockets with ranges up to 300 km. Having thus gained sufficient experience and expertise with SRBM-sized rocket motors, Iran married this Chinese-origin solid-propellant technology with Chinese-origin guidance technology to begin developing its own indigenous ballistic missiles (i.e., large guided rockets).[10]

- Iran began developing the 200-225 km range "Fateh-110" solid-propellant SRBM in 1995, conducted the first flight test in 2001, and deployed the system in 2004.[11]

- It has since claimed to be developing variants of the Fateh-110 with anti-radar homing (Hormuz), with an anti-ship capability using an electro-optical sensor (Khalij Fars), and with longer range (the 300 km Fateh-313 and 700 km Zolfaghar). In October 2018, Iran claimed to have extended the range of its "land-to-sea ballistic missile" to 700 km, suggesting that the sensor of the Khalij Fars had been married up with the longer-range Zolfaghar booster.[12] The U.S. has confirmed that Iran has "flight-tested a short-range ballistic missile in an anti-ship role that can threaten U.S. and allied naval vessels in the Arabian Gulf and Strait of Hormuz."[13] In February 2019, Iran claimed to have developed a 1000 km range version of the Zolfaghar called "Dezful."[14]

- Iran also drew on this technology base to develop the two-stage "Sejil" (or Ashura) 2000 km range MRBM. Flight tested up to six times between 2008 and 2011,[15] Iran has claimed the system is deployed.[16] The lack of subsequent flight testing makes its deployment status uncertain, however.

Longer-range rocket systems. Iran since 2017 has claimed to be limiting itself to ballistic missiles of 2000 km range by order of the supreme leader,[17] and has not yet launched ballistic missiles beyond this range. Even so, Iran continues to pursue at least four major paths that it could use to develop ICBMs able to reach the United States, strongly indicating that it is at least actively hedging its bets to be able to deploy such systems in the future.

- **SLVs.** Iran has launched two different SLVs based on ballistic missiles, which have demonstrated technologies important for longer-range missiles (including stage separation and flight control of an upper stage) and could be used to carry re-entry vehicles as ballistic missiles if desired.
    - The "Safir" uses a stretched Shahab-3 MRBM as its first stage and a small liquid-propellant second stage of uncertain lineage. It has been launched eight times since 2008, four times successfully orbiting 50 kg-class satellites into low-earth orbits of up to 250 km.[18] Configured as a ballistic missile, which would need to be launched from a silo or roll-out site, one estimate (noting this would not offer much of an upgrade to Iran's current capabilities) is that the Safir could deliver a 500 kg payload to a range of 2100 km.[19]
    - The much larger "Simorgh," based at least externally on the North Korean Taepo Dong-2, uses a cluster of four Shahab-3 (No Dong) engines in its first stage and a second stage apparently using four steering engines from the Khorramshahr MRBM (see below).[20] At least one Simorgh launch also has used a small solid-propellant third stage.[21] The system was launched twice, in apparently unsuccessful flights in 2016 and 2017. In early January 2019, Iran announced that it would be launching three satellites using the Simorgh.[22] A launch on January 15 failed to orbit a satellite despite successful first and second stage operation due to inadequate velocity generated by its third stage; Iran subsequently announced that it would be ready in a few months to launch a second satellite.[23] One estimate is that the Simorgh used as a ballistic missile (which would need to be launched from a silo or roll-out site) could deliver a 500 kg payload to a range of 4000-6000 km (an "ICBM" is defined as having a range of at least 5500 km).[24]
    - If equipped with a different second stage based on the Shahab-3, akin to the two-stage version of the Taepo Dong-2, the Simorgh used as a ballistic missile (which would need to be launched from a silo or roll-out site) could deliver a "several hundred kilogram" payload some 7500 km (the distance from North Korea to Hawaii).[25] By also using a small third stage, as North Korea did with the Taepo Dong-2, such a Simorgh used as an ICBM could have a range similar to the three-stage Taepo Dong-2 of over 12,000 km.[26]
- **Khorramshahr/BM-25.** In 2005, Iran reportedly imported from North Korea 18 assembly kits for the Musudan ballistic missile, based on the former Soviet SS-N-6 liquid-propellant submarine-launched ballistic missile (SLBM).[27] The imported missiles were referred to as "BM-25s," suggesting these "**B**allistic **M**issiles" had an intended range of **25** hundred km. Given that the North Korean Musudan has

a range of up to 4000 km (IRBM range) with a 500 kg payload,[28] a 2500 km range system (an MRBM) suggests the use of a much heavier payload on the version imported by Iran. Iran first flight tested the BM-25 in 2016 (a failure) and then again in 2017 (apparently only a partial success).[29] The passage of over a decade between acquisition of the BM-25 and the first flight test suggests that, similar to the case of how Iran worked the North Korean No Dong into the Shahab-3, Iran took extensive time to make its own modifications to the Musudan/BM-25, which it subsequently named "Khorramshahr." Iran paraded the Khorramshahr missile on a road-mobile launcher in 2017, displaying a much larger nosecone than the Musudan—consistent with a much heavier payload.[30] Iran claims the Khorramshahr has an 1800 km payload and a 2000 km range.[31]The system was apparently tested again in December 2018.[32]

  - Clearly, therefore, the Khorramshahr has the potential to carry a lighter payload to a longer range, presumably akin to the 500 kg and 4000 km IRBM performance of the Musudan. Moreover, the SS-N-6-based missile uses much more energetic types of liquid propellants than Iran's Scud/No Dong-based Shahab series missiles, offering much better range/payload performance as well as the potential for use in even longer-range systems. As North Korea has done with its KN-08 and KN-14 road-mobile ICBMs that use two Musudan engines in their first stages, Iran has the potential to cluster Khorramshahr engines (as it did with No Dong engines in the Simorgh) and use them in multiple stages to develop a road-mobile ICBM of some 8000-10,000 km range.[33]

- **Large liquid-propellant rocket engine.** Various sources since 2013 suggest Iran has been receiving cooperation from North Korea in the development of a large liquid-propellant rocket engine suitable for ICBMs or SLVs.[34] A U.S. Treasury Department sanctions notice from January 2016 refers to Iranian work on a North Korean "80-ton rocket booster."[35] Although the "80-ton" figure might refer to the mass of an overall rocket stage or SLV (which would suggest something along the lines of the Simorgh/TD-2),[36] it is more likely, given traditional U.S. government naming conventions, that it refers to the engine's thrust—suggesting a much larger and more powerful rocket engine along the lines of the 80-ton thrust engine North Korea claimed to have ground tested in September 2016.[37]

  - North Korea's road-mobile Hwasong-12 IRBM and its Hwasong-14 and Hwasong-15 ICBMs apparently use an 80-ton thrust engine more capable than the engine of the Musudan/Khorramshahr,[38] and this may be the engine Iran is working on. The single-stage Hwasong-12 is estimated to have a 4500 km range; the two-stage Hwasong-14 a range of over 10,000 km; and the longer, two-stage Hwasong-15, using a cluster of two rocket engines in the first stage, a range of up to 13,000 km.[39] Iran's development of a similar rocket engine would give it a capability to develop road-mobile IRBMs and ICBMs.

- **Large solid-propellant rocket motor.** In November 2011, a development site in Iran, reportedly for long-range solid-propellant missiles, was destroyed in a huge explosion.[40] This was the first public indication that Iran was working on such systems, which would need much more energetic (and thus, explosive) propellants than used in Iran's current Fateh-110-based solid-propellant SRBMs and Sejil MRBMs. Press reports in May 2018 indicate that the program has continued at a new location where ICBM-class solid rocket motor production facilities and evidence

of ground testing of ICBM-class motors have been detected in open source imagery.[41] This appears to be a clear indication of development, testing, and production work directly applicable to an ICBM option. The origin of the technology for the more energetic solid propellant is unclear.

LACMs. LACMs (cruise missiles intended to attack land targets) provide Iran with a supplemental means of striking targets at longer ranges.[42] Although having a slower flight time than ballistic missiles, LACMs have the potential for high accuracy and are difficult to detect and intercept when flying at very low altitudes.

- Iran obtained 6 former-Soviet Kh-55 (AS-15) air-launched cruise missiles in 2001 from Ukraine via a criminal smuggling group. Although the 2800+ km range Kh-55/AS-15 was originally designed to carry a nuclear warhead,[43] the missiles in Ukraine were not equipped with warheads.[44] In 2012, Iran announced the existence of the 2000 km range "Meshkat" LACM, and in March 2015 displayed what it called the 3000 km range "Soumar" LACM that appeared to be a Kh-55 with a booster added to permit ground launch. Soumar presumably is the updated name of the Meshkat.[45] Iran has apparently tested the Soumar at least twice, in 2015 and 2017,[46] and thus the system may be deployed.

- Iran also has claimed to have developed a 700 km range air-launched LACM called "Ya-Ali."[47] The system does not appear to have been mentioned since 2015, so its status is unclear.

- The establishment of an indigenous production capability for the Soumar opens up the possibility for future indigenous Iranian LACMs with longer ranges.

Dependence on imported components and materials. Long subject to various international export restrictions and sanctions, the Islamic Republic has always prioritized the ability to produce its missile systems indigenously. It clearly has succeeded in being able to produce complete missile systems, both imported and indigenously designed (albeit based on foreign technology), and apparently also is able to produce major missile subsystems such as rocket engines and motors, guidance sets, thrust vector control systems (which steer missiles in flight), and re-entry vehicles. Iran no doubt is seeking to establish the ability to produce the underlying components and materials used to make complete missile systems and subsystems, which also means it must import associated production equipment and technology. But Iran remains dependent on importing many such components and materials, as well as their constituent subcomponents and materials.[48] Key items that Iran apparently continues to seek from abroad include:

- Guidance technologies to increase missile accuracy like gyroscopes, navigational sensors, gyrocompasses, and accelerometers;[49]

- Ultra high-strength steels and high-grade aluminum alloy used to make lighter rocket bodies for longer-range liquid-propellant missiles;[50]

- Ball bearings for use in liquid-propellant rocket engines;[51]

- Valves, electronics, and measuring equipment suitable for use in ground testing of liquid-propellant ballistic missiles and SLVs;[52]

- Production equipment and feedstock material for high-quality carbon fiber and aramid fiber (kevlar),[53] used to reduce weight in missile components like solid rocket motor cases (and thus increase missile range);

- Graphite cylinders that are machined to make heat-resistant lightweight missile parts like nozzle throats and re-entry vehicle nose tips (which again can help increase missile range);[54]

- Tungsten metal powder and tungsten-copper alloy plates used to make jet vanes for thrust vector control systems.[55]

Iran has obtained such items in the past, and likely will continue to do so in the future, from entities in China, North Korea, and Russia.[56] It also will continue trying to seek them from U.S. and Western entities despite largely effective export controls in these countries, in part by trying to disguise Iran as the true destination and misusing transshipment hubs such as the UAE, Hong Kong, Singapore, and Turkey.[57]

Missile technology exports. One key reason why the development of an indigenous missile production capability by Iran is of proliferation concern is because it provides Iran with the "secondary proliferation" capability to export missiles and missile production facilities to yet other countries and to non-state actors. Iran has unfortunately fulfilled this potential, becoming a significant missile technology exporter in cases such as the following:

- *Libya*: Iran reportedly agreed to supply technical assistance to the Gadhafi regime's ballistic missile program in the early 1990s,[58] and in the early 2000s was reportedly providing assistance to the regime's MRBM program.[59] The program ended with the end of the Gadhafi regime in 2011, if not when Gadhafi agreed to relinquish his weapons of mass destruction programs in 2003.

- *Syria*: Iran cooperated in establishing a production capability in Syria for the Fateh-110 SRBM, which the Syrians call the M-600.[60] Syria reportedly transferred some M600s to Hezbollah in 2010, in addition to Iran's own transfers of Fateh-110s (see below).[61]

- *Lebanese Hezbollah*: Iran has provided this group with over 100,000 unguided rockets of various ranges since 2006, beyond the 4000 Iran-provided rockets Hezbollah fired at Israel during their conflict in 2006. It also has reportedly provided Fateh-110 and Scud SRBMs, at least to the group in Syria. The group therefore can threaten targets throughout Israel. Moreover, Iran reportedly is working to provide a guidance capability for Hezbollah's formerly unguided rockets, thus substantially increasing their military utility. The U.S. government has also announced it has evidence that Iran is helping Hezbollah build missile production facilities.[62]

- *Hamas*: Iran also has supplied rockets of varying ranges to Hamas in the Gaza Strip.[63] Iran reportedly also has supplied rocket production technology.[64]

- *Palestinian Islamic Jihad*: Iran has reportedly also sent rockets to Palestinian Islamic Jihad in the Gaza Strip.[65]

- *Iraqi Shiite militias*: In December 2018, Secretary Pompeo announced at the U.N. that "Iran is transferring ballistic missile systems to Shia militias in Iraq,"[66] going beyond a November 2018 statement noting "credible reports indicate" this was

occurring." [67] Media reports in August 2018 claimed that Iran had transferred dozens of Fateh-110 and Zolfaghar SRBMs and Zelzal rockets, and possibly missile production facilities.[68]

- *Yemeni Houthis*: Secretary Pompeo also said the United States has "hard evidence that Iran is providing missiles, training, and support to the Houthis." This includes debris from Qiam-1 MRBMs launched by the Houthis at Saudi Arabia,[69] which has reported to the U.N. over 100 SRBM and battlefield rocket attacks by the Houthis between 2015 and 2017, including by 20 Iranian-supplied Qiam-1s and two Zelzal 2/3s.[70]

Not just a missile program, but a missile force. As discussed in Section III below, Iran relies on missiles to meet important national security and foreign policy objectives. In particular, Tehran relies on its missile programs as an integral part of its military strategy and conventional warfighting capability. It has therefore devoted substantial time, energy, and resources to amass and exercise a militarily significant and credible missile force.

Size: Iran has the largest ballistic missile force in the Middle East.[71] It is estimated to have deployed to military units upward of some 100 road-mobile launchers for SRBMs,[72] perhaps half as many road-mobile launchers for MRBMs,[73] and hundreds of associated missiles (perhaps over 1000).[74]

Lethality: Iran is assessed to deploy unitary high-explosive and submunition warheads on its missiles as part of payloads ranging in size from 250 to 1800 kg.[75] These relatively small payload sizes would require accurate delivery in order to threaten point targets, beyond the capability of the guidance systems used in Soviet Scud missiles.[76] Moreover, accuracy in inertially guided missiles degrades as a function of range, so for a given class of inertial guidance technology, SRBMs will be more accurate than MRBMs. Iran has recognized the need for more accuracy in order to increase the military utility of its missiles,[77] and so has been seeking more accurate inertial guidance components, augmenting inertial guidance with GPS satellite receivers on at least the Fateh-110,[78] and as noted above, has claimed to develop anti-radar and electro-optical terminal guidance and a maneuvering re-entry vehicle.

