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Iran's Missile Technology

Revealed Capabilities and Hidden Reserves:
The Chemistry, Architecture, and Procurement of Iran's Missile Forces

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PREFACE

The missiles have become the instruments through which Iran expresses power beyond its borders. Deprived of a modern air force by revolution and embargo and unwilling to depend on the goodwill of others for its security, the Islamic Republic spent four decades building the largest and most varied missile arsenal in the Middle East. For most of that period the arsenal was assessed from the outside through a narrow and unreliable aperture: parades, controlled tests, and the confident claims of a state with every reason to exaggerate. The wars of 2024, 2025 and 2026 changed that. Sustained combat firing has produced an evidentiary record far richer than a generation of displays, and with it an obligation to reassess what Iran has built and how.

This report is London Dialogue's attempt to meet that obligation. It sets out to examine the Iranian missile force not as a catalogue of systems but as an industrial and technological enterprise and to ask of each layer of that enterprise a single disciplined question: what does Iran make, and what must Iran obtain? The answer that emerges, developed across the chapters that follow, is that Iranian missile power is best understood as an assembled capability, resting on a genuine and often underestimated national competence in design, integration and production, and on a continuing dependence on foreign materials, components, machinery and intelligence that four decades of sanctions have taxed but not severed.

Three commitments have shaped the writing. The first is evidence. A subject this contested is served better by visible uncertainty than by false confidence, and the report therefore grades its significant claims by their evidentiary strength, distinguishing what has been independently verified from what a government has asserted, what has been credibly reported, what the author has inferred, and what a belligerent or manufacturer has merely claimed. The second is to proportion. Where the evidence supports only a range, the report gives a range; where it supports only a qualified judgement, it gives a qualified judgement; and where it supports nothing, as with the precise size of any withheld reserve, it says so plainly. The third is to be restrained about matters beyond its proper scope. This is a study of an industrial and technological system, not of Iranian intentions, nuclear or otherwise, and it does not trespass into speculation about weapon design that the open record cannot support.

A word on timing is owed to the reader. This report is written during an active war whose course and outcome remain undetermined, with an evidentiary cut-off of 21 July 2026. Its historical and structural analysis should prove durable; its operational assessment of the current conflict is an interim judgement, offered in the knowledge that it will require revision as the fighting and the record develop. It is published in that spirit, as a contribution to an argument rather than a final word upon it.

The proliferation lesson at its centre, however, is unlikely to date. A medium power under comprehensive technology denial has assembled a strategically consequential precision-strike complex by marrying indigenous integration to a transnational supply base that no control regime has managed to close. States with no interest whatever in Iran will have drawn the same conclusion, and it is for their analysts, as much as for those concerned with Iran itself, that this report is written.

Dr Tahir Mahmood Azad

EXECUTIVE SUMMARY

Iran fields the largest and most diverse missile arsenal in the Middle East, and the wars of 2024, 2025 and 2026 have converted four decades of inference about that arsenal into observed fact. This report examines the force in the round: its historical formation, the chemistry of its propulsion, the architecture of its subsystems, the combat record of its employment, and above all the question of how a state under four decades of export control built it.

The central finding is that Iran occupies an unusual and unstable position on the spectrum between dependence and autarky. It designs, integrates, assembles and fires its own missiles, and it has demonstrated system-level engineering competence that few developing states have matched. It does not, however, produce the full input set those missiles require. The evidentiary record, assembled from United States Treasury designations, Department of State procurement advisories, Department of Justice indictments and United Nations reporting, shows sustained and continuing external dependency in four categories: oxidiser chemistry and propellant precursors; guidance-grade inertial sensors and the microelectronics that host them; aerospace structural materials, notably carbon fibre and ultra-high-strength steels; and the precision production machinery required to make any of the foregoing at scale.

