



The Role of Missiles in Iran's Military Strategy

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Iran has the largest missile force in the Middle East, consisting of more than a thousand short- and medium-range ballistic missiles, and possibly land-attack cruise missiles. Although its missiles are conventionally armed, many could deliver a nuclear weapon if Iran were to acquire such a capability. While the recent nuclear accord with Iran—the Joint Comprehensive Plan of Action (JCPOA)—will likely defer such an eventuality, it did not impose new constraints on Iran's missile program. On the contrary, it loosened them—and included provisions for their lifting in eight years, if not sooner.¹

Iran's missile force could double or triple in size by the time the major limits imposed by the nuclear deal are lifted, fifteen years from now. By then, Iran's growing missile and cyber capabilities will pose major challenges to regional missile defenses, military and critical infrastructure targets, and civilian population centers. This would make preventive action by Israel or the United States, in the event of an attempted Iranian nuclear breakout, much more costly.

Finally, an Iranian nuclear missile force would be highly destabilizing. Short missile flight times between Iran and Israel, the lack of reliable crisis communication channels, and the impossibility of knowing whether incoming Iranian missiles are conventional or nuclear could someday spur Israel—and any other regional nuclear states that emerge in the interim—to

adopt a launch-on-warning posture, undermining the prospects for a stable nuclear deterrent balance in the region.

DETERRENCE, WARFIGHTING, PROPAGANDA

The Iran-Iraq War (1980–88) convinced Tehran that a strong, capable missile force is critical to the country's security.² Missiles played an important role throughout that war, especially during the February–April 1988 “War of the Cities,” when Iraq was able to hit Tehran with extended-range missiles for the first time. Iranian morale was devastated: more than a quarter of Tehran's population fled the city, contributing to the leadership's decision to end the war.³

Since then, missiles have been central to Iran's "way of war," which emphasizes the need to avoid or deter conventional conflict while advancing an anti-status quo agenda via shaping activities—particularly propaganda, psychological warfare, and proxy operations. Iran's deterrence triad rests on its ability to: (1) threaten navigation through the Strait of Hormuz, (2) undertake unilateral and proxy terrorist attacks on multiple continents, and (3) conduct long-range strikes using its own missiles, or by way of long-range rockets and short-range missiles in the hands of proxies such as Hezbollah.⁴ Iran's growing cyber capabilities may eventually become a fourth leg of this deterrent/warfighting triad, enabling it to strike at adversaries and to project power globally, instantaneously, and on a sustained basis, in ways it cannot in the physical domain.⁵

Each leg of the triad has distinct advantages and drawbacks. Efforts to close the strait could roil global financial markets but would be a last resort for Iran because nearly all of its imports and oil exports pass through this route. And even a temporary disruption of traffic through the strait would alienate countries in Europe and Asia that depend on Gulf oil. Moreover, Tehran's ability to wage terrorism has atrophied in recent years—as demonstrated by the ill-conceived plan to assassinate the Saudi ambassador to the United States (2011) and a series of bungled attacks on Israeli targets in Asia (2012). Iran cannot be sure that planned terrorist operations will succeed.⁶

Iran can mass missile fires against population centers to undermine enemy morale, though only a small number of its missiles currently have the accuracy to precisely strike military targets or critical infrastructure; these are largely short-range systems such as the Fateh-110 and its derivatives, and perhaps the longer-range Emad. Longer-range systems such as the Qiam, Shahab-3, and Ghadr (see table 1) could disrupt enemy operations at much greater ranges, though they lack the accuracy to inflict significant damage on military or civilian installations. With increased accuracy, Iran could effectively target military facilities and critical infrastructure, and

greatly stress enemy missile defenses—as nearly every incoming missile would pose a threat and would need to be intercepted.⁷ Increased accuracy may be important even if Iran acquires nuclear weapons, given that first- and second-generation devices might provide relatively small yields.

Although terrorist attacks afford Iran a degree of standoff and deniability, follow-on attacks might take weeks or months to plan, and could be difficult to implement against an alerted enemy. By contrast, missiles permit quick, flexible responses during rapidly moving crises. Missile salvos can also generate greater cumulative effects on enemy morale and staying power in a shorter period than can terrorist attacks. For these reasons, Iran's missile force constitutes the backbone of its strategic deterrent.

Indeed, Iranian officials have often discussed their missile force using terms borrowed from classic deterrence theory. Thus, shortly after the first test launch of the Shahab-3 missile in July 1998, then defense minister Ali Shamkhani explained that to bolster Iran's deterrent capability,

we have prepared ourselves to absorb the first strike so that it inflicts the least damage on us. We have, however, prepared a second strike which can decisively avenge the first one while preventing a third strike against us.⁸

Iran has likewise threatened to respond to an American or Israeli attack on Iran with a "crushing response,"⁹ the destruction of the Israeli cities of Tel Aviv and Haifa,¹⁰ and strikes against U.S. bases throughout the region.¹¹ Missiles would likely play a central role in any major military contingency that Iran is involved in, at least until its still-nascent offensive cyber capabilities mature, at which point cyber will likely supplement missiles as the mainstay of Iran's strategic forces.¹²

Missiles are also ideally suited to Iran's "resistance doctrine," which posits that victory comes through the demoralization of one's enemies by terrorizing their civilians, bleeding their armies, and denying them success on the battlefield.¹³ In this regard, the way in

which proxies such as Hezbollah and partners such as Hamas used rockets in recent wars with Israel provides a useful template for understanding the role of conventionally armed missiles in Iran's warfighting doctrine.¹⁴ Moreover, as terror weapons, rockets and missiles are equally effective, given that civilians are indifferent to whether they are killed by unguided or guided systems.