Survivability: The bulk of Iran's ballistic missile launchers are road-mobile. Iraq's experience in protecting all but a few of its mobile Scud launchers in the First Gulf War demonstrates that a properly operated mobile missile force can remain highly survivable during war, even in desert topography against a superpower military threat.[79] Iran has disguised some of its road-mobile launchers as civilian vehicles.[80] It also uses underground facilities to conceal and protect many aspects of its missile program,[81] including deploying a few missiles in silo launchers and some in underground launch facilities.[82]

Exercises: Iran also has put considerable effort into training its missile force to be able to conduct wartime operations in the field, with ballistic missile units participating frequently in larger military exercises and conducting troop training launches using operational missile units.[83]

III. GOALS OF IRAN'S MISSILE PROGRAM

Iran is widely assessed to pursue the following national security and foreign policy goals:

- to deter or thwart U.S. or other efforts to invade or intimidate Iran, or to bring about a change of regime (presumably the most important goal);
- to overturn a power structure in the Middle East that Iran's leaders assert favors its adversaries and to tilt the regional balance in Iran's favor; and
- to enhance Iran's international prestige and restore a sense of Persian "greatness."[84]

To help promote these goals, Iran has been developing, deploying, and operating a force of ballistic missiles and long-range land-attack cruise missiles. Iran's missile behavior and the specific types of missiles it is pursuing suggest this missile force is intended to perform five key roles in support of its overall national security and foreign policy goals:

- Deter aggression against Iran, and deter retaliation for Iran's conduct of low-level aggressive activities throughout the region.
- If deterrence fails, or as otherwise needed, engage in military operations against adversaries.
- Provide rocket and missile capabilities to allies and proxies.
- Enhance Iran's domestic and international prestige and influence.
- Maintain a capability to deliver nuclear weapons if Iran decides to develop them.[85]

Deterrence. Iran learned the hard way in the "War of the Cities" during the Iran-Iraq War in the 1980s the value of ballistic missiles as a terror weapon and in deterring missile attacks by others.[86] Since then, it has made a concerted effort to deploy and integrate into its conventional military a force of hundreds of SRBMs and MRBMs, now being augmented by LACMs. Taken together, these missiles give Iran the credible capability to strike many targets throughout the region. It uses this capability to deter coercion or attacks against Iran, as well as retaliation by others in response to Iranian acts of terrorism, proxy subversive activities, or interference with navigation in the Straits of Hormuz or Persian Gulf.

Warfighting. Iran's ballistic and land-attack cruise missiles are not just terror weapons to hold over adversaries, however. These missiles also are an integral part of Tehran's overall conventional warfighting capability, fulfilling key strike roles traditionally taken by manned aircraft in Western militaries, but beyond the capabilities of Iran's inferior and sanctions-hobbled air force (not to mention beyond the capabilities of Iran's proxies). The head of the Islamic Revolutionary Guard Corps' (IRGC) Aerospace Division (which oversees Iran's missile force) said on November 21, 2018 that Iran's missiles could strike U.S. bases in Afghanistan, the UAE, and Qatar, as well as U.S. ships in the Persian Gulf. "They are within our reach and we can hit them if they (the Americans) make a move."[87]

If deterrence fails or if Tehran decides to initiate hostilities, Iran's missile force and/or the missile forces of its proxies already have sufficient numbers and accuracy to launch large-scale strikes against regional targets to disrupt the use of ports and airbases (including for bringing in U.S. and other outside reinforcements), inflict civilian casualties, and cause panic.[88] As the accuracy of Iran's missiles improves, it also will increasingly be able

to strike point military, economic (e.g., oil, desalination), and political targets. Moreover, Iran claims to be developing anti-ship ballistic missiles that could support its existing access-denial strategy and harass shipping in the Straits of Hormuz and Persian Gulf.[89] Finally, given concerns about Iran's capability to produce, and its past and potentially present involvement with, chemical and biological weapons,[90] it also cannot be ruled out that Tehran would be able to use missiles armed with such weapons as a further disruption and panic multiplier.

And Iran's use of ballistic missiles in warfighting is not just theoretical.

- Iran launched 13 Scud-Bs in March 1985 and at least six in 1986 to retaliate against Iraqi attacks against Iranian cities, shocking Iraq and leading to a de facto missile launch moratorium.[91] In February-April 1988, Iraq resumed launches of some 190 missiles against Iranian cities in six weeks, having a major impact on Iranian morale (with over 25 percent of Tehran's population fleeing the city) that Iran's retaliatory launches of 77 Scud-Bs were insufficient to forestall.[92] This "War of the Cities," and the prospect that Iraq could conduct future missile attacks using chemical weapons, contributed importantly to Iran's decision to end the war.[93]

- Iran also fired Shahab-1 SRBMs in November 1994 (three to six missiles), June 1999 (three missiles), November 1999 (five missiles), and April 2001 (30 missiles) against camps of the anti-regime Mujahidin-e Khalq terrorist organization in Iraq.[94]

- According to Iranian media, in June 2017, Iran fired at least one Qiam-1 (modified Shahab-2) and five Zolfaghar SRBMs in a strike against ISIS militants in Syria's eastern Deir ez-Zor region in retaliation for ISIS terror attacks in Tehran.[95] Iran also announced similar strikes involving six Qiam-1 and Zolfaghar missiles in October 2018.[96]

- In September 2018, Iran announced launches of seven SRBMs against headquarters in Iraq of the Kurdistan Democratic Party of Iran and the Democratic Party of Iranian Kurdistan in retaliation for incursions into Iran.[97] The head of the IRGC, which controls Iran's ballistic missile force, also termed the strike a "message to the … superpowers who think they can impose their evil plots on Iran and bully us."[98]

- In January 2019, Israel reported that Iranian forces near Damascus, Syria had launched a "medium-range missile" into the Israeli-occupied Golan Heights.[99] The missile was reportedly intercepted by Israel's Iron Dome missile defense system.[100]

Supplying proxies. As detailed above, Iran has provided Lebanese Hezbollah, Hamas in the Gaza Strip, and to the Houthis in Yemen with varying combinations of unguided rockets, SRBMs, MRBMs, guidance technology, and missile production capability. These rocket and missile capabilities are potential additions to Iran's own missile threats to Israel and the Gulf States, which help further deter attacks on Iran or deter retaliation for Iranian mischief-making, and help Iran expand its regional influence and control (including over the proxies themselves). These rockets and missiles also provide options for independent strikes by proxies in support of their own regional agendas, or strikes in furtherance of Iranian interests that are quasi-deniable by Tehran. Whether or not in league with Iran, these rocket and missile forces permit strikes against regional states and U.S. bases from different directions than direct strikes from Iran and with different flight times—both of which can complicate the task of Israeli, Gulf Arab, and U.S. missile defenses.

Prestige and influence. Iran has long used missile tests, parades, and exercises (and associated propaganda, such as the October 2015 televising of the interior of an underground storage facility for Shahab-3 MRBMs on mobile launchers) to underscore its technological and military prowess, intimidate regional adversaries, and complement its other forms of regional influence.[101] These same perceptual attributes add to the ability of missile forces to intimidate and, if necessary, coerce Iran's adversaries. Iran's provision of missiles to its proxies allows them to do the same to some extent. The inherent capability of many of Iran's short- and medium-range missiles to carry nuclear weapons adds to the prestige and influence factor.

Nuclear delivery hedge. Those Iranian ballistic and cruise missiles capable of delivering a payload of at least 500 kg to a range of 300 km are designated as Category I missile systems by the 35-nation MTCR in its Equipment and Technology Annex—and therefore are internationally regarded as inherently capable of delivering nuclear weapons.[102] Such missiles are physically capable of delivering a payload with a weight representative of a first-generation nuclear warhead (500 kg) to a range of regional strategic significance (300 km), irrespective of whether they were designed, intended, or tested to do so. Beyond this inherent technical capability, Iran at least studied developing a nuclear warhead for the Shahab-3 MRBM in the early 2000s.[103] Thus, should Tehran decide to acquire nuclear weapons, its ballistic missile force provides a readily adaptable capability for delivering them. It currently has such an inherent delivery capability regionally, and its apparent ongoing efforts (noted in Section II above) to develop at least a hedge for IRBMs and ICBMs mean that it can decide to have an inherent nuclear delivery capability in the future against all of Western Europe and against the U.S. homeland .[104] Iran's ongoing pursuit of an SLV program also provides the inherent technical capability to deliver nuclear weapons directly, as well as a technology base and potential cover for the development of IRBMs and ICBMs.

IV. U.S. OBJECTIVES REGARDING IRAN'S MISSILE PROGRAM

Iran's large and growing ballistic missile and land-attack cruise missile force can strike a wide variety of targets throughout the region with short flight times, is difficult to intercept once launched, and has improving accuracy. Iran has also made it a point to demonstrate these capabilities, through media exposure, parades, exercises, test launches, and as noted above, missile strikes against non-state adversaries. These capabilities, in conjunction with the missile force's role in Iran's pursuit of policy interests adversarial to those of the United States and U.S. regional partners, give Iran's missile force the potential to pose the following key threats to the United States, and its forces, friends, and interests:

- Disrupt U.S. basing in and reinforcement of the Middle East region;
- Intimidate or coerce U.S. regional friends (and seriously damage and disrupt them in an actual conflict)—directly and/or via proxies;
- Add to the threat Iranian naval and anti-ship cruise missile forces pose to U.S. naval operations and sea lines of communication within the Gulf and potentially the Arabian Sea; and
- Expand these threats in the future by being able to strike targets beyond the region (in Western Europe and even the continental U.S.), and by the possibility of nuclear weapons delivery. (As State Department Special Representative for Iran Brian Hook put it, "History tells us clearly that advancements in ballistic missile systems often go hand in hand with the development of nuclear weapons. … [B]allistic missiles are the most likely way that Iran would deliver a nuclear warhead."[105])

One can posit five key objectives the United States should be pursuing specifically against the above threats posed by Iran's missile force:

1. Deter attacks and intimidation against the United States and its friends;
2. Impede qualitative and quantitative improvements to the regional missile capabilities of Iran and its proxies;
3. Posture offensive and defensive military capabilities that can degrade the ability of Iran's (and its proxies') missile programs to achieve their warfighting objectives;
4. Dissuade and delay development of missile capabilities that can reach beyond the immediate region, especially to the continental United States; and
5. Dissuade and delay acquisition of nuclear warheads for Iran's missiles.

Deter attacks and intimidation against the United States and its friends. This is an overriding U.S. objective vis-à-vis Iran, and of course applies not just to Iran's missile force but to any form of Iranian attack or intimidation. Given the centrality of missiles in Iran's military strategy and warfighting approach, deterrence of missile-based attack and intimidation by Iran and its proxies would be particularly important, and would help undermine the credibility of Iranian options to escalate.

Impede qualitative and quantitative improvements to the regional missile capabilities of Iran and its proxies. These regional missile capabilities already exist, but it remains worthwhile to take steps to impede them from improving. Reducing the number, extent, and/or pace of such improvements—and making improved missile capabilities more

costly and less effective and reliable than would otherwise be the case—limits the growth of the threat, reduces the potential political and military pressure on U.S. regional friends, and eases the task of missile defense and other options for coping with the threat. But the pursuit of this objective has diminishing marginal utility due to Iran's substantial current quantitative and qualitative capabilities, the natural diffusion of improved missile-usable technologies (e.g., GPS), and the persistent inability of China and Russia to prevent Iran's missile program from obtaining advanced technology from and through their entities and territories.

Posture offensive and defensive military capabilities that can degrade the ability of Iran's (and its proxies') missile programs to achieve their warfighting objectives. The missile forces of Iran and its proxies already pose significant regional threats, and quantitative and qualitative growth in that regional threat can be impeded but not prevented. Thus, the United States and its friends increasingly will have to rely on their own military capabilities to deny Iran and its proxies the military benefits of attacks and intimidation using missiles. Such reliance can bolster deterrence of missile attacks and intimidation by Iran and its proxies, provide options to pre-empt an imminent Iranian missile threat, and limit the effectiveness of Iran's missile force in case deterrence fails. A combination of offensive, active defense, and passive defense capabilities will be required.

Dissuade and delay development of missile capabilities that can reach beyond the immediate region, especially to the continental United States. Protecting the homeland from direct attack is a paramount U.S. national security goal, and maintaining sanctuaries from Iranian missile attack in the United States, Western Europe, and other areas outside the Middle East gives the United States more political and military flexibility in acting against Iran and in supporting U.S. friends inside the Middle East. (U.S. friends in the region, however, often express concern that a U.S. priority on preventing Iranian ICBMs will come at the expense of efforts against Iran's regional missiles.) Achieving this objective is facilitated by the fact that Iran has not yet flight tested intermediate- or intercontinental-range missiles, and indeed that Iran seems to be cautious right now in openly developing longer-range systems. At the same time, however, achieving this objective is complicated by Iran's apparent ongoing interest in at least maintaining a long-range missile hedge (as noted in Section II above), its pursuit (probably related) of SLVs, and its inherent technical ability to use rocket and unmanned air vehicles systems militarily at longer ranges and in different roles than demonstrated in flight testing.

Dissuade and delay acquisition of nuclear warheads for Iran's missiles. Nuclear-armed missiles would qualitatively increase the Iranian missile threat both regionally and beyond, open up the possibility of supplying nuclear weapons to Iran's proxies and terrorists worldwide, and create the problem of distinguishing between conventional and nuclear attacks by Iranian missiles. Preventing Iran from possessing nuclear weapons of any kind is the surest way of preventing these problems, but that lies beyond the scope of this paper.[106] But some of the measures to inhibit Iran's missile program that will be discussed below also can impede the development of nuclear-armed missiles. Dissuading Iran's acquisition of missile warheads armed with chemical and biological weapons (CBW) would be important for similar reasons. CBW delivery by missile is relatively technically straightforward, however, so reliance would have to be placed on broad measures to dissuade Iran's pursuit of any CBW program (such as export control and interdiction measures against CBW-relevant exports to Iran) rather than on missile-specific measures.

V. PREVIOUS EFFORTS TO ADDRESS IRAN'S MISSILE PROGRAM

The United States has actively sought to constrain Iran's missile capabilities since the Islamic Republic began missile procurements in the 1980s. Washington stepped up these efforts in the 1990s as it became increasingly concerned about Tehran's nuclear ambitions and the role of Iran's missile systems as potential nuclear delivery vehicles. Usually on the basis of intelligence about Iranian procurement efforts, Washington pressed Iran's suppliers of missiles, missile components, and technology—including Russia, China, and North Korea—not to engage in such transfers, threatening to impose, and sometimes imposing, sanctions against entities in those countries. It also encouraged its partners in the MTCR to be mindful of illicit Iranian procurement attempts and to avoid any transfers that could be of assistance to Iran's missile programs. While these efforts helped impede Iran's missile technology acquisitions, especially of the best Western technology, Iranian programs continued to advance.