Three conclusions follow from that finding. First, the analytically correct description of Iranian missile power is neither "indigenous" nor "imported" but assembled: a national integration capability drawing on a transnational input base concentrated in China, with a design inheritance from North Korea and a more recent, narrower Russian contribution. Second, the binding constraint on interdiction is not enforcement effort but control-list design. The single clearest illustration is the perchlorate chain, where the precursor is unlisted while the product is prohibited, allowing bulk cargoes to move as ordinary commerce. Third, the war has demonstrated that this assembled model is sufficient to generate strategically consequential effects against a technologically superior adversary, which is the proliferation lesson most likely to outlast the current fighting.

The report also addresses, and declines to resolve with false confidence, the question of what Iran has not used. Claims that Tehran is withholding its most advanced systems are plausible but rest on evidence equally consistent with attrition and reconstitution constraints. Open sources do not support a credible count of unused inventory, and figures offered with precision should be treated with suspicion.

LIST OF ACRONYMS

CSIS	Center for Strategic and International Studies
IAEA	International Atomic Energy Agency
IRGC	Islamic Revolutionary Guard Corps
JINSA	Jewish Institute for National Security of America
LD	London Dialogue
UAE	United Arab Emirates
UN	United Nations
US	United States

PART I: THE ANALYTICAL PROBLEM

1. The Disclosure Problem

For most of its existence, Iran's missile programme has been assessed through a narrow and unreliable aperture. Parade footage, state television unveilings, controlled test launches conducted for domestic and deterrent audiences, and the periodic display of hardware in tunnel complexes constituted the bulk of the observable record. Each of these is a curated artefact. A missile displayed at a parade may be a mock-up; a successful test may be the fifth attempt after four failures; a tunnel filled with canisters reveals nothing about what the canisters contain. Analysts have long understood this, and the resulting literature is properly hedged, but hedging does not eliminate the underlying problem that the observer sees what the observed wishes to show.

Sustained combat firing substantially widens that aperture, though it does not eliminate opacity. A missile fired in anger against a defended target under operational conditions cannot be curated in the way a parade can. Its flight is tracked by multiple sensors, its terminal behaviour observed, and its gross successes and failures are harder to conceal. When Iran launched more than 300 munitions at Israel in April 2024 and roughly 180 ballistic missiles in October of the same year, and then sustained multi-theatre firing through the 12-Day War of June 2025 and the war that began on 28 February 2026, it generated an evidentiary record far richer than a decade of tests and displays had produced.[1] The correct formulation is that combat employment widens the evidentiary aperture; it does not dissolve the underlying uncertainty, and it introduces a distinct set of wartime distortions in its place.

Those wartime distortions are worth naming at the outset, because they condition every operational claim in this report. Accuracy cannot be inferred reliably from an impact location unless the intended aim point is known, and it rarely is. Failure counts are uncertain, since a missile that falls short may have failed in flight, been intercepted, or been aimed elsewhere. Interception reporting attributes engagements imperfectly, and it is frequently impossible to know which interceptor engaged which missile, or whether damage resulted from a warhead, an interceptor, or falling

[1] "Iran's Missiles: Timeline of Attacks," The Iran Primer, *United States Institute of Peace*, https://iranprimer.usip.org/blog/2021/feb/17/iran%E2%80%99s-missiles-timeline-attacks.

debris. Battle-damage assessment conducted from satellite imagery captures surface effects and misses much else. And casualty and damage figures issued by belligerents during an active war are shaped by deterrent and reassurance motives on all sides. This report, therefore, treats wartime operational claims as the most provisional category of evidence it handles and grades them accordingly under the framework set out in the next section.