Missiles are also Iran's most potent propaganda weapon. They are a central fixture of just about every regime military parade, where they are often dressed with banners calling for "death to America" and for Israel to be "wiped off the map."¹⁵ They are used as symbols of Iran's growing military power and reach, and as a surrogate for the nuclear arsenal it has ostensibly foresworn. (Many observers will subliminally link missiles and nuclear weapons, since missiles are the delivery system of choice of every nuclear weapons state.) For Iran, missiles are a key psychological warfare prop, and play a central role in its emerging doctrine of nuclear ambiguity and its efforts to create a "virtual" nuclear deterrent.¹⁶

Finally, while most nuclear weapons states created their missile forces years after testing their first nuclear weapon and joining the "nuclear club" (due to the significant R&D challenges involved), Iran will have a sophisticated missile force and infrastructure in place if it eventually abandons its nuclear nonproliferation commitments. Thus, an Iranian nuclear breakout would produce a more rapid and dramatic transformation in its military capabilities than that typically experienced by new nuclear weapons states, potentially exacerbating the conflict-proneness often exhibited by proliferators.¹⁷

IRAN'S MISSILE INVENTORY

As previously noted, Iran has a large, diverse, highly capable missile force consisting of very accurate short-range solid fuel missiles, more than 1,000 less accurate but longer-range liquid-fuel Shahab-type missiles, and an unknown number of land-attack cruise missiles. Its short-range ballistic missiles (SRBMs) are for use against near enemies in the Gulf and include the Fateh-110 (with a claimed range of 300 km),

Shahab-1 (300 km), Shahab-2 (500 km), Fateh-313 (500 km), Zulfiqar (700 km), and Qiam (800 km). Its medium-range ballistic missiles (MRBMs) are for use against Israel and include the Shahab-3 (1,000 km), Ghadr (1,600 km), and Emad (1,700 km).¹⁸ (See figures 1 and 2.) These are believed to be conventionally armed with unitary high-explosive or submunition (cluster) warheads.¹⁹ The aforementioned MRBMs have sufficient excess range to be launched against Israel and the Gulf states from the heart of Iran, where they would be less vulnerable to preemption, and some may have the ability to fly depressed or lofted trajectories, thereby complicating the task of missile defenses.

Iran has also tested a two-stage solid fuel missile, the Sejil-2, whose range of over 2,000 km would allow it to target southeastern Europe—though it is apparently still not operational.²⁰ In June 2011, IRGC Aerospace Force commander Brig. Gen. Amir Ali Hajizadeh announced that Iran was capping the range of its missiles at 2,000 km (sufficient to reach Israel but not Western Europe). He stated that "there is no threat from any country to us other than the U.S. and the Zionist regime" and that "the range of our missiles has been designed on the basis of the distance to the Zionist regime and the U.S. bases in the Persian Gulf region." He added that while Iran "possesses the technology...we have no intention to produce such missiles," implicitly eschewing the development of intercontinental ballistic missiles (ICBMs) in a presumed bid to deflect U.S. and European concerns.²¹ However, Iranian defense minister Brig. Gen. Hossein Dehqan stated in August 2016 that "we don't have any limit for the range of liquid- or solid-fuel ballistic missiles," apparently indicating the lifting of the previous self-imposed limit.²² Accordingly, Iran is reported to have recently tested, unsuccessfully, a version of the North Korean BM-25 Musudan intermediate-range ballistic missile (IRBM), with an estimated range of 4,000 km.²³ This missile would enable Iran to hit the heart of Western Europe.

Iran's Safir space launch vehicle (SLV), which has put four satellites into orbit since 2009, could provide