Security Council restrictions. Concerned by progress in Iran's nuclear program, the U.N. Security Council began in 2006 to adopt a succession of increasingly demanding, legally binding resolutions that were aimed primarily at stopping Iran's sensitive nuclear activities, but also targeted its ballistic missile programs as potential nuclear delivery systems. The resolutions sought to prevent missile-related transfers to and from Iran as well as to prevent Iran from engaging in activities, including missile launches, aimed at acquiring ballistic missiles capable of delivering nuclear weapons. The high-water mark in terms of Security Council mandates regarding Iran's missile programs was UNSC Resolution 1929, adopted in 2010, which "decided" that "Iran shall not undertake any activity related to ballistic missiles capable of delivering nuclear weapons, including launches using ballistic missile technology, and that States shall take … necessary measures to prevent the transfer of technology or technical assistance to Iran related to such activities." It was clear from the language of the resolution that it was legally binding on Iran and other U.N. members.

While U.N. member governments, for the most part, took Resolution 1929 and its prohibition on missile-related transfers to Iran seriously, Tehran called the resolution illegal and refused to be bound by it. In the nearly six years that Resolution 1929 was in force, Tehran repeatedly violated it by continuing its illicit procurement efforts, exporting missile equipment and technology to its regional proxies, and carrying out launches of nuclear-capable ballistic missiles.

Missiles not addressed in the JCPOA. In the course of negotiations on the JCPOA, the United States discussed the inclusion in the agreement of restrictions on Iran's ballistic missile program, although the U.S. delegation did not table a formal proposal. To buttress its case for missile constraint, the United States cited International Atomic Energy Agency (IAEA) reports of an Iranian project to examine the integration of a nuclear payload into a re-entry vehicle for the Shahab-3 medium-range missile.[107]

The Iranians rejected any inclusion of missile constraints in the JCPOA. In addition to denying that they had examined the integration of a nuclear payload into the Shahab-3, they asserted that ballistic missiles were an integral part of their conventional defense posture, that Iran was under no legal obligation not to possess them, and that the JCPOA should only address nuclear matters.

For their part, the other members of the P5+1 (China, France, Germany, Russia, and the U.K.) were of little help in pressing Iran to accept missile restrictions in the JCPOA. Although the European participants shared the view that Iran's missile program was provocative and destabilizing, they quietly encouraged the United States to drop its push for inclusion of missile constraints. The Russians and Chinese were opposed to any consideration of missiles in the JCPOA negotiations.

UNSC Resolution 2231. Unable to address Iran's missile program in the JCPOA, the United States sought to retain existing Security Council missile restrictions in negotiations on what became UNSC Resolution 2231, which endorsed the JCPOA and replaced all previous resolutions on Iran, including Resolution 1929. The Iranians proposed that all previous UNSC provisions on their missile activities simply be dropped. With no support for missile constraints from the Russians and Chinese and little support from the Europeans, the United States agreed to a compromise. Restrictions on missile technology transfers to and from Iran as well as on Iran's own missile activities would remain in the new resolution. But they would expire after eight years, and the language on missile activities would be altered from the language of Resolution 1929. Instead of a legally binding obligation on Iran not to engage in ballistic missile activities, Resolution 2231 "calls upon" Iran to cease those activities—language that is not mandatory. And instead of Resolution 1929's requirements that Iran not engage in any activity related to "ballistic missiles capable of delivering nuclear weapons," Resolution 2231 "calls upon" Iran not to engage in any activity related to "ballistic missiles designed to be capable of delivering nuclear weapons."

Iranians subsequently argued that, with respect to their missile activities, Resolution 2231 is only a non-binding appeal that they are not obligated to accept. And although many Iranian missiles are inherently capable of delivering nuclear weapons, the Iranians contend that they have never designed their missiles to be capable of delivering nuclear weapons and that therefore the Resolution 2231 restrictions do not apply to them in any case. Iranian Foreign Minister Javad Zarif, who personally negotiated Resolution 2231's provisions on missiles, told Iran's parliament: "This paragraph speaks about missiles with nuclear warheads capability, and since we don't design any of our missiles for carrying nuclear weapons, therefore, this paragraph is not related to us at all."[108]

Consistent with this interpretation, the Iranians continued and, according to the United States, accelerated their missile activities after the JCPOA and Resolution 2231 took effect. At a Security Council meeting in December 2018, Secretary Pompeo said: "Iran's pace of missile activity, including missile launches and tests, did not diminish since the JCPOA. In fact, Iran's missile testing and missile proliferation is growing."[109] Among Iranian missile activities carried out since the beginning of 2016, Pompeo and other senior administration officials cite the introduction of two new short-range missiles; a test of the Simorgh space launch vehicle; flight tests of medium-range missiles (including a December 1, 2018 test of a missile that Pompeo claimed is capable of delivering multiple warheads); the transfer of missiles, missile technology, and missile production facilities to regional proxies (Hezbollah in Lebanon, Shiite militias in Iraq, and the Houthis in Yemen); and the IRGC's use of short- and medium-range missiles to strike what Iran called "terrorist" targets in northern Iraq and eastern Syria in September and October of 2018. After Pompeo's statement on the December 1 test, General Amir-Ali Hajizadeh, the IRGC's aerospace chief, boasted that Iran carries out 40 to 50 missile tests a year.[110]

U.S. reactions to Iran's missile activities

Both major American political parties have condemned Iran's missile programs and called for efforts to constrain them. While defending the JCPOA's exclusive focus on Iran's nuclear capabilities, President Obama maintained that his administration would confront Tehran's destabilizing non-nuclear activities, including its missile activities, separately from the nuclear deal. In January 2016, soon after the JCPOA took effect, Obama announced a new round of missile sanctions: "Iran's recent missile test … was a violation of its international obligations. And as a result, the United States is imposing sanctions on individuals and companies working to advance Iran's ballistic missile program. And we are going to remain vigilant about it."[111]

Republicans on Capitol Hill hoped the election of Donald Trump would mean a tougher approach to Iran's missile program. Senator Bob Corker, then chairman of the Senate Foreign Relations Committee (SFRC), stated, "No longer will Iran be given a pass for its repeated ballistic missile violations."[112] He said he would work with the administration on new legislation to deter Iran's threatening behavior, including its missile activities. Senator Ben Cardin, ranking Democrat on the SFRC, supported additional sanctions to counter the Iranian missile threat, but questioned whether new legislation was required to provide the necessary authority.[113]

The Trump administration's approach. During his presidential campaign and from the time he assumed office, President Trump attacked the JCPOA and its failure to address Iran's missile activities. In an October 2017 statement on Iran, the president regarded the JCPOA's "near total silence on Iran's missile program" as one of the agreement's major shortcomings and noted approvingly that Congress was working on legislation to prevent Iran from developing an intercontinental-range ballistic missile.[114] In January 2018, Trump indicated that his administration was working with France, Germany, and the United Kingdom on a new supplemental agreement that would impose new multilateral sanctions if Iran develops or tests long-range missiles, thwarts inspections, or makes progress toward nuclear weapons.[115]

Although talks with the Europeans in early 2018 made substantial progress on an arrangement intended to keep the United States in the JCPOA by addressing the administration's stated concerns, President Trump decided in May to withdraw from the JCPOA. Brian Hook, the administration's special representative on Iran, later noted that the JCPOA's separation of nuclear and missile issues and its failure to cover the latter were among the reasons why the president decided to end U.S. participation.[116]

In a May 21, 2018 speech, Secretary Pompeo stated that President Trump "is ready, willing, and able to negotiate a new deal" with Iran and outlined 12 highly ambitious requirements that any new deal would have to meet. The requirements covered the full range of Iran's activities that the administration found objectionable, including its nuclear and missile programs, its support for regional proxies, its presence in Syria, its detention of U.S. citizens, and its meddling in the affairs of its neighbors. On the missile issue, the requirement was that "Iran must end its proliferation of ballistic missiles and halt further launching or development of nuclear-capable missiles."[117]

It is not clear what kind of new deal administration officials have in mind, although they say it should be "comprehensive" and in the form of a treaty. They seem to be counting on their maximum pressure campaign to produce a fundamental change in Iran's outlook and policies—what Pompeo has called "a 180-degree turn from its outlaw behavior"[118]—

that would be reflected in an across-the-board capitulation to U.S. demands. Comments by administration officials suggest that an alternative, even preferable, outcome of the pressure campaign would be the collapse of the Iranian regime. In the highly probable event that neither Iran's wholesale acceptance of U.S. demands nor the collapse of the regime is achievable, it is uncertain whether the Trump administration would be prepared to negotiate a separate missile deal or a separate nuclear and missile deal, with or without major Iranian concessions on regional and other issues.

In a December 2018 presentation at the annual Wilton Park non-proliferation conference in the United Kingdom, Chris Ford, assistant secretary of state for international security and non-proliferation, expanded upon Secretary Pompeo's requirement that Iran cease its development and testing of nuclear-capable missiles. Citing Iran's claim that it does not seek or desire missiles with a range in excess of 2000 km, he said that "a negotiated solution that really handles the Iran missile problem … would presumably need to … not least … requir[e] that Iran divest itself of the range class of missiles that Iran itself has irretrievably tainted by trying to develop nuclear warheads for them—missiles such as the Shahab 3."[119]

But Ford hinted at even more comprehensive missile restraint. While stopping short of officially proposing a specific requirement, Ford said "it's probably best" that Iran be prohibited from developing or possessing missiles capable of carrying a payload of at least 500 kg to a range of at least 300 km, which is the definition of MTCR Category I systems (those regarded as inherently capable of delivering nuclear weapons). A ban on all MTCR Category I systems would cover all Iranian ballistic missiles with range/payload capabilities greater than the original Fateh-110, which would mean the elimination of the vast majority of Iran's ballistic missile systems.

Finally, Ford said that, "given the interchangeability between space launch vehicle (SLV) and ballistic missile technologies," Iranian missile restraint would "presumably need to include a restriction on SLVs." He suggested that Iran could forgo its own SLVs and rely on the well-developed and competitive market in space launch services to boost its satellites into orbit.

In its two years in office, the Trump administration has focused repeatedly on Iran's missile program—including by protesting Iranian ballistic missile launches viewed in the West as inconsistent with UNSC Resolution 2231, highlighting and seeking international condemnation of Iranian transfers of missile technology to proxies (including former U.S. Ambassador to the U.N. Nikki Haley's efforts to prove that missiles fired into Saudi Arabia by the Houthi rebels in Yemen were supplied by Iran); imposing several rounds of sanctions against Iranian missile-related entities and their foreign supporters; continuing interdiction actions against Iranian missile-related exports (especially to the Houthis); providing political support for Israeli military strikes aimed at halting Iran's missile-related assistance to its proxies (especially in Syria and Lebanon); and giving high-profile speeches devoted to the Iranian missile threat. In a December 12, 2018 appearance at the U.N. Security Council, Secretary Pompeo highlighted the Iran missile issue, calling on the Council to re-impose the ballistic missile restrictions of UNSC Resolution 1929 that were replaced by those in Resolution 2231 and urging the Council "to establish inspection and interdiction measures, in ports and on the high seas, to thwart Iran's continuing efforts to circumvent existing arms restrictions."[120]

Reactions of other countries to Iran's missile programs

European reactions. France, Germany, and the United Kingdom have strongly opposed U.S. withdrawal from the JCPOA and worked hard to persuade Iran to stay in the agreement, including by devising a Special Purpose Vehicle intended to enable Iran to continue receiving economic benefits from the agreement by circumventing U.S. financial sanctions. At the same time, the E3 and some of their European Union partners have joined with the United States, at least rhetorically, in calling Iranian missile activities provocative and destabilizing, condemning Iranian ballistic missile launches as "inconsistent" with UNSC Resolution 2231, opposing Iran's missile-related assistance to its regional proxies, and encouraging negotiations aimed at placing restraints on Iran's missile capabilities and exports. The Europeans emphasize that any actions to counter or constrain Iran's missile programs should do nothing to undermine the JCPOA.

France has been the most vocal European partner on the Iran missile issue, with President Emmanuel Macron often in the lead. In November 2017, Macron stated, "France is concerned about the continued pace of the Iranian missile program, which does not conform with Security Council Resolution 2231 and which is a source of destabilization and insecurity for the region."[121] The French president has been an outspoken proponent of negotiations with Iran on the missile issue, stating in February 2018: "I want a new cycle of negotiations with regional parties and the permanent members of the Security Council, like we did for the nuclear deal, but widening it to regional countries so that we can reduce and eradicate this insecurity."[122] The French, however, have not gone into detail publicly regarding the objectives of any missile negotiations with Iran.

The United Kingdom has also been a firm critic of Iran's regional behavior, including its missile program, while strongly defending the JCPOA. In a December 12, 2018 statement to the Security Council criticizing Iran's "expeditionary and expansionist security doctrine," British Ambassador to the United Nations Karen Pierce said that Tehran's compliance with the JCPOA "is not a license to engage in destabilizing behavior elsewhere, whether or not that has a nuclear link." The ambassador took issue with those who argue that the Council should not concern itself with Iran's ballistic missile activities on the grounds that certain language of Resolution 2231 (i.e., "calls upon") is not legally binding. She said no U.N. member should openly defy the clearly expressed will of the Council on a matter of such importance to non-proliferation and regional and international security, whether or not that collective will is expressed in a legally binding manner. She therefore demanded that Iran cease activity that defies Resolution 2231 and demanded that Iran and all U.N. member states fully comply with the resolution's prohibitions on the proliferation of missile technology to and from Iran—"on which, by the way, there is no doubt that these are indeed legally binding."[123]

More than its E3 partners, Germany tends in its statements on Iran's regional and missile activities to stress the importance of continuing dialogue with Tehran and ensuring that Iran receives the benefits of sanctions relief. Still, Germany consistently joins with its European partners to condemn Iranian ballistic missile tests and missile strikes, to maintain that Iran's ballistic missile activities are inconsistent with UNSC Resolution 2231, and to demand that Iran refrain from any missile-related transfers and fully respect the resolution.[124]

While all 28 member states of the European Union share the E3's support for the JCPOA and their determination to keep Iran in the deal, and support the missile-related provisions of Resolution 2231 and other relevant UNSC resolutions,[125] there

are significant differences within the EU on the threat posed by Tehran's regional and missile activities and on the means of countering them. For example, former Swedish Prime Minister Carl Bildt has questioned whether the EU should single out Iran's missile program for punishment: "Certainly true that Iran has ballistic missiles within regional reach. But so have others in that region. Saudi Arabia has Chinese-supplied ones. Israel has advanced ones with nuclear capability."[126] The United States has called on the Europeans to join in sanctioning Iranian and third-party entities involved in or assisting Iran's ballistic programs, noting that the imposition of such sanctions is not barred by the JCPOA. However, the adoption of additional EU missile sanctions requires the unanimous support of the group's 28 members—which, despite the support of the E3, has not proved possible since before completion of the JCPOA. As a result, a large gap has opened between the number of Iranian entities under U.S. and European missile sanctions.[127]

The Russian response. Russia was a constructive partner in the JCPOA negotiations, working closely with the United States and other P5+1 countries to urge Iran to accept tight limits on its nuclear program. It also joined in unanimous support for UNSC Resolution 2231. But since the conclusion of the JCPOA—and the sharp deterioration of U.S.-Russian relations in the wake of Russia's aggression in Ukraine, support for Assad in Syria, and interference in the 2016 U.S. elections—the positions of Washington and Moscow on Iran issues have significantly diverged, including on the question of Iran's missile programs.