That record has produced surprises in both directions. On the capability side, Iran demonstrated an ability to sequence complex, multi-axis attacks combining slow loitering munitions with cruise and ballistic missiles timed to arrive together, a synchronisation problem that the Begin-Sadat Center characterised as comparable in complexity to the Russian opening strike against Ukraine in 2022; that comparison concerns command-and-control complexity rather than overall effect, and is qualified in Section 22.[2] It appeared to place warheads on or near specific hardened aim points, and it maintained firing across waves under sustained air attack. On the limitation side, it revealed persistent failure rates in flight, a continuing reliance on saturation rather than precision to defeat defences, and, most consequentially for this report, an input dependency that its adversaries could see clearly enough to target directly through naval interdiction and sanctions. This report is careful throughout to separate what the war demonstrated from what enthusiastic commentary has read into it.

The purpose of what follows is to exploit that disclosure systematically. The report treats the missile force not as a catalogue of systems but as an industrial and technological enterprise and asks of each layer of that enterprise a single question: what does Iran make, and what must Iran obtain?

2. What "Indigenous" Means: An Analytical Framework

Public discussion of Iranian missile capability tends to collapse into a binary. Iranian official statements assert self-sufficiency; adversary statements assert dependence on Chinese, Russian, and North Korean support. Both claims are defensible on selected evidence, and both are, as stated, analytically useless. A more disciplined framework is required.

[2] Uzi Rubin, "Operation True Promise: Iran's Missile Attack on Israel," Begin-Sadat Center for Strategic Studies, June 2024, https://besacenter.org/operation-true-promise-irans-missile-attack-on-israel/. The characterisation is a single-source assessment, not independently corroborated.

Any missile system can be decomposed into five layers, each with a distinct production economics and a distinct vulnerability to external control. The first is the airframe and structure: the load-bearing case, the interstage, the control surfaces, and the thermal protection that allows a re-entry body to survive. The second is propulsion, comprising both the motor or engine hardware and the propellant chemistry that fills it. The third is guidance, navigation and control, encompassing the inertial measurement unit, any external navigation augmentation, the flight computer, and the actuators that translate computed corrections into physical steering. The fourth is the payload section, including the warhead, its integration into the airframe, and the arming and fuzing logic that determines when it functions. The fifth is the ground segment: the transporter-erector-launcher, the silo or hardened aperture, the survey and alignment equipment, and the command and control that decides what is fired at what.

Cutting across these five layers is a sixth consideration that is frequently omitted and is arguably the most important: the machine tools and test equipment required to produce any of them at scale and to acceptable tolerance. A state may possess a complete design and still be unable to manufacture it because the five-axis machining centre, the filament-winding machine, the environmental test chamber or the precision measurement rig is itself a controlled item. Export control regimes have long understood this, which is why the Missile Technology Control Regime Annex controls production equipment alongside end items.