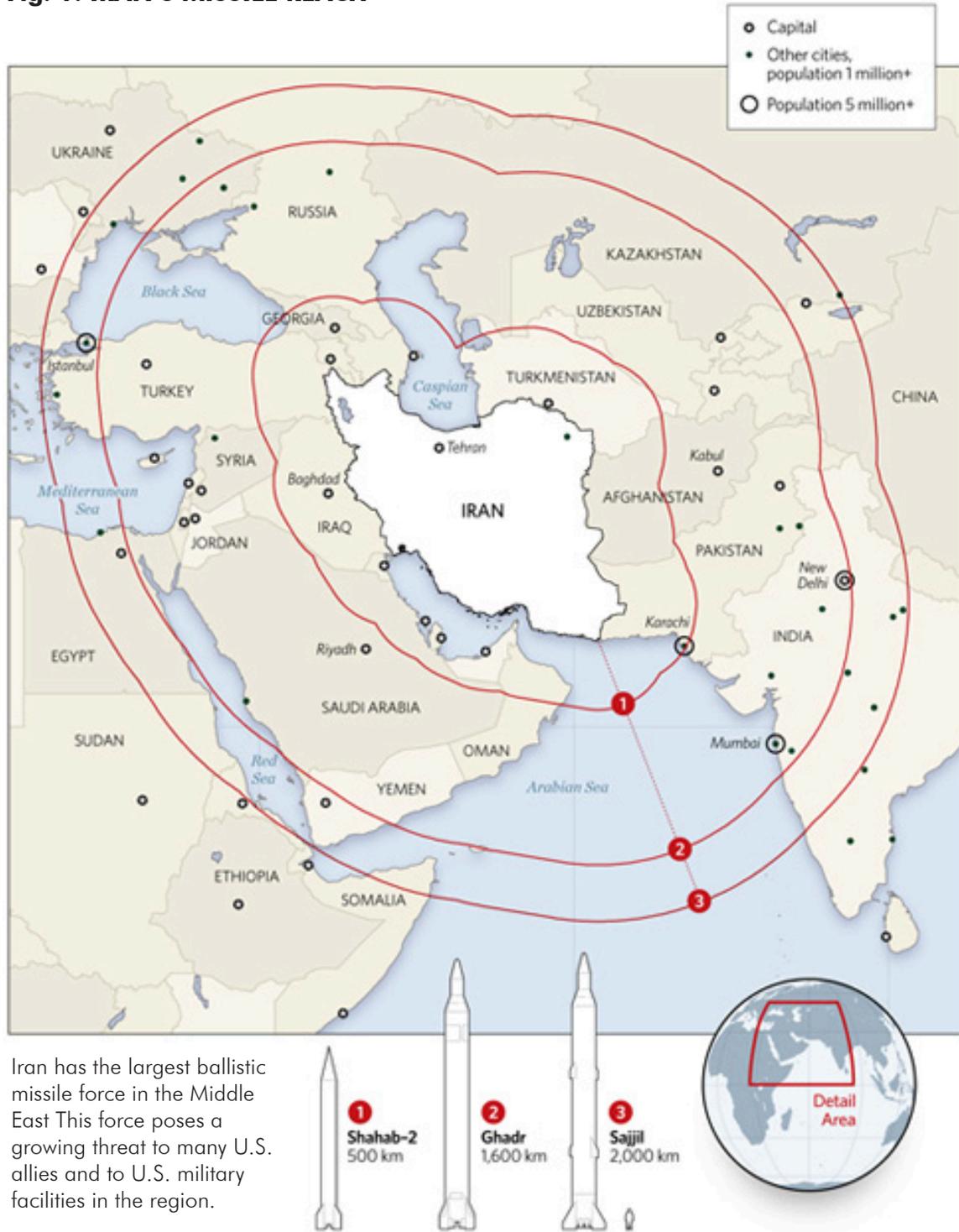
Table 1: SELECT IRANIAN ROCKETS AND MISSILES

This table demonstrates the degree to which Iran’s rocket and missile programs reflect a cautious, incremental approach to military innovation and R&D; the result is an operational rocket and missile force built around a small number of base systems and derivatives.

ROCKET/MISSILE	REPORTED RANGE (KM)	FUEL/PROPULSION	COMMENTS
Fajr-3/-5	45/75	Solid	Mid-range rocket—transferred to Hezbollah
Zelzal-1/-2/-3	125/210/300	Solid	Long-range rocket—transferred to Hezbollah
Fateh-110	300	Solid	Missile derived from Zelzal series rockets—Syria’s M-600 (a derivative) transferred to Hezbollah
Khalij-e Fars	300	Solid	Electro-optically guided antiship ballistic missile—derived from Fateh-110
Hormuz-1/-2	300	Solid	Antiradiation/antiship missiles—derived from Fateh-110
Shahab-1	300	Liquid	Derived from Russian Scud-B missile via North Korea
Shahab-2	500	Liquid	Derived from Russian Scud-C missile via North Korea
Fateh-313	500	Solid	Extended-range Fateh-110
Zulfiqar	700	Solid	Extended-range Fateh-313
Qiam	800	Liquid	Finless design derived from Shahab-2 missile
Shahab-3	1,000	Liquid	Derived from North Korean Nodong missile
Ghadr	1,600	Liquid	Derived from Shahab-3 missile
Emad	1,700	Liquid	Derived from Ghadr missile, reportedly has a maneuvering RV
Sejjil-2	2,000+	Solid	Multistage missile, test flown but not operational
BM-25	4,000	Liquid	North Korean design based on Russian R-27 submarine-launched ballistic missile, test flown?
Ya Ali	700	Turbojet	Air-launched land-attack cruise missile, operational status unknown
Soumar	2,500–3,000	Turbofan	Ground-launched land-attack cruise missile based on Russian Kh-55?