Russia has become Iran's main defender in the Security Council against condemnations for its missile-related violations of UNSC resolutions. Despite a finding in November 2017 by the U.N. Panel of Experts on Yemen that missiles fired into Saudi Arabia by the Houthis were manufactured by Iran (although the panel cautiously said there was "no evidence as to the identity of the broker or supplier"),[128] the Russian U.N. ambassador vetoed a British-drafted resolution condemning Iran for violating the UNSC-mandated Yemen arms embargo, arguing that there was no proof that the missiles had been supplied by Iran. Moscow has fully supported Iran's claim that the missile restrictions contained in UNSC Resolution 2231 do not apply to its missile activities. In a November 2018 letter to the U.N. secretary general, the Russian mission to the United Nations contended that Iran had been respecting in good faith the call to refrain from activities related to ballistic missiles designed to be capable of delivering nuclear weapons. The letter went on to say that missiles designed to be capable of carrying nuclear weapons included certain features and that no "evidence of the existence of such features on Iranian ballistic missiles or space launch vehicles" had been presented to the Council.[129]

Middle East states. Not surprisingly, the countries that are America's closest Middle East partners, Iran's major regional adversaries, and the most significant potential targets of Iranian and Iranian-assisted missile attacks—Israel, Saudi Arabia, and the UAE—are the strongest opponents of Tehran's missile programs and the missile and rocket capabilities of Tehran's regional proxies. Adel al-Jubeir, the former Saudi foreign minister, called for "firmer positions with regards to ballistic missiles and with regards to Iran's support for terrorism. Iran must be held accountable."[130] In the wake of Houthi launches of Iranian-made missiles toward Riyadh—and the concern expressed by the UAE ambassador to the United States that "if it's Saudi now, it's the UAE next"[131]—Anwar Mohammad Gargash, UAE state minister for foreign affairs, maintained: "This is a serious escalation and one that undermines Iranian claims about the defensive nature of its missile program. The UAE will not remain idle under the shadow of such threat."[132]

Referring to Iran's ballistic missile program, Danny Danon, Israel's ambassador to the United Nations, said, "Its activities pose a direct threat to Israeli and the entire region," and urged the Security Council to "remain vigilant in the face of Iranian aggression."[133]

Unlike the Europeans, several of America's Middle East partners oppose the JCPOA, are pleased that the Trump administration withdrew from it, and do not believe that efforts to counter Iran's missile capabilities should be circumscribed to avoid undermining the JCPOA. Also, their preferred means of addressing the missile threat from Iran and its proxies do not include direct negotiations with Tehran. Instead, they prefer more coercive policy tools—sanctions, interdiction, missile defenses, and pre-emptive military strikes.

Iranian opposition to missile constraints

Iran has repeatedly and adamantly rejected Western interest in constraining its missile capabilities, arguing publicly that its missiles are designed exclusively to be armed with conventional munitions and that its missile force is an essential part of its legitimate self-defense capabilities. Iranians claim that their missile programs are needed to rectify "a destabilizing conventional weapons imbalance in the region" created by the decades-old Western conventional arms embargo against Iran and by the supply of advanced weapons systems, including high-performance combat aircraft, by the United States and other Western countries to Iran's regional rivals, including Israel, Saudi Arabia, and the UAE.[134] Foreign Minister Zarif tweeted in March 2018, after French Foreign Minister Jean-Yves Le Drian visited Tehran and called for missile negotiations, that the United States and Europe "should stop pouring hundreds of billions of dollars of weapons into our region instead of questioning Iran's missiles."[135] Iranian officials often invoke Iraq's 1980s missile attacks against Iran as both justification for Iran's own missile activities, as well as an example of Western hypocrisy, given Iranian popular sentiment that the West enabled and encouraged Saddam Hussein to attack Iran.

Iranians say they are suspicious of Western motives for pursuing missile negotiations. According to Hossein Mousavian, a former senior Iranian diplomat with close ties to the Iranian government, "Iranian officials are united in the view that efforts to curtail [Iran's] missile and deterrence capabilities are ultimately aimed at weakening the ability of Iran to defend itself and preserve its territorial integrity."[136]

Senior Iranian officials have sought to convey a consistent message ruling out negotiations on Iran's missile capabilities. President Hassan Rouhani tweeted: "We have never negotiated regarding our defense capabilities, including our missile program & will not accept any restrictions in this regard."[137] Major General Ali Jafari, commander of the IRGC, asserted, "Our missile power is non-negotiable and the Iranian people will not permit this."[138] Admiral Ali Shamkhani, secretary of the Supreme National Security Council, was equally categorical: "Under no circumstances will Iran negotiate with any country in the world regarding its missiles or its missile capabilities."[139] However, Armed Forces Spokesman Masoud Jazayeri did mention one circumstance that could permit such negotiations: "The condition for negotiating Iran's missiles is the destruction of the nuclear weapons and long-range missiles of the United States and Europe."[140]

On the question of whether Iran will continue to observe a voluntary range limit of 2000 km on its missiles reputedly established by Supreme Leader Ayatollah Ali Khamenei, Iranians have been ambiguous. IRGC Commander Ali Jafari maintained, "We have the scientific ability to increase our missile range but it is not our current policy since most of the enemies' strategic targets are already within this 2000-km range. This range is

enough to protect the Islamic Republic."[141] Reacting to French statements of support for missile negotiations, IRGC Deputy Commander Brigadier General Hossein Salami signaled less allegiance to a range ceiling, stating: "So far we have felt that Europe is not a threat, so we did not increase the range of our missiles. But if Europe wants to turn into a threat, we will increase the range of our missiles."[142] Similarly, maintaining that the figure of 2000 km "is not a divine decree," IRGC aerospace chief Amir-Ali Hajizadeh held that "what we have decided thus far is based on our needs." He noted that many enemy bases are in a distance of 300-400 km away from Iran, while another group of such enemy targets are distanced 700-800 km from the country. Regarding the range of its missiles, he said Iran does not feel restrained either in technical terms or because of any agreement on the range of missiles.[143]

Iran is proud to advertise advances in its indigenous missile development efforts, including its ballistic missile flight tests, as well as to acknowledge its missile strikes against "terrorist" targets in northern Iraq and eastern Syria. However, in connection with U.S. and Gulf Arab assertions that missiles fired toward Riyadh by the Houthis were supplied by Iran, Foreign Ministry Spokesman Bahram Ghasemi contended that "we have no arms link with Yemen" and "the accusation that Iran gives weapons to various groups is rejected and we strongly deny it."[144]

VI. POLICY TOOLS TO ADDRESS THE IRANIAN MISSILE THREAT

Iran's heavy reliance on missiles to meet its military and foreign policy objectives means that Tehran will resist stoutly measures to impede the threat its ballistic and land-attack cruise missile force poses. This resistance, combined with the extensiveness of Iran's existing missile force, also means that the Iranian missile threat will not easily be addressed by the United States. Promoting the U.S. objectives outlined in Section IV above against the Iranian missile program, and impeding Iran's ability to meet the goals of its missile program outlined in Section III, will thus require the simultaneous application of a broad range of policy tools. Some of these tools are mutually reinforcing, and in other cases the strengths of one tool help compensate for the shortcomings of another. While there is no panacea to obviate the Iranian missile threat, pursuing the full range of tools as intensively and creatively as possible would provide the maximum benefit in blunting that threat.

This paper will outline a range of nine key policy tools to address the Iranian missile threat:

1. Trade controls to impede transfers of equipment and technology to Iran's missile program and its proxies' programs.
2. Interdiction of equipment, technology, and financial transfers to and from Iran's missile program.
3. Targeted sanctions against Iranian missile-related entities and third-country entities doing business with them.
4. Diplomatic pressure against Iran's missile program and its foreign supporters.
5. Ballistic missile defenses and defenses against land-attack cruise missiles.
6. Passive defense of key regional assets.
7. Capabilities to attrite Iran's missile force and production infrastructure (to bolster deterrence, provide options for pre-emption, and limit Iran's ability to achieve its warfighting objectives during a conflict).
8. Declaratory policy.
9. Diplomacy with Iran to promote missile restraint.

Each of these tools will be discussed in turn, and each tool's effectiveness realistically assessed.

Trade controls. Although increasingly indigenous, Iran's missile program (and the programs of its proxies) will always prefer to obtain more, better, or cheaper items from or through other countries. Iran's efforts to import, export, transship, broker, and finance missile-related materials, equipment, and technology for its missile programs—and flows from Iran and other origin points to its proxies' programs—can be impeded by countries other than Iran using effective trade controls to identify and stop such transactions passing through their jurisdictions. This impedes the missile programs of Iran and its proxies by:

- Making the programs pay more for less capable items that take longer to obtain;
- Making it more difficult for Iran to supply its proxies; and
- Giving Iran fewer opportunities to earn hard currency for its missile program and foment instability by selling missile technology to other countries.

UNSC Resolution 2231 already requires Security Council approval until 2023 for sending Iran any item on the MTCR Annex—or any other items, materials, equipment, goods, or technology that a member state determines could contribute to the development of nuclear weapon delivery systems. That UNSC resolution also bans the export without UNSC approval by Iran of missiles and "related materials" for the same period. Taken together with UNSC Resolution 1540's open-ended requirement that all U.N. member states have non-country-specific missile-related trade controls, there is a fairly solid legal basis for international efforts to impede transfers of equipment and technology to Iran's missile program and from Iran to its proxies.

That said, similar UNSC restrictions have been in place since at least 2006, and Iran's missile program has been a focus of multinational missile non-proliferation efforts since at least the formation of the MTCR in 1987. Such trade controls have not been able to prevent Iran from increasing the size and technical capability of its missile program or from arming its proxies, although they have substantially denied advanced Western missile technology to Iran's missile program and have impeded the pace and quality (and increased the price) of Iranian and proxy missile improvements.

To improve the effectiveness of trade controls in impeding the missile programs of Iran and its proxies, the U.S. and like-minded states should:

- Work to further bolster the implementation and enforcement of missile-related trade controls in key source countries (e.g., China) and transit and transshipment countries (e.g., UAE, Singapore, Malaysia) through Iran-specific diplomatic outreach and capacity-building efforts.
- Share information and best practices more intensively among MTCR members to help impede trade control evasion by Iran and its proxies, and use the MTCR to better coordinate like-minded members' broader missile non-proliferation policies against Iran's program. The United States over the years has frequently provided information to the MTCR on Iran's missile programs and procurement practices and objectives, and urged various specific actions be taken, but Washington could share more detailed information and policy recommendations that are more focused on specific Iranian chokepoints and vulnerabilities, and that are better coordinated with U.S. interdiction and sanctions efforts.
- Reinvigorate efforts to add to the MTCR Annex (the list of technologies subject to export control) items of particular use to Iran's missile program, especially to the development of longer-range missiles. Examples include items related to penetration aids, maneuvering re-entry vehicles and other post-boost control, terminal guidance, large-diameter solid-propellant motors, composite materials production, and missile mobility. With Russia as an MTCR member, getting the necessary consensus of all MTCR members to add items to the MTCR Annex will be difficult, so the United States and like-minded states should apply the controls of the MTCR Guidelines to such items for exports to Iran on a national basis, and press others both inside and

outside of the MTCR to do the same. (Most such items already are controlled by most countries as munitions items, and are on the Wassenaar Arrangement Munitions List, but are not explicitly subject to the stricter control and denial standards of the MTCR Guidelines.)

Trade controls also should be bolstered by improved efforts to interdict specific transactions that evade controls, and to impose economic sanctions on missile-supplying and -facilitating entities that evade trade controls. These steps will be discussed below.

Interdiction. "Interdiction" encompasses the entire spectrum of efforts to stop specifically identified individual transfers of equipment, technology, and funds to and from Iran's missile program. This helps slow such transactions down and make them more costly and less effective than would otherwise be the case. Interdiction also helps stop transfers that "leak" through national trade controls and evade U.N. and other sanctions, including by identifying additional entities that should be sanctioned. Most Iranian missile-related transfers are not interdicted directly by the United States or another third-country initiator. Rather, they usually involve the United States (or sometimes another third country) initiating an interdiction by using diplomatic, intelligence, customs, law enforcement, or Treasury channels to alert another foreign government that has potential jurisdiction over such a transfer and prompting or persuading that government to enforce its own trade controls.

In addition to the trade control measures noted above, the U.S. and like-minded states should take the following steps to improve the effectiveness of interdiction against the missile programs of Iran and its proxies:

- Share actionable intelligence on more individual missile-related transactions with countries that have the opportunity and political will to interdict them, and be more prepared to share such information on a trial basis with other countries to test their political will to interdict.

- Use the Proliferation Security Initiative as a transmission belt for Iran-specific information and best practices to help promote more and better missile-related interdictions.

- Increase efforts to inspect cargo going to Yemen by sea and land (including via Oman) to screen out missile-related items.[145]

- Exploit cross-linkages between international efforts to impede North Korea's missile program and efforts to impede Iran's missile program, which has benefitted greatly from imports of equipment and technology from Pyongyang. For example, UNSC bans on North Korean missile-related imports and exports impede improvements in Iran's missile program from exports by North Korea. At the same time, these UNSC bans help deny North Korea hard currency from its missile technology sales to Iran and other countries that Pyongyang uses to improve its own missile program (and the quality of its future missile-related exports to Iran). A particular focus should be put on improving the enforcement of U.N. sanctions against North Korea by countries in the Middle East concerned by the Iranian missile threat, and the enforcement of U.N. sanctions against Iran by countries in East Asia concerned about the North Korean threat.

Sanctions. Trade and financial sanctions play an important role in impeding Iran's missile program and its missile support to proxies.

Broad sectoral or country sanctions against Iran have largely been imposed for reasons other than its missile program (human rights, support to terrorism, its nuclear program), but still have an impact on Iran's missile program. Such sanctions can in theory help restrict the resources available to Iran to pursue its missile program, and help force resource trade-offs between missiles and other priorities of the Iranian regime. But their impact on Iran's missile program may be modest because the resource requirements of the missile program are small relative to Iran's entire economy and because pursuing the missile program thus far clearly has been a priority of the regime. Perhaps more significantly, broad sanctions also can help provide an incentive to Tehran to restrain or negotiate on its missile activities in order to secure relief from such sanctions or avoid having such sanctions increased. That might be one reason why Iran has refrained from testing missiles beyond 2000 km range (see below). But the impact of broad sanctions, and the potential for more sanctions, has thus far not been not enough to lead Iran to negotiate on its missile program or to restrain its regional missile force. It is unclear whether much more severe sanctions could produce these results, whether there is enough international support in the U.N. Security Council and elsewhere for imposing and enforcing such sanctions, and how the "currency" of much more severe sanctions—and the use of sanctions relief—to incentivize Iran should be spent across all of the areas of problematic Iranian behavior that require a solution (nuclear, missile, fomenting regional instability, human rights, etc.).