FIGURE 1: Subsystem Architecture and Assessed Indigenisation

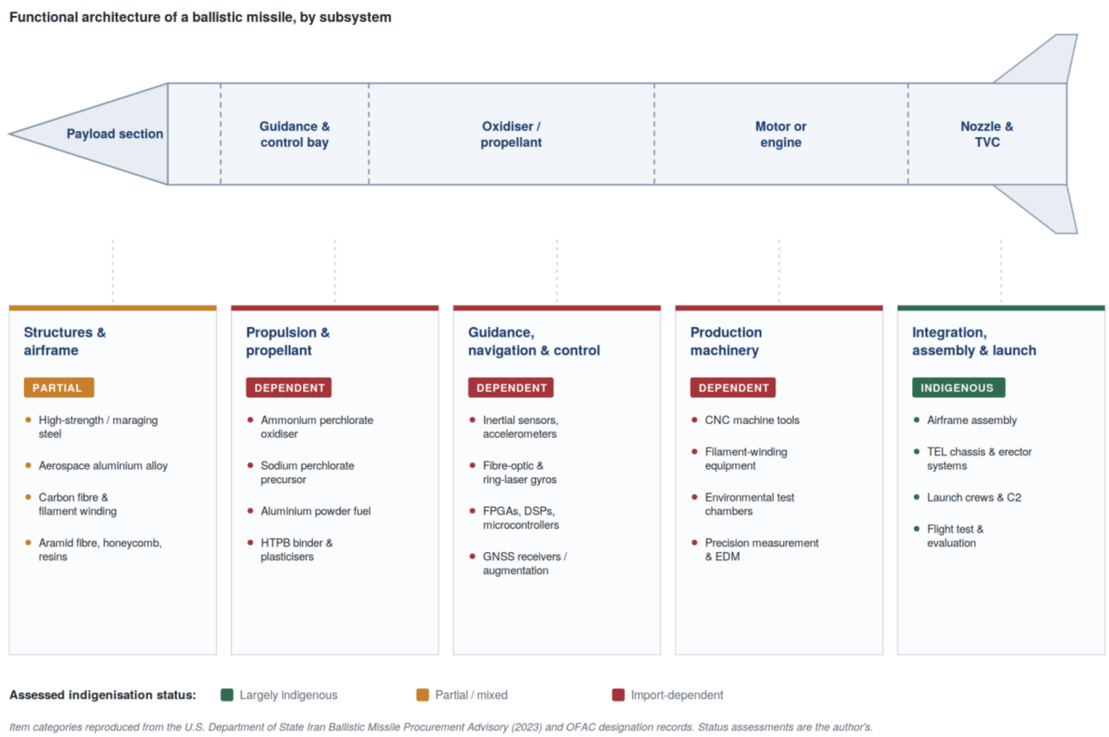

Figure 1: *The five functional layers of a ballistic missile mapped against Iran's assessed production position in each. Item categories are reproduced from the U.S. Department of State Iran Ballistic Missile Procurement Advisory, which enumerates the goods, electronics, and production equipment that Iranian entities have been documented seeking abroad. The pattern is consistent: integration and assembly are indigenous, while the material and electronic inputs that make integration possible are not.*[3]

With this decomposition in hand, the binary dissolves into a more useful proposition. Iran is highly capable at the fifth layer and at system integration generally. It designs missiles, matches subsystems to one another, manages the airframe-motor-guidance interface, conducts flight test campaigns, corrects failures, and fields the result in militarily meaningful numbers. That is not a trivial accomplishment, and a great many states with larger economies and better technical access have failed at it. Iran is simultaneously dependent at the level of specific material and electronic inputs, and that dependency is not diminishing with time, because the performance improvements Iran has pursued since roughly 2015 higher accuracy, lighter composite structures, and manoeuvring re-entry bodies, have raised rather than lowered the sophistication of the inputs required.

[3]Department of State, Procurement Advisory; see also the annexed version issued through the Department of Justice, https://www.justice.gov/d9/2023-10/2023_iran_ballistic_missile_procurement_advisory_10-17_final.pdf.

This is the framework the report applies throughout. It generates a testable claim rather than a slogan: that the correct term for Iranian missile power is assembled capability, resting on a national integration competence and a transnational input base.

An evidentiary framework

The sources available for a study of this kind do not carry equal weight, and a report that presents them as though they do misleads its reader regardless of how carefully each individual claim is sourced. A sanctions designation may rest on strong classified intelligence, but it is not equivalent to an independently verified technical examination or a judicial finding, and it is issued by a government with policy interests in the subject. A manufacturer's performance claim and a multi-source technical assessment are not the same kind of statement. Wartime figures issued by belligerents are not neutral data. This report, therefore, grades its significant claims according to evidentiary strength, using the five categories below; the grade attaching to a particular claim is stated in the footnote that supports it so that the reader can weigh the claim without the prose itself being interrupted.

Evidence grades used in this report	
VERIFIED	Independently verified or corroborated by multiple independent sources of differing provenance. The strongest category and the rarest for a subject this contested.
OFFICIAL	An official government assessment, designation, indictment or advisory. Attributable and legally consequential but reflecting one state's judgement and often resting on intelligence that cannot be independently checked.
REPORTED	Credible but unconfirmed reporting from journalists, analysts or research institutions, not independently corroborated here.
INFERENCE	The author's own analytical inference, drawn from the graded evidence but going beyond what any single source states.
CLAIM	A belligerent or manufacturer claim, recorded because it is significant that the claim was made, not because it is accepted as true.