Sources: Michael Elleman, *Iran’s Ballistic Missile Capabilities: A Net Assessment*, IISS Strategic Dossier (London: International Institute for Strategic Studies, 2010); Michael Elleman, “Are Iran’s Missiles a Threat?” *The Iran Primer* (United States Institute of Peace, April 25, 2016), <http://iranprimer.usip.org/blog/2016/may/23/part-i-are-iran%E2%80%99s-missiles-threat>; Uzi Rubin, *The Global Reach of Iran’s Ballistic Missiles*, Memorandum 86 (Tel Aviv: Institute for National Security Studies, 2006), [http://www.inss.org.il/uploadimages/Import/\(FILE\)1188302022.pdf](http://www.inss.org.il/uploadimages/Import/(FILE)1188302022.pdf); Uzi Rubin, “Rockets and Missiles in the Middle East: Global Implications,” PowerPoint presentations, March 2014 and April 2016, <http://documents.mx/news-politics/uzi-rubin-global-threat-evolution-an-update.html>, and https://rusi.org/sites/default/files/uzi_rubin.pdf; Tal Inbar, “The Ballistic Axis: DPRK and Iran’s Cooperation in Missiles and Space—Strategic Implications,” PowerPoint presentation, April 21, 2016, <http://www.slideshare.net/TWIPubs/the-ballistic-axis-strategic-implications-of-dprk-and-irans-cooperation-in-missiles-and-space>.

Fig. 1: IRAN'S MISSILE REACH



Iran has the largest ballistic missile force in the Middle East. This force poses a growing threat to many U.S. allies and to U.S. military facilities in the region.

Source: International Institute for Strategic Studies, *The Military Balance 2014* (London: Routledge, 2014). heritage.org

the experience and know-how needed to build an ICBM. Some assessments suggest that the Safir struggled to put a very small satellite into low-earth orbit and has therefore probably reached the outer limits of its performance envelope—and could not serve as an ICBM.²⁴ In 2010, Iran displayed a full-size mockup of a larger two-stage SLV, the Simorgh, which it first tested in April 2016.²⁵ It would seem that Iran is keeping its options open for developing an ICBM.²⁶ Indeed, U.S. intelligence reports indicate that Iran and North Korea are collaborating on the development of a large rocket motor suitable for use in an SLV or ICBM—which may have been the engine tested by North Korea in September 2016.²⁷

Tehran has also claimed an antiship ballistic missile capability for potential use against U.S. carrier strike groups: the Khalij-e Fars and its derivatives, the Hormuz-1 and 2, each with a claimed range of 300 km. It is not clear that these systems are yet sufficiently accurate or effective to pose a serious threat to U.S. naval surface elements in the Gulf.²⁸

As for land-attack cruise missiles, Iran claims to have produced two: the 700-km range air-launched Ya Ali, and the 2,500–3,000-km range ground-launched Soumar—which appears to be based on the Russian Raduga Kh-55 missiles obtained some years ago from Ukraine.²⁹ The Kh-55 was the Soviet air force's primary nuclear-delivery system. It is not clear that either system is operational.

Iran also fields a very large number of rocket systems used by allies, such as Hezbollah, for strategic bombardment. These include the Fajr-3 and 5 (with claimed ranges of 45 and 75 km) and the Zelzal-1, 2, and 3 (125–300 km). During the Iran-Iraq War, rockets played a major role in bombarding Iraqi cities along the border, and they are central to the “way of war” of Hezbollah and Hamas.

Hezbollah is believed to have received relatively small numbers of M-600, SS-21, and Scud-type SRBMs from Syrian stocks, in addition to more than 150,000 short-range rockets from Syria and Iran. In a future war with Israel, Hezbollah could use its highly accurate M-600 missiles (Syrian versions of the Iranian

Fateh-110) to hit strategic targets—e.g., military headquarters in Tel Aviv, power stations, Israel's offshore natural gas production facilities, Ben Gurion International Airport, and its nuclear reactor at Dimona—and could attempt to suppress Israeli missile defenses with massive rocket and missile salvos from Lebanon to facilitate the penetration of SRBMs launched by Hezbollah or MRBMs launched by Iran.

While many of Iran's missiles are mounted on mobile launchers (some of which are configured to look like civilian vehicles—see figure 3), others are deployed in large numbers of austere “onetime-use” silos³⁰ (see figure 4), and massive underground launch complexes.³¹ These launch complexes consist of tunnel systems (see figure 5) that service underground missile halls built under mountains (see figure 6) as well as presurveyed launch sites adjacent to these mountains (see figure 7). Most of Iran's silo fields and launch complexes are located in the country's northwest, toward the frontier with Iraq, and in the vicinity of the Persian Gulf.³² The use of mobile launchers and underground facilities would greatly complicate preventive or preemptive targeting of its missile force. It would enable Iran to undertake prolonged pre-launch preparations for liquid-fuel missiles (see figure 8) and to conduct mass fires from protected positions without fear of interdiction or disruption by the enemy. The use of underground facilities could also shield preparations for a surprise strike.³³

Iran will likely continue producing SRBMs and MRBMs and may introduce IRBMs in the coming years. United Nations Security Council Resolution 2231, which gave international legal force to the nuclear deal with Tehran and “called upon [Iran] not to undertake any activity related to ballistic missiles designed to be capable of delivering nuclear weapons,” has not proved a hindrance in this regard, and at any rate, Iran has pledged to ignore it.³⁴ Assuming Iran continues its current production rate of fifty-plus MRBMs a year,³⁵ in fifteen to twenty years, when most of the restrictions imposed by the nuclear accord are lifted, it will have doubled or tripled its missile inventory. This will further stress regional missile defenses and dramatically



Fig. 2: “Family Portrait” of Iran’s missile force (right to left): Shahab-1 (camouflaged), Qiam, Shahab-2, Shahab-3, Ghadr, Sejjil, Safir SLV, and Simorgh SLV. (IRNA: Islamic Republic News Agency)

Fig. 3: Camouflage and deception. Iranian missile-support vehicles are configured and painted to resemble civilian vehicles (see the white fuel truck in the background). Likewise, some transporter-erector launchers (TELs) carry rail-mounted curtains that make them look like civilian semitrailers from afar (see the curtain frame—partially obscured by a camouflage net—on the TEL in the foreground).