Sanctions against Iranian entities (individuals, firms, government ministries, etc.) involved in the missile program generally do not have a direct economic impact because these entities have no direct exposure to the world economy. Such sanctions primarily have an indirect impact, highlighting these entities to foreign parties interested in avoiding doing business with Iran's missile program, and supporting the imposition of additional sanctions against third-country entities (see below) that do such business nonetheless. Since the 1990s, the United States has sanctioned scores of Iranian missile-related entities, many of which remain under sanctions.[146] Ideally, additional such sanctions against Iran and its missile program should come via the U.N. Security Council. But given the U.S.' current poor relations with UNSC veto-holders China and Russia, these countries' economic and political interests in not impeding their own trade with Iran, and broad international dissatisfaction with the U.S. withdrawal from the JCPOA, additional UNSC sanctions are highly unlikely. (This should not, however, exclude making attempts in the UNSC to bolster missile-related sanctions as events warrant, such as after Iranian long-range missile or SLV tests or other provocations.[147])

Sanctions on non-Iranian foreign entities ("third-country entities") doing business with Iran's missile program (suppliers, customers, financiers, trade facilitators, etc.) can adversely affect those entities. Since the 1990s the United States has sanctioned dozens of third-country entities for their support of Iran's missile program, and many such entities remain under sanctions.[148] Although U.S. sanctions often do not impose direct costs on these entities (some are just front companies that can easily change their names, and many have no commercial ties to the United States), sanctions also affect these entities by publicly exposing them, and most importantly, by dissuading yet other third-country entities from doing business with the sanctioned ones. Legitimate businesses and financial institutions in many other countries, despite being outside the jurisdiction of U.S. sanctions requirements, historically have been reticent to do business with foreign entities sanctioned by the United States. Given the low likelihood of further UNSC sanctions on Iran

and given the extensiveness of long-standing U.S. sanctions on Iran and on Iranian missile-related entities, *intensifying U.S. sanctions on third-country entities would be the sanctions measure likely to provide the biggest additional impact on Iran's missile program*. Overall, the intensification of sanctions against third-country entities doing business with Iran's missile program would be intended to force third-country (and even some legitimate civil Iranian) entities to choose between doing business with Iran's missile program (and the program's third-country entity supporters) or doing business with the United States and any other sanctioning states. In many cases, the economics should drive third-country entities toward the latter choice.

- To be effective, this use of sanctions would need to be widespread, including against missile-supporting entities in countries that are economically significant, or that are friendly with or important to the United States. Thus, Washington would have to be prepared to elevate the priority of the Iranian missile issue relative to other bilateral issues with these countries, and to incur costs with these countries in the interest of impeding Iran's missile program. Given available information on foreign support for Iran's missile program, countries likely to be affected would include China (and Hong Kong), Malaysia, Russia, Singapore, Turkey, and the UAE.

- Ideally, such sanctions also should be imposed not just by the United States, but by as many like-minded governments as possible (EU, Japan, South Korea, Australia, etc.), although this is not absolutely necessary for third-country sanctions to be effective given the indispensable role of the United States and the U.S. dollar in the international economy.

- The sanctions effort also should be accompanied by robust U.S. and like-minded enforcement efforts to the extent that intelligence and foreign policy sensitivities allow. This should include (a) multi-country naming and shaming of entities supporting Iran's missile program and (b) diplomatic outreach to educate foreign governments about the sanctions, alert them to entities under their jurisdiction that are supporting Iran's missile program, and give these governments a chance to change missile-supporting entities' behavior before the entities are sanctioned (and the chance to have sanctions lifted if behavior changes later).

Diplomatic pressure. The United States and like-minded countries have varying levels of diplomatic influence that they could bring to bear against other countries doing business with or facilitating Iran's and its proxies' missile programs, or hosting entities that do so. In addition to the diplomatic aspects of trade control, interdiction, and sanctions implementation noted above, the United States and like-minded countries should:

- Engage in energetic public and private diplomatic efforts to underscore the threats posed by Iran's missile force, the need for Iran to forgo missile-related exports to proxies, and the potentially deleterious effects (including to Iran's interests, as well as to regional and global stability) if Iran improves and expands its regional missile force and proceeds with long-range missile development. These efforts should be directed to Iran itself, key countries with influence on Iran (including Russia and China, who should also be warned that improving Iranian missile capabilities will spur the deployment of U.S. missile defenses they oppose), and various international organizations (e.g., NATO, regional organizations like the Arab League and the Association of Southeast Asian Nations, and the Hague Code of Conduct Against Ballistic Missile Proliferation). The objective should be to build up government and public opposition to Iran's missile program, help discourage Iran from improving its

missile programs (especially longer-range systems), improve third-country receptivity to U.S. and like-minded counterproliferation and trade control efforts, and increase third-country understanding for the military and other countermeasures that the United States and its friends may have to take if Iran's program is not restrained.

- In the wake of this effort, seek specific concrete actions tailored to individual target countries (e.g., shut down specific front companies, enact specific trade control measures, halt certain banking practices), making clear that non-performance would result in public exposure and adverse U.S. action in areas of the target country's interest. Again, this would require the United States to elevate the priority of the Iran missile issue relative to other bilateral issues with these countries and to incur costs with these countries on other important issues in the interest of impeding Iran's missile program.

Missile defenses. The size and increasing capability of Iran's ballistic missile and land-attack cruise missile force, and the role this force plays in Iran's pursuit of threatening policies, clearly necessitate active defenses as part of the U.S. policy mix. The United States and its friends need some ability to blunt the threat Iran's missiles pose to their territories and forces (including ships), both regionally and extra-regionally (including future threats to Western Europe and the continental United States). That said, ballistic and cruise missile defenses are expensive and imperfect. Particularly within the region, merely increasing the number of offensive missiles gives Iran a simple and relatively cost-effective counter to expanding missile defenses, while still leaving it other options such as conducting defense suppression attacks and using penetration aids.

But even when imperfect, missile defenses still can make an important contribution as part of a spectrum of military and counterproliferation responses to Iran's missile force. The presence of defenses deprives Iran of a "free ride" in making missile threats or launching attacks, and helps particularly against threats and attacks involving small numbers of missiles. Iran cannot know which missiles it launches will be engaged, or which or how many engaged missiles will be shot down, increasing its uncertainty in planning and relying on missile attacks against specific targets. Overall, to the extent that such defenses are effective (or Iran thinks they are), the ability of Iran's missile program to meet Iran's political and military goals would be reduced, thereby making it less likely that Iran would seek to conduct missile attacks or intimidation.

Ballistic and cruise missile defenses also work in conjunction with other policy tools. For example, trade controls and interdiction over the years have impeded the size and sophistication of the Iranian missile threat that U.S. and friendly missile defenses have to cope with. Having missile defenses to pick up some of the survivors also makes imperfect capabilities to attrite Iran's missile force more tolerable. And passive defenses can help blunt the effect against specific military targets of those attacking missiles that leak through active missile defenses.

All other things being equal, the United States and its friends in the region should continue increasing the quantitative and qualitative capability of deployed ballistic and cruise missile defenses as Iran increases and improves its own and its proxies' missile forces.[149] The Trump administration's January 2019 Missile Defense Review echoes this approach: "Defending U.S. forces abroad, allies, and partners, and helping them better defend themselves against the full range of regional missile threats is a vital element of U.S. regional security strategy in Europe, Asia, and the Middle East. The United States will strengthen regional missile defense capabilities and cooperative relationships with allies

and partners on a broad range of missile defense activities, and encourage additional allied investments in missile defense, including co-development and co-production efforts to better share the burden of common defense." [150]

Beyond this general principle, the United States and its friends should take a number of other steps related to expanding missile defenses, including:

- The United States should continue (and, where possible, increase) financial assistance to Israel in its development and deployment of defenses against rockets, ballistic missiles, and cruise missiles.

- The United States should offer to transfer or facilitate the transfer of Israeli-designed rocket and missile defense systems (produced in the United States as needed) to Gulf Arab states to complement U.S.-designed systems in helping protect against Iranian or proxy rocket and missile attacks.

- The United States should continue efforts to persuade the Gulf Arab states to expand and integrate their ballistic missile and air defense systems, and be prepared to promote the expansion of interoperable national systems even where Gulf states are not prepared to integrate them.[151]

- The United States and NATO should continue efforts to deploy Phased Adaptive Approach missile defenses in Europe capable of engaging Iranian ballistic missiles with ranges exceeding 2000 km, and the United States should retain and improve its capability to engage small strikes against the homeland by possible future Iranian ICBMs. Having these capabilities in place can help deter Iran's deployment of missiles with ranges exceeding 2000 km and help cope with the unexpected advent and deployment of Iranian long-range missiles—including Iranian cheating on any future negotiated missile limits. A similar approach was announced in the January 2019 U.S. Missile Defense Review: "It is imperative that U.S. missile defense capabilities provide effective, continuing protection against rogue state missile threats to the homeland, now and into the future. The United States is technically capable of doing so, and has adopted an active missile defense force-sizing measure for protection of the homeland. DoD will develop, acquire, and maintain the U.S. homeland missile defense capabilities necessary to effectively protect against possible missile attacks on the homeland posed by the long-range missile arsenals of rogue states, defined today as North Korea and Iran, and to support the other missile defense roles identified in this 2019 MDR."[152]

    - Pursuing this course also provides future options for negotiations with Russia (and possibly China), if U.S. relations with these countries improve, to restrain U.S. missile defense deployments in exchange for serious Russian and Chinese pressure against Iran not to develop or deploy long-range missiles (and for their efforts to impede assistance to Iran's missile program). For example, consideration could be given to completing the Phased Adaptive Approach missile defense site in Poland, but not making the site operational if Iran agrees to suspend the flight testing of missiles with ranges exceeding 2000 km. Russia, which has strongly opposed the Polish site, would presumably have an incentive to encourage Iran to observe such a flight test limit agreement.[153] It should be noted that current U.S. policy apparently would oppose such an arrangement with Russia and China; the January 2019 Missile Defense Review states bluntly that "The United States will not accept any limitations on the development or deployment of missile defense capabilities."[154]

Passive defense. These measures include camouflaging, obscuring, hardening, duplicating (including via decoys), concealing (including via mobility where possible), and being prepared for rapid repair of key airbase, port, command-and-control, military, economic, and political nodes in the region. While such measures presumably have been implemented already to some extent as a general military response to the Iranian conventional threat, a more concerted effort taking into account the improving accuracy of Iranian short- and medium-range missiles and their role in Iranian military planning could further reduce the vulnerability of protected assets to missile attack, and thus the ability of Iran's missile program to meet specific regional military goals. Passive defenses also can help compensate for limitations in attrition capability against Iran's missile force and in missile defenses. In addition, although less effective than measures to protect specific point targets, civil defense measures for the general populace of regional states can help lessen the political and psychological effects of Iranian missile attacks or intimidation.

- Israel has the only substantial civil defenses in the region, and the United States should therefore work to leverage Israeli expertise in civil and passive defense to help improve Gulf Arab countries' ability to limit the impact of Iranian or proxy missile attacks.

Attrition capability for deterrence and warfighting. Given the important role missiles play in Iranian military operations, the diminishing marginal utility of technology denial in reducing the Iranian missile threat means that there will be an increasing need to rely on U.S. and partner offensive military capabilities in addressing that threat. Such capabilities could include the ability to attrite Iran's missile force and production infrastructure before conflict—through "left of launch" measures ranging from cyber operations,[155] to supply chain sabotage,[156] through options for kinetic pre-emptive attacks—as well as the ability to do so during conflict through counterforce strikes. U.S. and allied attrition capabilities would help deter Iran from conducting attacks and intimidation using its missile force, provide options to pre-empt contemplated Iranian missile attacks before they occur, and (in conjunction with missile defenses and passive defense) help limit Iran's ability to achieve its warfighting objectives during a conflict. As noted previously, if deterrence fails, attrition also would reduce the pressure on missile and passive defense in coping with residual Iranian missile capabilities.

The United States has substantial attrition capabilities in the region and based in the homeland that could be used against Iran's missile force (to include cyber, intelligence, surveillance, and reconnaissance assets, and strike systems such as bombers, fighters, and air- and sea-launched land-attack cruise missiles).[157] And the further steps that the United States already must take to prepare for future conflict with any of its other likely nation-state adversaries (including China, North Korea, and Russia)[158]—all of which are increasing deployments of mobile ballistic and cruise missiles, and associated passive defenses for their missile forces like underground facilities—should result in an improved capability to attrite Iran's missile force.

In addition to U.S. forces, Israel has some 259 F-15 and F-16 fighter ground attack (FGA) aircraft with weapons including Popeye air-to-surface missiles that can provide significant attrition capabilities against Iran's missile force, albeit limited by their distance from Iran. Israel also is prepared to attrite Hezbollah and Hamas rocket and missile capabilities using these and other of its forces, and has launched periodic airstrikes against Iranian efforts to improve Hezbollah missile capabilities in Lebanon,

as well as in and through Syria.[159] In January 2019, Prime Minister Benjamin Netanyahu said that Israel has attacked "hundreds" of Iranian and Hezbollah targets in Syria and "acted against the manufacturing of precision weapons in Lebanon."[160]

The Gulf Arab states also possess varying levels of attrition capability that could be used against Iran's missile force (some of which is being used currently by Saudi Arabia and the UAE against the Houthis' Iranian-supplied missiles in Yemen):[161]

- Saudi Arabia has some 170 F-15, Typhoon, and Tornado FGA/attack aircraft armed with weapons including the Storm Shadow air-launched land-attack cruise missile.
- The UAE has some 137 F-16 and Mirage 2000 FGA aircraft and the Black Shaheen version of the Storm Shadow.
- Bahrain, Kuwait, Oman, and Qatar each have some 12-39 FGA aircraft, with Qatar also having Storm Shadow missiles.

All of these countries likely will improve their strike capabilities over time (including to deal with Iran writ large), which will improve their attrition capabilities against Iran's missile force to varying degrees. But intelligence and targeting support from the United States would be critical to the effectiveness of Gulf states' forces against Iran's missile force.

Declaratory policy. The United States also can seek to deter Iran and its proxies from using missile attacks or intimidation by issuing public threats of retaliation directed at Iran's development, use, or threat of use of missiles. On September 19, 2018, for example, U.S. Special Representative on Iran Brian Hook noted in the context of Iran transferring ballistic missiles to its proxies that:

> "As the president has said, the United States will hold the regime in Tehran accountable for any attack that results in injury to our personnel or damage to United States Government facilities. America will respond swiftly and decisively in defense of American lives."[162]

Obviously, any further such statements should not be made lightly and would have broad and important ramifications. The United States would have to possess a credible capability to provide any such threat or assurance and would have to be fully prepared to follow through. But extending the above declaratory policy is an available option if it is deemed important enough to deterring Iranian missile use and intimidation. For example:

- The United States could extend the above declaration, which is limited to attacks by Iran and its proxies that affect U.S. personnel or facilities, to Iranian attacks (or only Iranian missile attacks) on U.S. partner countries beyond those that affect U.S. forces or facilities.
- The United States could announce that it would consider Iranian flight testing or deployment of an ICBM capable of reaching the U.S. homeland and/or an intermediate-range missile capable of reaching all of Western Europe to be a threat to the security interests of the United States and its partners, which warrants an appropriately strong response.