The grade attaching to a claim is stated in its supporting footnote; where a claim carries no footnote, its standing is indicated in the prose. Unmarked statements are matters of general record or the connective analysis linking graded claims.

The discipline this imposes is deliberate. Where a footnote grades a claim as official, the reader should understand that a government has asserted it and that this report has not independently confirmed it. Where a footnote records an inference, the reader should understand that the report is reasoning beyond its sources and should weigh that reasoning on its merits. Where a claim carries no footnote, it is either a matter of general record not in dispute, the connective analysis that links graded claims together, or, in a few cases, a statement whose status the surrounding prose makes plain. Section 33 sets out the framework in fuller detail and explains the selection of sources, the cut-off date, and the assumptions behind the report's quantitative estimates.

Dependency is not the same as vulnerability

A second distinction must be drawn before the analysis begins, because the report's central claim about dependency is easily overread. To document that Iran imports a given material or component is not to demonstrate that Iran cannot produce it, that it has no stockpile, that it lacks an alternative supplier, or that interrupting the supply would halt production. A state may import because a foreign product is cheaper, better, or simply more convenient than a domestic equivalent it could make if compelled. Import dependence and strategic vulnerability are related but distinct, and conflating them overstates the leverage that denial confers.

This report therefore treats dependency as a compound rather than a single property, disaggregated into foreign origin, the frequency of recurring import, the concentration of supply in a single source, the ease of substitution, the plausibility of stockpiling, the existence of domestic production at any grade, and the operational consequence if supply were interrupted. A dependency that is high on every dimension, as the perchlorate case approaches, represents genuine strategic vulnerability. A dependency that reflects only foreign origin, with domestic substitution available at some performance cost, does not. The dependency matrix in Section 28 applies these dimensions systematically, and the reader should carry the distinction through the material sections that precede it.

One methodological note governs the treatment of dependency in particular. The evidence for input dependency used here is drawn overwhelmingly from official designation and enforcement records rather than from technical speculation about how particular components function. A government that designates a firm for supplying carbon fibre to a named Iranian missile entity is making a specific, attributable, legally consequential assertion, and this report treats such statements as official-source claims, graded accordingly in their footnotes. That is a materially higher standard than inference about the internal architecture of a warhead, which this report does not attempt. The corresponding limitation, examined in Section 33, is that designation records reflect what one government has detected and chosen to publicise, not an audited account of all that occurred.

PART II: THE HISTORICAL RECORD

3. Origins: The War of the Cities, 1984–1988

Iran's missile programme was born of an air force it could no longer operate with. The Imperial Iranian Air Force that the Shah had assembled was, in 1979, among the best-equipped in the developing world, built around American airframes and sustained by American spare parts, training pipelines and contractor support. The revolution severed all of it. By the time Iraq invaded in September 1980, Iran was fighting a war of attrition with a fast-degrading capacity to deliver ordnance at range, and the degradation accelerated as airframes were cannibalised and pilots purged.[4]

The response was to seek a delivery system that did not require an air force. In August 1984, the Islamic Revolutionary Guard Corps minister Mohsen Rafiqdoost led a delegation to Syria and Libya seeking ballistic missiles. The composition of that delegation is worth noting, because it included men who would shape the programme for decades: the deputy Islamic Revolutionary Guard Council (IRGC) commander Yahya Rahim Safavi, the artillery commander Hassan Tehrani Moghaddam, and Mohammad Bagheri. Syria declined to transfer missiles but offered operator training; Libya agreed to transfer Scud-B.[5] In October of that year, the IRGC established a dedicated missile team under Moghaddam within its artillery division, with Amir Ali Hajizadeh as deputy, and dispatched 13 personnel to Syria for training on Scud-B and Frog-7.[6]