Fig. 4: Silo-based Shahab-3 missile.



Fig. 5: Ghadr missile TELs and crews in an underground missile base.



Fig. 6: Qiam missile in a launch hall, part of an underground missile base.



Fig. 7: Iranian missiles being launched from camouflaged TELs that likely emerged from tunnels in the adjacent mountains. (Mehr News Agency | Mohammadreza Abbasi)

increase the potential weight of Iranian missile strikes in a future conflict.

The United States and its Israeli and Gulf allies have been investing significant resources in missile defense in recent decades—while Israel has been investing in rocket defenses as well. America and its Gulf partners, however, still face major challenges: insufficient numbers of interceptors to deal with Iranian saturation tactics, gaps in the coverage of currently deployed missile defenses, and the lack of an integrated missile defense architecture in the Gulf.³⁶ The continued growth in size and accuracy of Iran's missile force ensures its ability to saturate and overwhelm missile defenses in the Gulf and Israel. Moreover, the improving accuracy of its missile force, in tandem with its growing offensive cyber capabilities, will enable it to target enemy critical infrastructure and missile defenses with a powerful one-two punch in the physical and virtual domains. This will likely render an American or Israeli preventive strike much more costly, and hence less likely, should Iran attempt a nuclear breakout.

NUCLEAR LINKAGES— POLICY IMPLICATIONS

The International Atomic Energy Agency's "final assessment" of outstanding issues regarding Iran's nuclear program, published in December 2015, confirmed the existence of a number of activities dating to 2002–3 "related to the development of a nuclear payload for a missile," including the integration of a spherical payload (presumably a nuclear implosion device) into a Shahab-3 reentry vehicle (RV) and a fusing, arming, and firing system for the spherical payload to ensure it remained safe until the RV reached its designated target.³⁷

Moreover, in 2004, Iran began deploying triconic, or "baby bottle," RVs—a design almost exclusively associated with nuclear-armed missiles—on its Shahab variants (e.g., the Qiam and Ghadr). Some analysts believe that Iran may have deployed the triconic RV to enhance the accuracy of its conventional warheads and achieve higher terminal velocities to defeat

missile defenses.³⁸ But Iran's experience in designing, testing, and operating triconic RVs could also expedite deployment of a miniaturized nuclear device. Indeed, members of the A. Q. Khan nuclear smuggling network possessed plans for smaller, more advanced nuclear weapon designs that might have found their way to Iran.³⁹

As mentioned previously, the ability to deploy a first-generation nuclear device atop a missile—an achievement that took a decade for most nuclear weapons states—could magnify the destabilizing impact of an Iranian nuclear breakout. Moreover, short flight times and the absence of crisis hotlines might cause Israel—and any other regional state that acquires nuclear weapons by then—to eventually respond to an Iranian nuclear breakout by adopting nuclear force postures that include launch-on-warning or predelegation of missile launch authority to military commanders. Such measures could increase the risks of accidental or unauthorized use of nuclear weapons.⁴⁰ These potential outcomes may increase the incentive for prevention or proliferation by regional states able to do so.

Iran's creation of a hybrid missile force capable of delivering conventional or nuclear warheads would add another destabilizing element to the mix. In a crisis or war, for instance, Israel might not be able to discern whether incoming Iranian missiles are conventional or nuclear, confronting it with the dilemma of absorbing what might be a devastating nuclear first strike—as some missiles will almost certainly get through its defenses—or launching a nuclear counterstrike in response to what might be a conventional attack.⁴¹ In such circumstances, Israel's nuclear forces might be kept on hair-trigger alert. Reckless Iranian rhetoric, moreover, including ritual calls for Israel's destruction, might incline Israeli decisionmakers to interpret Iranian actions in the darkest possible light.⁴²

Israel's missile defenses reduce the risk posed by this scenario by ensuring the survival of the country's nuclear second-strike capability⁴³ (consisting of strike aircraft, and land- and sea-based missiles) and its ability to unleash a devastating counterstrike against Iran.⁴⁴ But should Iran continue to build large numbers

of increasingly accurate missiles and start employing penetration aids and countermeasures (simple decoys, a modest terminal-phase maneuver capability, chaff, or low-power electronic countermeasures), the efficacy of Israel's missile defenses could come into question, with negative implications for its margin of security and the potential for miscalculation during a crisis.⁴⁵ Risk, however, cuts both ways, and Tehran has to consider the potential for such a catastrophic miscalculation, which could jeopardize Iran's very survival should it integrate nuclear weapons into its missile force. This should be a major theme of Washington's quiet and public diplomacy to shape the Islamic Republic's future nuclear choices.