Diplomacy with Iran to promote missile restraint.[163] The final tool for countering the threat of Iran's (and proxies') missile program is direct diplomacy with Tehran to limit or roll back its missile capabilities. Such restraints could be tacit or explicit, private or public, and unilateral, bilateral, multilateral, or regional. Presumably, tacit, private, or unilateral restraints would be easier and quicker to obtain from Iran than explicit, public, or multilateral restraints.

But given the central role of missiles in Iranian national security and foreign policy, Iran's consistent rejection of negotiating limits on its missile force,[164] Iran's long record of previous noncompliance with the Nuclear Non-Proliferation Treaty and its IAEA Comprehensive Safeguards Agreement,[165] and the difficult nature of all previous negotiations with Iran, obtaining any form of negotiated missile restraint with Iran is likely to be fraught with difficulty. The process would take substantial time; present interpretation, monitoring, and circumvention challenges; require the provision to Iran of carrots from a limited pool for which there are other claimants (nuclear, regional troublemaking, human rights); and leave some parts of the Iranian missile threat unconstrained. Moreover, given the acrimonious state of U.S.-Iran relations in the wake of Washington's pullout from the JCPOA, negotiated restraint is unlikely to be a realistic tool to employ anytime soon.

For these reasons, the other policy tools described above may well be the most dependable ways of reducing the Iranian missile threat. They may also pressure Iran over time to accept negotiated constraints. These other tools have significant limits, however. If effective, they can complicate, slow, and impede Iran's missile activities; but they cannot prevent a determined and resourceful country from pursuing those activities. Ultimately, it is up to Iran to restrain its missile program.

Therefore, diplomacy with Iran to obtain missile restraint should remain part of the overall toolkit used against Iran's missile program, both because circumstances might change in the future to make missile negotiations more promising and because U.S. readiness to negotiate on this issue could help build international support for the other measures the U.S. must take to impede the Iranian missile threat in the event that diplomacy is not feasible or fails.

U.S. efforts to engage Iran on missile issues would not take place in a vacuum, but in the context of overall U.S.-Iranian relations and specifically in the context of U.S. efforts to engage Iran on other areas of concern, including its nuclear program, its support for regional proxies, and its meddling in the affairs of its neighbors. The Trump administration has called for a new deal with Tehran that would cover 12 ambitious demands, including that Iran stop all uranium enrichment, end its proliferation of ballistic missiles, halt further flights tests and development of nuclear-capable missiles, withdraw all forces under its command from Syria, and end its support for Hezbollah and other regional proxies.[166] It is unclear at this stage whether the administration has in mind a single negotiation and agreement covering all of its concerns or a series of engagements and arrangements addressing individual concerns or groups of concerns (e.g., nuclear and missile) separately. A successor U.S. administration presumably would also want to address a similarly broad range of Iranian behaviors, although its objectives in the various areas and its methods for pursuing them might well be quite different.

It is therefore too early to predict how U.S. missile diplomacy with Iran would fit into broad U.S. engagement with Iran, whether any negotiated restraints on Iran's missile activities would be free-standing or part of a larger package, or how sanctions relief and

other sources of leverage would be parceled out to incentivize Iranian concessions in the various areas of U.S. concern. This section discusses the types of negotiated missile restraint measures that might be pursued in the future, leaving aside the question of their relationship to other aspects of U.S. policy toward Iran.

Seven broad potential negotiating objectives (which could be pursued singly or combined in various ways in a restraint proposal) are discussed below:

- Banning "development" of nuclear-capable missile systems.
- Banning launches of nuclear-capable missile systems, or just long-range missiles.
- Limiting qualitative improvements in missile systems, by banning "new types" of missiles or missiles with certain attributes, or by limiting the number of missile launches.
- Banning the possession of MRBMs or all nuclear-capable missile systems.
- Limiting space-launch vehicles.
- Banning Iranian missile-related exports.
- Middle East regional missile limitations.

Each of these prospective missile arrangements with Iran will be evaluated against three key criteria:

- The extent of reduction in the missile threat, including what is limited, what runs free, and the risks of circumvention;
- Monitorability, including the extent to which negotiated intrusive monitoring measures would be required; and
- Negotiability, including the likelihood Iran would agree to the prospective arrangement.

Banning "development" of nuclear-capable missile systems. In his May 21, 2018 speech on "A New Iran Strategy,"[167] Secretary of State Pompeo noted that U.S. demands of Iran include that "Iran must end its proliferation of ballistic missiles and halt further launching or development of nuclear-capable missile systems." Although not defined in the speech, based on past positions taken by the United States, U.K., and France, it is reasonable to conclude that "nuclear-capable missile systems" are those covered by Category I of the MTCR Annex: rocket and unmanned air vehicle (UAV) systems capable of delivering a payload of at least 500 kg to a range of at least 300 km.[168] As noted previously, such systems are multilaterally agreed to be considered inherently capable of delivering nuclear weapons.

Less clear is the extent of a ban on the "development" of such missiles. A starting point might be the MTCR Annex definition of "development":

> "related to all phases prior to "production" [another Annex-defined term essentially relating to series production] such as: design, design research, design analysis, design concepts, assembly and testing of prototypes, pilot production schemes, design data, process of transforming design data into a product, configuration design, integration design, layouts."

Based on these MTCR definitions, the extent of reduction in the threat of a ban on the "development" of "nuclear-capable missile systems" would primarily come from impeding the creation of new or extensively modified systems. Deployment and production of existing missile systems apparently would be unaffected, as such systems have already completed "development." Moreover, "development" apparently does not include series production. Thus, the existing regional threat posed by Iran's missile force would be unaffected quantitatively (and could grow), and would be affected qualitatively only to the extent that "development" (and flight testing if there were an associated launch ban) is required to realize qualitative improvements. An associated ban on missile launches (see below) could degrade the reliability of existing regional missile systems over time, but such degradation probably would be very gradual for robust and well-tested Scud-derived SRBMs and MRBMs. A "development" ban (especially in conjunction with a launch ban) would have a much greater impact in impeding the introduction of intermediate-range missiles that could reach all of Western Europe and intercontinental-range missiles that could reach the U.S. homeland.

Because many relevant "development" activities can occur indoors or be difficult to distinguish from "production," a "development" ban would be difficult to monitor. But prohibited "development" would have a much better chance of being detected over time (and distinguished from permitted activities involving existing systems) if it involves entirely new missile types, particularly if new types had proceeded to series production and deployment. One could conceive of on-site inspection schemes that could improve confidence in monitoring a "development" ban, especially as it relates to entirely new missile types that are visually distinct from existing ones, but such schemes would need continuous or highly frequent access to all relevant facilities to be most effective and could still be circumvented by conducting prohibited "development" at undeclared facilities. Realistically, an associated launch ban would be the biggest safeguard against circumvention of a "development" ban: In the absence of flight tests, the reliability of any new or extensively modified missile system would be questionable (a possible ban on launches of "new types" is discussed below).

Iran's long-standing public opposition to negotiating limits on its missile force, its clear messaging that maintaining missiles with ranges up to 2000 km is a national security imperative, and the important role regional missiles appear to play in Iran's national security strategy and warfighting doctrine all suggest that the negotiability with Iran of a ban on the "development" of "nuclear-capable missile systems" would be highly questionable—or at least that the negotiating price Iran would demand for such an agreement would be very high. This would be further complicated to the extent that the United States deems intrusive on-site inspections are necessary to have adequate confidence in compliance with such an agreement, given long-standing Iranian substantive and domestic political sensitivity over the issue of access to military sites and the likely desire to protect from disclosure (and Western targeting) sensitive missile-related activities not prohibited by the "development" ban (much less any desire to retain a breakout hedge).

Banning launches of all nuclear-capable missiles. Banning launches of all "nuclear-capable missile systems" would substantially impede the introduction of intermediate- and intercontinental-range missiles, as well as new or extensively modified SRBM or MRBM systems or SLVs, while not having much of a near-term impact on the threat from existing types of Iranian regional-range systems. (Such a launch ban could be part of a larger set of missile limits, such as the "development and launch" ban proposed

by Secretary Pompeo, or a stand-alone measure.) A key virtue of missile launch bans is their monitorability; launches of "nuclear-capable" rocket systems can be detected unilaterally and with high confidence by the United States through its national technical means located outside Iran, and thus without the need for any monitoring measures negotiated with Iran. Except perhaps for rocket systems at the very low end of the "nuclear-capable" range/payload capability spectrum, launches of "nuclear-capable" rocket systems should be quite distinguishable from those of permitted systems. Other than that, such detection essentially cannot be circumvented except by launching prohibited rocket systems from another country (which would need to be banned in an agreement) and hoping the United States misidentifies them as non-Iranian systems (a problematic hope).

Launches of cruise missiles and other UAVs are more difficult to detect by U.S. national technical means located outside Iran because such systems have much less energetic propulsion systems and fly entirely within the atmosphere, often at low altitudes. And they could be hard to distinguish from launches of permitted UAVs that are not "nuclear-capable." This offers a circumvention avenue under which Iran could seek to conceal launches of prohibited cruise missiles in the guise of permitted systems, in addition to launching banned cruise missile systems from other countries (and exploiting the attendant detection and distinguishability problems).

As with a "development" ban, the biggest obstacle to a ban on launches of all "nuclear-capable" missiles would be negotiability. A launch ban would preclude Iran from using flight tests to maintain the reliability of existing types of regional missiles systems that it apparently would be permitted to retain and continue producing under a "development" ban, and preclude troop training launches of such systems. For the same reasons noted above, it is questionable whether Iran would agree to ban launches of all "nuclear-capable" missiles (or agree to do so at an acceptable negotiating price).

Banning launches of long-range missiles. Given the unlikelihood of Iran agreeing to ban all launches of the existing short- and medium-range missiles that play an important role in its national security strategy and conventional military planning, another approach would be to seek a ban just on launches of longer-range rocket systems. Iran already claims to be limiting itself to ballistic missiles of 2000 km range by order of the supreme leader,[169] and has not yet launched ballistic missiles beyond this range. The extent to which this will remain the case is both unknown and easily changed; for example, the deputy head of the IRGC said in November 2017 that Iran has kept below 2000 km as a matter of policy, not technology, and "if Europe wants to turn into a threat, we will increase the range of our missiles."[170] But the current set of circumstances may offer a basis for efforts to elicit from Iran clearer and/or more explicit and formalized restraints on longer-range systems. At a minimum, it has been easier historically to persuade countries to agree to continue not deploying certain military capabilities than to halt or roll back military capabilities they have been deploying for a long time.

The precise nature and scope of a launch ban would be critical to its effectiveness. To limit the potential for circumvention and to ease monitoring and the determination of violations, such a ban should:

- Apply to any trajectory equivalent to one that exceeds a 2000 km range measured for the most direct, range-efficient trajectory (a minimum energy trajectory). This will help prevent simulating longer ranges through the use of non-standard trajectories with a shorter ground range, as North Korea did in its highly lofted tests of ICBMs.[171]

Consistent with the MTCR Annex definition of "range," trajectories would be measured in a standardized way that is indifferent to the effects of the Earth's rotation (i.e., calculated on a non-rotating earth basis) and of the atmosphere (i.e., assuming International Civil Aviation Organization standard atmosphere with zero wind).

- Apply to any rocket system, whether it is classified by Iran as a "ballistic missile" or not. This would prevent circumventing the ban by testing in a long-range missile trajectory something Iran portrays as a "space launch vehicle" or otherwise not a "ballistic missile." Iranian launches of satellites in trajectories that are not equivalent to a minimum-energy trajectory exceeding 2000 km would be permitted. This would still allow launching satellites to low-earth orbit, just as Iran has being doing with its SLVs, but not to geosynchronous or other higher orbits that would require much larger SLVs than Iran currently possesses. Iran's near-term space plans involve low-earth orbit satellites; although it has posited ambitious space objectives that have waxed and waned,[172] and has worked toward geosynchronous satellites,[173] its true space objectives are unclear. (The issue of cruise missiles and other UAVs is addressed below).

- Apply to any rocket system launched from Iran, and to any rocket system launched anywhere else on behalf of or for the full or partial benefit of Iran. This provision would prohibit the previously discussed circumvention scenario of testing an Iranian missile from another country, including in the guise of a third-country SLV. An exception should be made for launches of Iranian satellites on SLVs produced by and launched from foreign countries, so Iran can continue to have access to space for civil purposes. But such launches should be limited to boosters belonging to those countries that had orbited payloads prior to 1998, which would prohibit Iran from using North Korea or another non-traditional spacefaring country to help it circumvent the launch ban (e.g., by using an "SLV" launch to test Iranian ballistic missile subsystems, testing an "SLV" imported from or co-developed with Iran, testing an "SLV" subsequently sold covertly to Iran and used as a ballistic missile, etc.). This assumes China, Russia, and other pre-1998 spacefaring countries would not conspire with Iran to circumvent the launch ban.

Obtaining such a ban on long-range rocket launches would be highly effective in reducing the threat of long-range Iranian ballistic missiles.

- The longer Iran refrains from testing rockets beyond 2000 km, the longer it will take to develop a viable ballistic missile threat against the continental U.S. and even most of Western Europe.

- While Iran's eschewing longer-range ballistic missiles may be of limited direct security value to Israel and Gulf Arab states within range of Iran's existing SRBMs and MRBMs, the lack of a viable ballistic missile threat to the U.S. homeland at least minimizes Iran's ability to use such a threat to "decouple" the U.S. from their security. (U.S. friends in the region often evince the inverse concern that a lack of such U.S. vulnerability would send the message that Washington will not get involved in their defense.[174])

Another virtue of a long-range launch ban is that it can be monitored with high confidence solely from U.S. national technical means outside Iran, as discussed above, without inspections or other on-site measures that Iran might resist, seek a high additional negotiating price for, or use to drag out negotiations.

These benefits would need to be assessed in light of the limitations of a long-range launch ban:

- The ban would not prevent Iran from deploying IRBMs or ICBMs (including in the guise of SLVs) if it is prepared to rely on systems that have only ever been flown in a trajectory below 2000 km, not to full range. (See below for discussion of a possible method of managing this risk by adding payload capability limits.) Based on the practice of most missile-developing states, a country should not be prepared to rely militarily on such untested systems, but Iran might have different standards or choose to have them in the future.

- The ban would not affect Iran's land-attack cruise missiles, which may already have ranges of 2000-3000 km.[175] As noted previously, cruise missile tests can be difficult to detect and properly characterize, and reasonable circumvention scenarios are available for Iran to portray launches of long-range cruise missiles as launches of permitted systems. Moreover, there are reasonable scenarios under which Iran could conduct launches of long-range cruise missiles to ranges of less than 2000 km and gain substantial confidence that such missiles would function reliably at much longer ranges. (That said, if one were prepared to accept such circumvention risks one could add UAVs, including cruise missiles, to a 2000 km rocket launch ban.)

- And, of course, the ban would not address the long-standing threat of Iran's ballistic missiles with ranges below 2000 km.