The first Scud-B airframes arrived from Libya in 1985. These were single-stage, liquid-fuelled, Soviet-designed weapons of roughly 300 kilometres range carrying a warhead of 770 to 1,000 kilograms, and Iran began firing them at Iraqi cities almost immediately.[7] The supply was small and was quickly exhausted. In June 1985 the speaker of the Majlis, Ali Akbar Hashemi Rafsanjani, led a higher-level delegation to Libya, Syria, North Korea and China with the explicit purpose of securing more.[8] Syria supplied a further tranche in 1986; North Korea emerged as the principal

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[4]Michael Elleman, "Iran's Ballistic Missile Program," in *The Iran Primer* (Washington, DC: United States Institute of Peace), http://iranprimer.usip.org/resource/irans-ballistic-missile-program.

[5]"Iran's Missile Milestones," Iran Watch, Wisconsin Project on Nuclear Arms Control, https://www.iranwatch.org/our-publications/weapon-program-background-report/irans-missile-milestones.

[6]Iran Watch, "Missile Milestones."

[7]"A History of Iran's Ballistic Missile Program," *Wisconsin Project on Nuclear Arms Control*, https://www.wisconsinproject.org/a-history-of-irans-ballistic-missile-program/.

[8]Iran Watch, "Missile Milestones"; Wisconsin Project, "History."

supplier, thereafter, delivering approximately 100 Scud-B in 1987 and, by most estimates, between 200 and 300 in total between 1987 and 1992.[9]

The arrangement with Pyongyang established a pattern that would persist for 30 years. Iran did not simply buy missiles; it offered to finance North Korean development in exchange for technology transfer and a purchase option on the resulting systems as they came off the line.[10] This was a proliferation partnership rather than an arms sale, and it gave Iran a claim on future North Korean designs rather than merely on present North Korean inventory.

The critical early lesson, however, came from failure. Iran attached high priority to producing the Scud-B itself and, from 1987, attempted to do so. The attempt failed. Iran Watch's assessment is unambiguous: despite technical talent broadly comparable to North Korea's, Iran's initial indigenous production effort did not succeed, and Tehran turned back to Pyongyang for technical assistance and resupply.[11] This is the single most instructive episode in the programme's history, because it establishes at the outset that possession of a design and possession of the capacity to manufacture it are different things. Everything in the subsequent four decades is an effort to close that gap, and the argument of this report is that the gap has narrowed considerably without ever closing.

4. The North Korean Bargain and the Chinese Opening, 1988–1999

The 1988 ceasefire did not slow the programme; it redirected it from a wartime expedient to a strategic project. Two developments in that year set the trajectory. First, Iran successfully tested the Mushak-160, a short-range system of roughly 160 kilometres, demonstrating a domestic design and production capability at the lower end of the range spectrum.[12] Second, and more consequentially, China agreed to provide equipment and know-how for the development and testing of medium-range ballistic missiles.[13] A 10-year agreement on scientific cooperation and military technology transfer followed in 1990.[14]

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[9] "Iran's Long Range Missile Capabilities," Iran Watch, https://www.iranwatch.org/library/government/united-states/congress/legislation-reports/irans-long-range-missile-capabilities.

[10] Wisconsin Project, "History."

[11] Iran Watch, "Long Range Missile Capabilities."

[12] "Iran Missile Milestones: 1985–2017," Wisconsin Project on Nuclear Arms Control, https://www.wisconsinproject.org/iran-missile-milestones/.

[13] Wisconsin Project, "Missile Milestones: 1985–2017."

[14] Wisconsin Project, "Missile Milestones: 1985–2017."

The Chinese opening of 1988 to 1990 deserves more analytical weight than it usually receives. It marks the point at which Iran acquired not merely hardware but development infrastructure, and it established Beijing as a supplier of the enabling layer, the materials, the machine tools, and the test equipment, rather than of finished systems. That division of labour, North Korea supplying design lineage and China supplying enabling inputs, has proved remarkably stable and describes the relationship as accurately in 2026 as it did in 1990.