Finally, while there is no evidence that Iran's leaders adhere to a "messianic, apocalyptic" ideology or that they view mutual assured destruction as "an inducement" and "not a constraint," in the words of Middle East historian Bernard Lewis,⁴⁶ neither should much credence be given to facile claims that because deterrence worked during the Cold War, it would also work with Iran.⁴⁷ Such claims are based on a superficial and selective reading of the Islamic Republic's strategic conduct.⁴⁸ For while Iran's leadership has shown that it is "rational" and generally risk averse, it is also occasionally prone to reckless behavior and to overreach—tendencies that its grandiose ambitions tend to amplify. (Examples of such behavior include the Beirut Marine barracks bombing in 1983, the Khobar Towers bombing in 1996, and the plot to assassinate the Saudi ambassador to the United States in 2011.)⁴⁹

Indeed, Tehran's resistance doctrine raises the possibility that under certain circumstances, Iranian decisionmakers might follow a path that could inadvertently lead to a conflict with Israel or the United States, or that they might welcome a limited conflict to achieve certain policy objectives.⁵⁰ Indeed, the resistance doctrine has already propelled Hezbollah and Hamas into four destructive wars with Israel (one involving Hezbollah, three involving Hamas). And Iran has responded to its perceived "victory" in its nuclear negotiations by doubling down on the path of resistance in other areas, testing to see what kinds of activities it can get

away with without jeopardizing sanctions relief and foreign investment. Thus, it has continued with the covert procurement of technology for its missile programs,⁵¹ reckless naval posturing in the Persian Gulf,⁵² provocative missile launch exercises,⁵³ and arms transfers to proxies and allies in Syria, Iraq, and Yemen⁵⁴ in violation of the spirit, if not the letter, of the nuclear accord and UN Security Council Resolution 2231.

A country's leaders do not have to be irrational to take irresponsible risks with potentially catastrophic consequences. By reducing the margin of error for regional decisionmakers, Iran's growing missile force could increase the potential for miscalculation and complicate efforts to create a stable deterrent balance with a potential nuclear Iran. The failure to effectively address Iran's missile program was therefore a major shortcoming of the nuclear deal and Security Resolution 2231. Iran's missile program should be an integral part of any future efforts to renegotiate aspects of the nuclear deal⁵⁵ in order to rectify its shortcomings and defuse a potential crisis if the Islamic Republic: (1) withdraws from the JCPOA because its high expectations were not met; (2) restarts clandestine nuclear activities in the JCPOA's out-years, when many of its intrusive monitoring provisions disappear; or (3) opts to build an industrial-scale nuclear infrastructure, as permitted by the JCPOA, once limits on the size of its program are lifted fifteen years from now, potentially reducing its breakout time to a matter of weeks.⁵⁶

In the meantime, Washington should do what it can to devalue the utility of the missile component of Tehran's deterrence/warfighting triad, into which Iran has invested billions of dollars and massive human and material resources, by strengthening America's ability to deter by denial, as well as punishment.⁵⁷ Thus, the United States should continue to build up coalition missile defenses and efforts to create an integrated missile defense architecture in the region; after all, Iran's missile force is a problem to which there is a viable solution—albeit an extremely costly one. It should continue to strengthen forces capable of delivering long-range precision fires and conducting aerial strikes against Iranian missile bases and launchers, to

attrite Iran's missile force on the ground and thereby reduce the burden on coalition missile defenses.⁵⁸ These forces also provide the United States and its partners with an ability to respond to Iranian missile strikes, should they opt to do so.

Finally, the United States should ensure that coalition missile defenses are hardened against cyberattacks by Iran and its proxies. It should encourage its Gulf Arab partners to improve their civil defenses (Israel's

capabilities in this area are already fairly robust). And it should counter Iranian missile propaganda and psychological warfare with a strategic communication campaign that highlights the extremely capable missile defenses of the United States and its allies, and emphasizes that Iranian missile strikes would prompt an overwhelming response in kind by coalition air and missile forces.

MISSILES 101: A PRIMER

ROCKETS VS. MISSILES: Rockets are unguided, while missiles are guided surface-to-surface weapons systems that follow a parabolic flight path to their target. Rockets have solid fuel motors; missiles may have solid- or liquid-fuel motors. Ballistic missiles fall into several range classes:

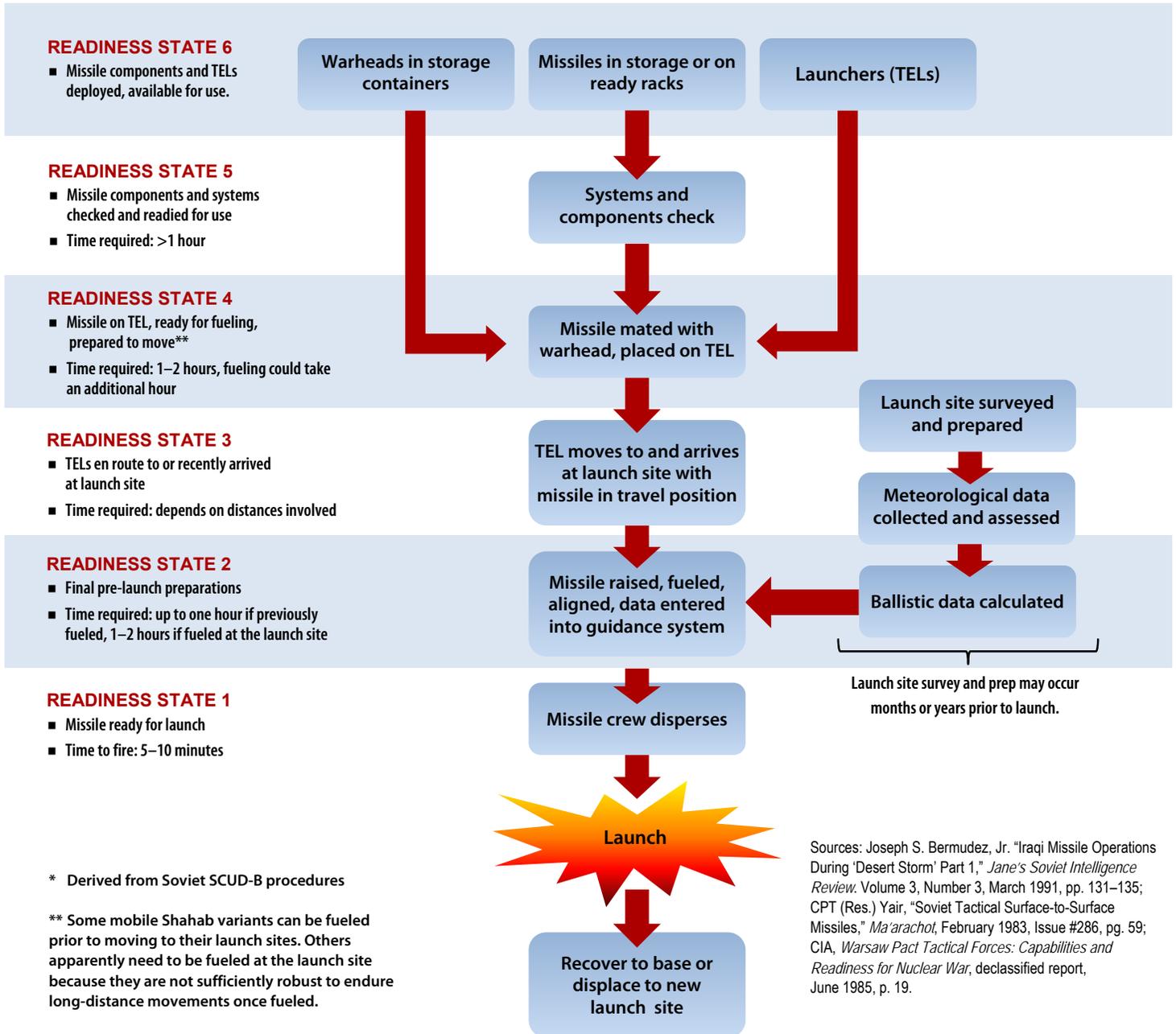
- **SRBMs:** short-range ballistic missiles have a range of up to 1,000 km.
- **MRBMs:** medium-range ballistic missiles have a range of 1,000–3,000 km.
- **IRBMs:** intermediate-range ballistic missiles have a range of 3,000–5,500 km.
- **ICBMs:** intercontinental ballistic missiles have a minimum range of 5,500 km.

Cruise missiles are generally powered by air-breathing engines (turbojets or turbofans) and rely on small wings to create aerodynamic lift to stay aloft, flying at low altitudes to their target.

Liquid-fuel missiles operate under a number of constraints. Predeployment systems checks and fueling can take several hours, and launch site procedures for mobile systems can take an additional hour, during which time the missiles are vulnerable to detection and interdiction (see figure 8). They are also more likely to incur damage en route to the launch site when they have been already fueled—due to the stress the filled fuel and oxidizer tanks place on the missile fuselage—increasing the risk of a catastrophic failure upon launch. After fueling, however, they can be kept in a state of readiness for months. Solid fuel missiles, by contrast, offer greater responsiveness and operational flexibility, as they are nearly always ready for use, can better endure cross-country movements, and can be launched from presurveyed launch sites or silos on short notice—often within minutes.

ACCURACY AND PAYLOAD: Missile accuracy is measured in terms of circular error probable (CEP), the radius of a circle within which 50 percent of missiles aimed at its center will land. The CEPs of Iran's missiles are believed to vary widely, from 100 meters for short-range systems like the Fateh-110 and its derivatives and perhaps the longer-range Emad, to several hundred meters for the Shahab-1 and 2, the Qiam, and the Ghadr, to 1 km or more for the Shahab-3. Moreover, missiles can deliver relatively limited payloads—from around 500 kg for some models of the Fateh-110 to 1,000 kg for the Shahab-3. By contrast, a single modern strike aircraft can carry thousands of kilograms of bombs and deliver them within meters of the target.