The negotiability of the above type of long-range launch ban is unclear. But because it is consistent with Iran's public claims of its practices under the supreme leader's instructions and its ballistic missile behavior to date, and because it would not affect the regional missile systems Iran has thus far relied upon for its national security and military planning objectives, such a ban logically should be more negotiable with Iran than measures directed at all "nuclear-capable missiles" and presumably would put Iran at pains politically to justify why it is not prepared to accept it.

It should be noted that another method of limiting Iran's ability to circumvent a long-range launch ban would be to expand the limit beyond just range to range/payload capability: to ban launches of rocket systems capable of delivering a nuclear-sized payload (say, 500 kg) to a range of at least 2000 km. This would protect against any launch by Iran of a nuclear-capable IRBM- or ICBM-class rocket system, even to a range below 2000 km, and prevent it from using sub-2000 km launches to at least ensure the reliability of such a system in the launch phase.[176]

- In addition to banning launches of IRBM- or ICBM-class systems, launches of Iran's developmental Khorramshahr and some of its existing deployed extended-range No Dong-class MRBMs also would be banned under such a range/payload capability approach, as would launches of most if not all SLVs. Thus, Iran would be forced to give up troop training launches of systems it already actively relies upon for its national security, as well as its ability to launch even civil satellites.

- Range/payload capabilities vary from rocket system to rocket system and are difficult to determine precisely—especially if capability is assessed based only on national technical means, which rely heavily on engineering judgments that could easily be disputed by Iran and its international supporters (although disputing that IRBM-

or ICBM-class systems fall within the permitted parameters would strain credulity). Avoiding this problem would require on-site access to Iranian rockets before they are launched, something that Tehran is highly unlikely to permit.

- Thus, a range/payload approach to a 2000 km launch ban is about as unlikely to be accepted by Iran as a ban on launching all "nuclear-capable" rocket systems—which itself is essentially a "range/payload" approach given the use of the MTCR Category I range/payload capability standard (300 km and 500 kg) to define "nuclear-capable."

Limiting qualitative improvements in missile systems. Limits that impede qualitative improvements in missile systems could be proposed to augment quantitative limits, to provide some coverage of missile types that Iran is not prepared to limit quantitatively (in particular, regional missile systems), or to ban particularly destabilizing capabilities.

- Banning launches of "new types" of missiles. As an example, the SALT-II treaty signed between the United States and USSR in 1979 banned the flight testing or deployment of "new types" of ICBMs beyond one "new type" of "light" ICBM per side.[177] "New types" in SALT-II differed from existing ones in terms of propellant type, numbers of stages, or more than a 5 percent difference in length, largest diameter, launch weight, or throw-weight. Such limits might be able to cap increases in the conventional warfighting capability and range of Iran's missiles. Although limits on "new types" presumably would be more acceptable to Iran than limits on "existing types," the priority Iran has put on improving the lethality of its regional missiles in order to boost their conventional warfighting utility suggest it would still resist limits on "new types." Seeking such limits also would add to the complexity and duration of negotiations, and probably to the price Iran would demand for any agreement. Moreover, monitoring limits on "new types" can be difficult, especially relying only on national technical means, and such limits can provoke compliance disputes such as the U.S. contention that the USSR violated the SALT-II limit on "new types."[178]

- Banning launches of missiles with certain attributes. This would be a way of impeding particularly destabilizing capabilities that could be easier to define and monitor than a "new type" limit. For example, launches featuring terminally guided, maneuvering, or MIRV payloads might be banned; or launches of ballistic missiles from air, sea, and submerged platforms. Such limits could help impede increases in the conventional warfighting capability of Iran's missiles, their ability meaningfully to threaten maritime targets, or their ability to evade missile defenses. Iran presumably would be less interested in banning capabilities it already is working on, such as terminally guided warheads, than capabilities it is farther away from, such as MIRVs or air-launched ballistic missiles.

- Limiting the number of missile launches. A more indirect way of slowing the pace of development and qualitative improvement would be to limit the number of certain rocket systems that can be launched, such as annual limits on the number of launches of "nuclear-capable" or long-range systems. Numerical launch limits could augment other limitations or could be proposed to cover missile types that Iran refuses to limit in other ways. In any case, launch limits could force Iran to make trade-offs between (a) troop training launches of existing deployed systems to maintain units' warfighting proficiency; (b) test launches needed to advance the development of new or modified systems; and potentially (c) launches of permitted SLVs. It is difficult to know what a realistic annual limit on launches would be. Iran

> appears to have launched an average of about eight "nuclear-capable" rocket systems per year between 2015 and 2018; it launched a high of 31 such rockets in 2001 and a low of zero to four such launches per year in eight of the years between 2001 and 2018.[179] Obviously, lower numbers of permitted launches would be better in terms of limiting the Iranian missile threat. As noted previously, launches of "nuclear-capable" rocket systems can be detected unilaterally by the United States through its national technical means with high confidence, and should be distinguishable from those of permitted systems except perhaps for rocket systems at the very low end of the "nuclear-capable" range/payload capability spectrum. Given the impact on both its existing deployed systems and its development of new and modified ones, Iran is likely to regard any substantial numerical launch limit as having an unacceptable impact on missile capabilities that play such an important role in its national security strategy and conventional military planning.

Banning missile possession. As noted previously, the current U.S. demand reflected in Secretary Pompeo's May 2018 speech that Iran must "halt further launching or development of nuclear-capable missile systems" does not appear to affect Iran's possession of such systems. In an amplifying speech on December 11, 2018, Assistant Secretary of State Chris Ford said that

> "[A] negotiated solution that really handles the Iran missile problem … would **presumably need to** … not least … requir[e] that Iran divest itself of the range class of missiles that Iran itself has irretrievably tainted by trying to develop nuclear warheads for them—missiles such as the Shahab 3 [i.e., MRBMs]. … Beyond that, **it is probably best** … that Iran be restricted from developing or possessing systems capable of carrying a payload of at least 500 kilograms to a range of at least 300 kilometers."[180] (emphasis added)

Banning the "possession" of rocket and UAV systems of medium range ("MRBMs" are defined as having ranges of 1000-3000 km), or of all "nuclear-capable" rocket and UAV systems, would prohibit the Iranian missile threat to Israel and the southeast of NATO posed by the Shahab-3 and other MRBMs, Soumar LACMs, and any future such systems. A ban on possessing "nuclear-capable" systems would additionally prohibit Iran's Scud-based SRBMs and perhaps the larger members of the Fateh-110 family (Fateh-313 and Zolfaghar), which comprise a substantial portion of Iran's missile threat against Gulf Arab states and U.S. bases there, and allow Iran to strike such targets from more secure locations in Iran's interior rather than from its borders. A "nuclear-capable" ban would not affect the original Fateh-110 and other smaller members of that family of SRBMs, or future ballistic and cruise missile systems that are not capable of delivering a 500 kg payload to a range of at least 300 km.

Assuming Iran agrees to a possession ban, its incentives to deploy existing and newly developed types of ballistic and cruise missile systems that are not covered by the ban would greatly increase. In addition, its options for circumventing a possession ban include (1) concealing portions of its existing inventory of banned systems, (2) producing additional numbers of existing banned systems in covert facilities, and (3) developing new systems it claims are not covered by the ban that actually are capable of exceeding it (e.g., "non-nuclear-capable" ballistic or cruise missiles actually capable of exceeding 300 km range with a payload of at least 500 kg, or "short-range" ballistic or cruise missiles actually capable of ranges over 1000 km).

The monitorability of a possession ban would be complex. Western estimates of the size and locations of Iran's missile deployments and production facilities likely include uncertainties and intelligence gaps. Missiles and their support equipment (and even production facilities, especially for liquid-propellant systems) can be hidden in many locations among Iran's large number of civil and underground military facilities, as well as among the large infrastructure that would remain for permitted missile and other military systems. Over time, the reliability of existing types of banned systems that are retained or (especially) covertly produced probably would degrade, but such degradation probably would be very gradual for Iran's existing robust and well-tested Scud-derived SRBMs and MRBMs, and even for any banned Fateh-110-class systems (given the permitted retention of the infrastructure for the smaller systems in the family). Managing these substantial monitoring challenges almost certainly would require extensive and intrusive on-site inspections, including the ability to inspect any site suspected of housing or producing banned systems.

The profound effect of a medium-range or nuclear-capable missile ban on Iran's ability to execute its military strategy means these bans are the missile limits least likely to be accepted by Iran. (Assistant Secretary of State Ford's contention that "Even without Category I systems, it would still have formidable capabilities and would be quite capable of defending itself" is highly unlikely to be shared by Iran.) That unacceptability would be compounded by the U.S. need for intrusive on-site inspections, given long-standing Iranian substantive and domestic political sensitivity over the issue of access to military sites and the likely desire to protect from disclosure (and Western targeting) sensitive missile-related activities not prohibited by the possession ban (much less any desire to retain a breakout hedge).

SLV limits. SLVs, as MTCR Category I rocket systems, are internationally recognized as being inherently capable of delivering weapons of mass destruction. The most effective negotiated restraints on Iran's missile behavior, therefore, would treat SLVs no differently from "ballistic missiles" and cover all types of relevant rocket systems. But it is sometimes posited that limits on "ballistic missiles" that permit Iran to retain some or all types of "SLVs" would be necessary or desirable as an inducement for Iran to accept limits on its "ballistic missiles,"[181] or that Iran would agree to "ballistic missile" limits only if they did not affect "SLVs."

By definition, missile limits that do not differentiate between "SLVs" and "ballistic missiles" would be more effective in limiting the Iranian missile threat, block an obvious circumvention avenue, and be easier to monitor. Given Iran's long history of using its declared "civil" nuclear program to conceal and provide a breakout platform for nuclear weapons options,[182] Iran's motivations in seeking to exclude SLVs from ballistic missile constraints would have to be regarded as suspect. This is particularly the case given the lack of cost-effectiveness of SLV programs pursued purely as space-launch ventures without an overt or covert ballistic missile component,[183] and in light of the much more cost-effective alternative of Iran launching satellites on at least Chinese and Russian boosters.

Therefore, it is not in the West's interest to propose "missile" restraints that differentiate between "SLVs" and "ballistic missiles." A preferable alternative to excluding SLVs from ballistic missile limits would be to require Iran to forgo SLVs in exchange for the cost-free or subsidized ability to launch Iranian civil satellites on SLVs produced by and launched from countries that had orbited payloads prior to 1998, which would include Russia or China but not North Korea (as noted above).

If in the course of negotiations it becomes clear that Iran is only prepared to accept meaningful limits on ballistic missiles if SLVs are permitted, the United States would need to decide whether the type of ballistic missile limits Tehran is willing to accept, at the negotiating price it is asking, is worth running the risk of allowing Iran to retain "SLVs" inherently capable of delivering nuclear weapons and serving as a technology testbed and breakout repository for an IRBM or ICBM program. If the United States decides that permitting Iran to retain "SLVs" is worth the risk, various collateral constraints have been proposed to limit the weapons delivery potential of any Iranian SLVs permitted in an agreement constraining ballistic missiles, including: [184]

- Separating SLV programs, including bureaucracies, facilities, and personnel, from ballistic missile programs. This would be intended to keep "SLV" technology and know-how from contributing to a "ballistic missile" program, and vice-versa. Such an approach would require substantial additional investments by Iran to establish an independent "SLV" program that does not currently exist, and would offer myriad circumvention opportunities given the hundreds of people involved in an "SLV" program and the ease of moving know-how to a "ballistic missile" program in an age of the internet and thumb drives.

- Limiting the number of assembled SLVs and rocket engines permitted to exist at any one time, or even the amount of rocket propellant. This would be intended to limit the ability to misuse SLVs for military purposes, but could be circumvented by maintaining parallel covert production facilities to build SLVs and engines of the same types validated in overt production and testing (and by covertly stockpiling or producing propellants).

- Limiting "SLVs'" use of propellants to liquids, or just non-storable liquids. Solid propellants provide the most military utility in terms of response time, ease of handling, mobility, and concealability, so denying their use in "SLVs" would be very significant in limiting the military impact of a breakout. Allowing SLVs to use storable liquid propellants (as all of Iran's and North Korea's current road-mobile liquid-propellant ballistic missiles, which make up the bulk of their missile inventories, do) would still permit an "SLV" program to provide a breakout capability of substantial military utility. (It also has been proposed to ban SLV use of just the higher-energy liquid propellants better suited for IRBMs and ICBMs, such as those used in the Khorramshahr, not the lower-energy Scud-class propellants.) This breakout utility would be dramatically reduced if SLVs are allowed only to use non-storable liquid propellants (such as liquid oxygen), but Iran does not currently use such propellants and would have to make substantial investments to do so. Launches of SLVs under any of these propellant limitations would be straightforward to monitor.

- Limiting SLV payloads that can survive re-entry. This would protect against using "SLV" launches to test re-entry vehicles, which are indispensable for ballistic missiles but entirely unnecessary for satellite launches. Although there can be some civil uses for payloads or portions of payloads that survive re-entry, such as the return of test samples (and some have proposed SLV limits that would permit such uses in certain circumstances), the potential legitimate value to a neophyte spacefaring country like Iran (which could in any case be obtained by launching such spacecraft on foreign boosters) is significantly outweighed by the potential contribution to ballistic missiles. Launches of SLV payloads to re-entry would be straightforward to monitor.

- Limiting SLV launcher types to fixed, above-ground, land-based launchers. Such launchers are more easily targeted by an attacker, and thus have much less military utility than underground or mobile launchers, but are the type most commonly used for SLVs. This limit could be circumvented by using covert underground or mobile launchers elsewhere, although at least the mobile launchers would differ from the ones actually used to flight test the "SLV."

- Transparency measures and inspections. Most proposals for SLV limits as part of an Iran missile deal recognize that transparency measures (such as declarations of rocket characteristics and facilities, pre-launch notifications, etc.) and on-site inspections are needed to adequately ensure compliance with the SLV limits and impede support to a covert IRBM or ICBM program. Ideas range from having observers at SLV launches, to inspecting SLV production facilities to monitor the number of "SLVs" produced, to inspecting payloads before launch to ensure they are not re-entry vehicles. Circumvention possibilities depend on the details of the inspection regime, but an overriding limitation is that inspections only are effective at facilities that are inspected, for the time inspectors are present, and for what the inspectors actually see.

Any of these measures would need to be accepted by Iran and "paid for" by the West in negotiations—in addition to the direct missile limits that Iran also would need to accept and the West also would need to "pay for." Those SLV limits with the most ability to reduce the circumvention potential of a permitted Iranian SLV program presumably would be the most difficult for Iran to accept and carry the highest negotiating price.

Ban on Iranian missile exports. As noted previously, the current U.S. position on Iran includes that "Iran must end its proliferation of ballistic missiles" in addition to halting "development" and launches of "nuclear-capable ballistic missiles."[185] Presumably, the scope of such a ban on missile "proliferation" would essentially mirror the coverage of the current UNSC Resolution 2231 restrictions on Iranian exports of ballistic missiles and related equipment and technology, including missile production know-how. Compared to Resolution 2231, however, there would be a ban on such export activities rather than a requirement for UNSC approval; the ban would be in place for the duration of the new missile agreement rather than expiring in 2023 and Iran would be explicitly agreeing to accept the ban rather than disputing its legitimacy as it has that of the UNSC resolution.