Through the early 1990s the North Korean pipeline continued to deliver. United States (US) intelligence detected Scud-C shipments moving to Iran from 1991, and Iran test-fired a system identified as Scud-C in the same year. The Scud-C is longer and wider than the Scud-B, with expanded propellant tankage yielding a range beyond 500 kilometres with a 700-kilogram warhead. A further shipment, with launch equipment, arrived in early 1993.[15] Iran reportedly financed construction of a North Korean-built missile factory in Syria, cooperation that began in the autumn of 1991.[16]

The decisive acquisition of the decade was the Nodong. In November 1999, US intelligence assessed that North Korea had recently sold Iran 12 Nodong engines.[17] The Nodong is a scaled-up Scud derivative, and the transfer of its propulsion gave Iran the basis for a genuine medium-range capability. Iran designated the resulting system Shahab-3, tested it from 1998, and thereby moved from a battlefield weapon to one capable of reaching Israel. Michael Elleman's assessment for the United States Institute of Peace (USIP) captures the significance precisely: Iran demonstrated that it could take an acquired design and significantly extend its range, which is a development capability distinct from a production capability.[18]

By January 2000, Iran had commissioned three production lines at the Ministry of Defence’s Education and Research Institute.[19] The institutional architecture that would carry the programme forward, the Aerospace Industries Organization and its Shahid Hemmat and Shahid Bagheri industrial groups, was by then in place.

[15] Wisconsin Project, "History."
[16] Iran Watch, "Long Range Missile Capabilities."
[17] Wisconsin Project, "Missile Milestones: 1985–2017."
[18] Elleman, "Iran's Ballistic Missile Program."
[19] Wisconsin Project, "Missile Milestones: 1985–2017."

5. The Solid-Propellant Turn, 2000–2011

The most important technical transition in the programme's history was the migration from storable liquid to composite solid propulsion, and it occupied roughly a decade. The military logic is straightforward. A liquid-fuelled missile of the Scud lineage must be fuelled before launch, an operation that takes time, exposes the launcher and its crew, and involves highly corrosive and toxic propellants requiring specialised handling. A solid-fuelled missile is cast at the factory and stored ready to fire. Against an adversary with persistent overhead surveillance and prompt strike capability, the difference between an hour of exposure and a few minutes is the difference between a surviving force and a destroyed one.

Iran began at the short end. The Fateh-110, a solid-propellant system of roughly 200 to 300 kilometres in range, was developed by the Shahid Bagheri Industrial Group and entered service in the early 2000s.[20] SBIG also produced the Fajr rocket system under North Korean licence, an arrangement that again illustrates the transfer of production rights rather than product.[21] The Fateh line proved to be the most fertile in the arsenal, spawning the Fateh-313, the Zolfaghar at roughly 700 kilometres, and eventually the naval and anti-ship derivatives.

Scaling from a 600-millimetre tactical motor to a medium-range strategic one is a substantially harder problem, involving larger grain geometries, more demanding case materials, and thrust vector control at higher loads. The Sejjil, a two-stage solid-propellant system credited with 2,000 to 2,500 kilometres, was Iran's answer, developed by SBIG under the supervision of Sanam Industrial Group and first tested in 2008.[22] Its appearance marked Iran's arrival as a producer of strategic-range solid systems, a club with few members.