Fig. 8: IRANIAN SHAHAB-TYPE MISSILE LAUNCH PROCEDURES*
Mobile Launch Mode (Notional)



Studies have estimated that it could take large numbers of highly accurate short-range missiles (e.g., Fateh-110s) and massive numbers of less accurate long-range missiles (e.g., Shahab-3s) to destroy even a single oil-production facility or export terminal in the Gulf. Even inaccurate missile salvos, however, could disrupt operations at these facilities and do some damage, though systems redundancies and excess capacity would ensure that the effects of such attacks on oil exports would likely be short-lived. Likewise, Iran's missile force is believed to lack the accuracy and numbers needed to target military air bases in a way that would significantly disrupt U.S. and coalition air operations in the region.⁵⁹

The Gulf probably has scores of civilian and military targets like these, and attrition imposed by coalition missile defenses would further dampen the impact of Iranian missile strikes. That is why Iran's less accurate long-range missiles are likely to be launched against population centers in wartime. However, significant improvements to the accuracy of its missiles would be a game changer for Tehran, which is probably why it is devoting much effort to achieving this goal.⁶⁰

WARHEADS: Missile warheads come in a variety of types: nonseparating or separating, conventional or nonconventional, and unitary or cluster:

- **NONSEPARATING/SEPARATING:** Nonseparating warheads remain joined to the missile's fuselage during flight and through impact. Missiles with nonseparating warheads are simpler to produce, but may become unstable during descent and tumble, resulting in diminished accuracy. The airframe and warhead may also present a larger and slower—hence more vulnerable—target to missile defenses than separating warheads.
- **CONVENTIONAL/NONCONVENTIONAL:** Conventional warheads carry high-explosive (HE) payloads, whereas nonconventional warheads may carry chemical, biological, or nuclear payloads.
- **UNITARY/CLUSTER:** Unitary warheads carrying bulk HE or chemical/biological warfare (CBW) agent payloads explode upon impact or at a predetermined altitude. Cluster munitions warheads carry their explosive or CBW agent payload in numerous unguided bomblets and disperse them over the target at a predetermined altitude.

Cluster warheads should not be confused with the much more sophisticated MIRVs (multiple independently targetable reentry vehicles), which were developed by the superpowers during the Cold War to enable a single missile to deliver several nuclear weapons against multiple targets.

BASING AND LAUNCH MODES: Basing and launch modes can include: fixed aboveground launch sites; mobile transporter-erector launchers (TELs); conventional silos; underground launch complexes; and railway launchers.

- **FIXED ABOVEGROUND LAUNCH SITES:** Usually located near missile storage bunkers or depots so that the missiles can be rapidly assembled, fueled, erected on a launchpad, and launched. Fixed aboveground sites, however, are vulnerable to detection. During World War II, Germany used hastily established aboveground launch sites for its V-2 missiles, and built several hardened aboveground launch complexes that were never completed. Iraq built several fixed aboveground launch sites in western Iraq prior to the 1991 Gulf War but never used them. There is no evidence that Iran uses fixed aboveground launch sites, except for missile test launches.

- **MOBILE TELs:** Kept in underground or mountainside bunkers or camouflaged hide sites until needed. At that time, missiles are fueled (if they have not been fueled already) and transported on the TELs to presurveyed launch sites, where they are erected and launched. The mobility of TELs, many of which can move both on- and off-road, combined with camouflage and deception measures (e.g., disguising the TEL and support vehicles as civilian trucks, as done by Iran (figure 3), enhances their survivability. Russia, China, and North Korea all deploy road-mobile launchers for their strategic missile forces.
- **CONVENTIONAL SILOS:** Located underground, constructed of concrete and steel, and protected by overhead blast doors. Iran's austere conventional silos would seem to require a missile to be lowered inside by a crane, where it would then be fueled (figure 4).⁶¹ A fueled missile could stay on alert for several months, as long as the fuel remained viable. Iran's missile silos seem to be onetime-use installations, though the need to emplace missiles from aboveground increases the likelihood of detection prior to use. The United States and Russia have deployed large numbers of strategic missiles in these types of silos since the 1960s.
- **UNDERGROUND LAUNCH COMPLEXES:** Usually located under a mountain. Iran has released videos of one or more of these missile bases.⁶² Missiles are kept on ready racks and transported by truck via tunnels to underground missile halls, where they are fueled, erected, and launched through a small aperture in the ceiling (figure 6). They may also be fueled and then transported on TELs via entry/exit portals to nearby presurveyed aboveground launch sites, employing "surface and shoot" tactics (figure 7). Underground missile bases can be hard to locate, and thus make it difficult to detect launch preparations or to attack the missiles and their support infrastructure prior to launch. China is believed to operate an extensive network of underground tunnels for its road-mobile strategic missile forces.⁶³
- **RAILWAY LAUNCHERS:** Usually consist of a horizontal, coffin-type container on a railcar. Iran has shown a brief film clip of a railcar-based Shahab-type missile with a sliding overhead door. The missile would be transported by rail to a predesignated launch site, where it would be erected and launched from the railcar. While this option would enable Iran to hide its mobile railcar launchers among its civilian railway traffic, the launcher would be limited to areas served by rail lines. It is not known whether this is an operational Iranian capability.⁶⁴ The Soviet Union deployed missiles on railcars in the late 1980s, and Russia is reportedly considering reviving this capability. China has reportedly tested a railcar-based missile for future deployment. And the United States investigated the use of railcars for its strategic missile forces but never adopted this basing mode.

Iran may have also considered the possibility of launching missiles from merchant ships at sea, and reportedly test-launched a short-range missile from a barge in the Caspian Sea in 1998.⁶⁵ This option could greatly expand the reach of Iran's missile force, allowing it to target the United States before it developed an operational ICBM. However, beyond the single reported missile test, it is not clear that Iran has done more to acquire such a capability.

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