In terms of reducing the threat, a missile export ban could limit increases in the missile threat from Iran's existing proxies, especially qualitative improvements in proxy missile forces, and preclude missile exports to new proxies (or other new customers). Although Hezbollah and Hamas in particular already have a large number of rockets, a near-term export ban could impede further range and accuracy improvements in their stockpiles. But an export ban would not limit the direct threat posed by Iran's own missile force. Any individual violation of an export ban would be difficult to monitor, but over time the fact of continuing violations probably would be detected. An export ban also would be open to a variety of means of circumvention; indeed, Iran's proxies already have been provided substantial rocket and missile forces despite the fact that Iran's missile- and arms-related exports have been prohibited by UNSC resolutions for over a decade.

In terms of negotiability, one presumes Iran would be more willing to negotiate on limiting its exports of missiles and missile technology than to negotiate limits on its own existing SRBM and MRBM forces. Since an export ban would require a change in ongoing Iranian activity that Tehran clearly sees as being in its interest, however, this idea would be expected to encounter strong Iranian resistance. Moreover, in response to proposals for such an

export ban, Iran could demand concessions on non-missile issues related to its proxies (in the Palestinian territories, Lebanon, Yemen, etc.) or pledges by the United States not to export military equipment to its regional partners, thus adding complexity to negotiations and reducing their probability of success. That said, it might be easier to get support from China and Russia for Iranian export restraint (which is more akin to the restraint they themselves have committed to observe) than for restraining what they might regard as Iran's indigenous "legitimate defensive" missile programs.

Middle East regional missile limits. Finally, one could posit regional missile limitations on the premise that Iran would be more likely to limit its missile programs in this multilateral context than unilaterally. (Whether Iran genuinely would be prepared to limit its missiles in a regional context, as opposed to using the probable lack of support of all regional states for such limits as an excuse to avoid limits on its own missiles, would be an important consideration in the viability of this approach.) For example, in May 1991, President George H.W. Bush proposed a broad Middle East arms control plan that included "a freeze on buying, producing and testing all surface-to-surface ballistic missiles, with a view to the ultimate elimination of such missiles" from the arsenals of the Middle East.[186] The Bush proposal got a very cool reception in Israel and Arab capitals and was soon abandoned.

Regional control options could include:

- Confidence-building measures such as an agreement for pre-launch notifications of rocket launches (e.g., for launches beyond national territory and beyond 500 km within national territory).

- Regional rocket-launch bans akin to the 2000 km ban noted above. (Because Israel is an established spacefaring nation, the SLV aspect would be even more important than in the Iran-only context. One proposal would have established launch providers offer satellite launches to Middle East states in exchange for them forgoing further SLV launches.[187])

- Banning the development and possession of ballistic missiles capable of flying more than 3000 km.[188] (The 3000 km figure would grandfather existing Iranian, Israeli, and Saudi missiles. A 2000 km figure would affect Israeli Jericho-II and Saudi CSS-2 missiles.)

- A "no new types" ban, or a ban on launches of terminally guided rockets or maneuvering payloads on rockets capable of a range beyond 300 km, to limit qualitative improvements in the missile threat.

The geographic scope of such control measures could vary from the "Middle East;" to "members of the Arab League, Iran, Israel, and Turkey;"[189] to the Gulf Cooperation Council states and Iran; to the top missile-possessing "triangle" of Iran, Israel, and Saudi Arabia;[190] or to just Israel and Iran.

Simply by virtue of the fact that missile restraint would need to be negotiated among several countries rather than just with Iran, regional missile limits would be the most complex and difficult to obtain of the various negotiating objectives illustrated in this paper. Beyond just the generic "N-countries" problem of more participants in any negotiation leading to more complexities, the checkered history of the effort to discuss a Middle East Weapons of Mass Destruction-Free Zone shows the region-specific challenges a missile restraint effort would face,[191] including:

- Likely Arab efforts (with Iran smiling in the background) to link progress on missiles to Israeli accession to the Nuclear Non-Proliferation Treaty and to non-weapons issues such as the situation of the Palestinians;

- Likely Israeli efforts to maintain that a final missile deal must await resolution of the larger regional security issues that underlie regional states' possession of missiles; and

- Dynamics on all sides concerning intrusive on-site verification, where each side would maintain that allowing such access to the others is necessary, but argue that comparable access to its own territory (with the potential for misuse) would pose unacceptable risks to its own sensitive programs and facilities outside (and potentially within) the scope of its missile program.

These region-specific impediments to negotiated restraint are in addition to the Iran-specific issues noted previously. And regional missile negotiations would be further complicated by Israel's own national security reasons for maintaining a ballistic missile force, the existence of which it largely does not acknowledge, including retaining a credible regional delivery option for its putative nuclear weapons stockpile. Israel's long-standing pursuit of an SLV program would simply add to this complexity.

In short, for the foreseeable future, regional missile restraints are an even less realistic option for managing the Iranian missile threat than the option of negotiated restraints just on Iran's missile program.

The most promising restraint options. As noted previously, the central role of missiles in Iranian national security and foreign policy, Iran's consistent rejection of negotiating limits on its missile force, and the acrimonious state of U.S.-Iran relations mean that negotiated restraint is unlikely to be a realistic tool to employ anytime soon. Should circumstances become more favorable for negotiated restraint, most of the negotiating options identified above would still face serious monitoring and negotiability challenges. But the above evaluation also suggests that two of the seven potential negotiating options examined hold more promise than the others in terms of reducing the Iranian missile threat, monitorability, and negotiability:

- *Banning Iranian launches of long-range rockets* (with the stipulations noted above). This could substantially reduce the Iranian missile threat to the U.S. homeland with high monitorability and consistent with Iran's claimed policy and current practice.

- *Banning Iranian launches of rockets with MIRV payloads and launches of "nuclear-capable" rockets from air, sea, and submerged platforms*. This would impede in a highly monitorable way new attributes that would increase the warfighting capability, ability to penetrate missile defenses, and survivability of Iran's missile force. But it would not reduce the current Iranian missile threat, or increases in that threat using other payload types and basing modes; this same lack of current impact may mean that Iran would be more willing to accept it.

A third potential negotiating objective might have promise in the context of progress in reducing regional tensions or resolving key regional disputes: *banning Iranian missile-related exports*. This could limit increases in the missile threat from Iran's proxies, albeit not the direct threat posed by Iran's own missile force. Tehran presumably would be more willing to negotiate an export ban than limits on its own forces, and an improved

regional situation might reduce Tehran's interest in using missile-related exports to promote its foreign policy objectives. Over time, the fact of continuing violations of an export ban probably would be detected.

Incentivizing Iranian missile restraint. Iran can be expected to seek compensation for any negotiated missile restraints. But what "carrots" would be reasonable to provide Iran would depend on the kinds of restraint it is willing to accept. If, for example, it is only prepared to reaffirm or codify what the supreme leader has stated as Iran's existing position—that it does not need missiles that exceed a range of 2000 km—it should expect to receive little in return. But if Iran is willing to agree to more significant limits—such as restrictions on flight testing of such missiles or on missile exports—it could expect to receive more.

A logical and reasonable quid for meaningful Iranian restraint would be a relaxation or suspension of certain U.S. missile-related sanctions. Or, as noted above, in exchange for Iran agreeing to forgo SLVs, it might receive the cost-free or subsidized ability to launch its own civil satellites on SLVs produced and launched by certain other countries. But, as also noted above, U.S. missile diplomacy with Iran would be embedded in a broader diplomatic effort to seek modifications of Iranian behavior in several areas of concern, including Tehran's nuclear program and its destabilizing role in the Middle East. Therefore, the question of incentivizing Iranian missile restraint would have to be considered in the context of the leverage available to promote Iranian restraint across the board—and potentially how to allocate that leverage to achieve particular negotiating objectives.

Overall evaluation of policy tools to address the Iran missile threat. Iran's heavy reliance on missiles to meet its military and foreign policy objectives means that Tehran will resist stoutly U.S. measures to impede the Iranian missile threat. While there is no panacea to obviate the Iranian missile threat, pursuing simultaneously the full range of the nine policy tools discussed above as intensively and creatively as possible would provide the maximum benefit.

- **Trade controls** and **interdiction** will continue to play an important role in impeding quantitative and qualitative improvement in the Iranian missile threat, but are of diminishing marginal utility in the face of the large size of Iran's force and the increasing sophistication of its indigenous missile production capability.

- This means that there will be an increasing need to rely on military capabilities (the mutually reinforcing set of offensive **attrition**, **missile defenses**, and **passive defenses**) and **declaratory policy** to deter, defend against, and deny the objectives of Iran's missile program.

- At the same time, **sanctions** and **diplomatic pressure** will remain important in dissuading Iran from extending the threats its missile force poses, dissuading other countries from assisting its missile program, and increasing the prospects that Iran can be persuaded at some point to roll back aspects of its missile program. Sanctions and diplomatic pressure against third-country entities will become increasingly important.

For the foreseeable future, the above policy tools will remain more effective than direct diplomacy with Iran in impeding the Iranian missile threat. But these other tools cannot prevent a determined and resourceful Iran from continuing to advance its missile program. Therefore, diplomacy with Iran to promote missile restraint should remain part of the overall toolkit, both because circumstances might change in the future to make missile negotiations more promising and because U.S. readiness to negotiate on this issue could help build international support for the other measures the United States must take to impede the Iranian missile threat in the event that diplomacy is not feasible or fails.

VII. LOOKING AHEAD

Iran will continue efforts to improve the accuracy and lethality of its short- and medium-range ballistic missiles and to expand its regional ballistic and land-attack cruise missile forces. This will increase the ability of Iran's missile force to perform its key roles in support of the country's national security and foreign policy—and will increase the threat Iran's missile force poses to the United States and its forces, friends, and interests. Tehran also will continue to pursue several parallel paths to developing intermediate-range missiles capable of reaching all of Western Europe and intercontinental-range missiles capable of reaching the U.S. homeland, at least as a hedge.

There is much the United States can do using the full spectrum of policy tools at its disposal to impede improvements in Iran's missile force and to mitigate the threats that force poses. For example, the United States can help partner countries in the Middle East strengthen their trade controls and can cooperate with them to enhance their attrition capabilities, their defenses against ballistic missiles and land-attack cruise missiles, and their passive defenses. Washington can also coordinate closely with the Europeans and partners in Asia to increase diplomatic pressure against Iran's missile program, to raise international awareness of the Iranian missile threat, to remain vigilant against Iranian missile-related procurement efforts, to complete NATO's planned defenses against Iranian missile attack, and, despite the hesitation of some European states, to join in adopting additional EU or national sanctions against Iranian missile entities and third-country entities that cooperate with them.

Many of those policy tools would be most effective if the United States had the full cooperation of the international community. In the current contentious international environment, that cooperation will not always be forthcoming. In particular, Russia, China, and other countries that have problematic bilateral relations with the United States and are sympathetic toward Iran may often oppose U.S. efforts, for example, to condemn Iranian missile activities as inconsistent with UNSC Resolution 2231 or to impose additional UNSC sanctions against Iranian missile-related entities. They may also be less than fully conscientious about implementing existing measures directed at Iran's missile activities, for example, in complying with their responsibilities under various UNSC resolutions to prevent entities under their jurisdiction from providing materials or equipment to Iran's missile program.

In pressing the international community to help constrain Iran's missile program, the United States can and should take advantage of existing international mechanisms (e.g., the MTCR, the Proliferation Security Initiative, the Hague Code of Conduct, the U.N. Panels of Experts on Yemen and North Korea, and UNSC Resolution 1540); existing international obligations (e.g., UNSC Resolutions 2231, 1540, and 2140 on Yemen); and ongoing patterns of cooperation (e.g., intelligence sharing, interdiction cooperation). Much of this ongoing cooperation is routine, takes place at the professional level, and hopefully will not be unduly impeded by current differences on Iran among many key participating countries.

The United States should also continue to press hard on the Iranian missile issue with Russia, China, and other countries that do not share U.S. concerns about Iran generally and about its missile program specifically. Despite the deterioration in Washington's bilateral relations with Moscow and Beijing, the United States should urge them to consider the destabilizing regional and international impact of Iran's missile activities (including its exports to regional proxies), point out that the growth of Iran's program

would compel the United States to enhance its regional and homeland missile defense capabilities, press them to take more effective actions to stop entities under their jurisdiction from contributing in any way to Iran's missile program, and warn them that the United States is prepared to sanction their entities if they support Iran's missile program.

While seeking international support to address the Iranian missile threat, the United States will also need to act unilaterally—including by further developing and deploying missile defenses, imposing U.S. sanctions when UNSC and other multilateral sanctions are not possible, using public diplomacy to raise awareness of the missile threat from Iran, developing attrition capabilities potentially applicable in Iran, and announcing declaratory policy regarding how the United States may respond to Iranian missile-related provocations.

But as noted earlier in this report, measures such as trade controls, interdiction, sanctions, missile defenses, and declaratory policy can only go so far in impeding, containing, and countering the Iranian missile threat. They cannot stop a determined and resourceful country like Iran from building, improving, and increasing its missile capabilities. At the end of the day, it is Iran's choice whether to restrain its missile program.

This is why the United States must be prepared to engage in direct diplomacy with Iran to seek restraint in its missile program. That said, the near-term outlook for directly engaging Iran and negotiating meaningful missile limitations is poor—both because of Iran's opposition in principle to negotiations on its missile capabilities and because of the current confrontation between Washington and Tehran.

The Trump administration's maximum pressure campaign is putting great stress on the Iranian economy—but not nearly enough stress to compel a proud and resilient country like Iran to buckle under to demands that it considers extreme and unjustified and that it believes are motivated by a desired to undermine the stability of the Iranian regime. Unless much greater pressure is brought to bear on Iran (which probably requires much more support from the international community) or the Trump administration scales back its demands in a major way—both very unlikely—the impasse can be expected to continue. And the confrontation could sharply escalate if Iran decides to withdraw from the JCPOA and begins rebuilding its nuclear program.

In these circumstances, it is hard to imagine engagement with Iran on its missile program in the next two years, and still harder to imagine an agreement emerging from such engagement. Whether a successor U.S. administration will be in a better position to pursue negotiated limitations on Iran's missile activities will depend on a variety of factors, including whether the current U.S.-Iranian confrontation can be eased and whether talks on other issues, mainly on updating and extending the nuclear deal, can be gotten underway.

So, at least for the time being, the United States should focus its efforts to counter the Iranian missile threat on policy tools that do not require direct engagement with Iran or Iranian consent. Many of these efforts are already being pursued to varying degrees, and indeed have been pursued under several previous U.S. administrations. The United States should intensify these efforts, better integrate them, and elevate their priority in dealing with the overall Iranian challenge—and their priority in U.S. bilateral relations with key states. There is still much work the United States can do at present to address the Iranian missile threat.

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