The procurement record from this same period shows precisely what that arrival required from outside. Between 2007 and 2008, SBIG procured graphite cylinders, pressure bolts, gyroscopes and accelerometers with missile applications from the Chinese manufacturer LIMMT, operating under the name Dalian Sunny Industries.[23] In December 2009, SBIG bought five tonnes of missile-applicable carbon fibre from the Shanghai-based Korean Yoon Network company.[24] It sought a

[20] "Shahid Bagheri Industrial Group (SBIG)," Iran Watch, https://www.iranwatch.org/iranian-entities/shahid-bagheri-industrial-group-sbig.
[21] Iran Watch, "SBIG."
[22] Iran Watch, "SBIG."
[23] Iran Watch, "SBIG."
[24] Iran Watch, "SBIG."

cold-flow milling machine and attempted to procure environmental test chambers from a German firm by routing the shipment through the United Arab Emirates (UAE) using the Iranian procurement firm Rakin in 2008.[25] It bought specialty metals and chemicals from China North Industries Corporation.[26]

The pattern in that list is the argument of this report in miniature. Iran designed and built the Sejjil. To do so, it required Chinese graphite, Chinese carbon fibre, Chinese gyroscopes and accelerometers, German test chambers routed through Dubai, and machine tools it could not make. The New York prosecution of the LIMMT network, which the Wisconsin Project assisted, documented the maraging steel and tungsten components of the same trade: 25 tonnes of maraging steel from a Dalian entity and tungsten powder used for nose cones, nozzle throat inserts and jet vanes.[27]

6. The Reverse-Engineering Pathway: Cruise and Anti-Ship Systems

The ballistic missile programme is only one of two distinct technological lineages within Iran's strike complex, and the second is instructive precisely because it was built by a different method. Iran's cruise and anti-ship missiles were not developed from transferred designs or financed partnerships. They were reverse engineered from purchased examples, and tracing that process reveals both the reach and the ceiling of Iranian engineering.

Tehran became interested in Chinese anti-ship missiles after a visit to Beijing in the late summer of 1985 and had obtained Silkworm-family missiles by September 1986.[28] The nomenclature in public accounts is confused, since the Western label Silkworm has been applied loosely, but the systems exported to Iran were of the HY-2 and HY-4 series, themselves Chinese developments of the Soviet P-15 Termit.[29] These were coastal defence weapons of moderate range, and their arrival gave Iran the ability to threaten shipping in the Gulf and the Strait of Hormuz from mobile

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[25] Iran Watch, "SBIG."

[26] Iran Watch, "SBIG."

[27] "Chinese Exports to Iran," Wisconsin Project on Nuclear Arms Control, https://www.wisconsinproject.org/chinese-exports-to-iran/; see also U.S. Department of the Treasury, "Treasury Designates Iranian Proliferation Network and Identifies New Aliases," press release, https://home.treasury.gov/news/press-releases/tg84.

[28] "Saeqeh / Ahoya: HY-2 C201 Silkworm/Seersucker," GlobalSecurity.org, https://www.globalsecurity.org/military/world/iran/saeqeh-cm.htm.

[29] GlobalSecurity.org, "HY-2 C201 Silkworm/Seersucker"; "Missiles of Iran," Missile Threat, Center for Strategic and International Studies, https://missilethreat.csis.org/country_tax/iran/.

launchers on its own shores, islands and oil platforms, a capability that shaped the Tanker War and has shaped Gulf security calculations ever since.

Iran subsequently reverse-engineered the HY-2 into the Ra'ad, developed by the Iran Aviation Industries Organisation, entering full production in January 2004 and service in 2007 with a reported range of 350 kilometres.[30] The second and more consequential case concerns the C-802. Iran was the first export customer for that missile, signing a contract in 1995; the contract was cancelled under US pressure after approximately 60 missiles had been delivered.[31] Iran then reverse-engineered the delivered examples, producing the Noor, which it tested during the Unity-79 exercises in 2000 and early 2001, with officials claiming a range extension from 30 to 130 kilometres. Further development produced the Qader and unveiled in 2014, the Ghadir, with a range in the region of 300 kilometres, deployed on warships and coastal defence units.[32]

This lineage repays close attention for three reasons. The first is that it demonstrates real capability. Reverse-engineering a guided cruise missile from a small sample, then extending its range fourfold and productionising the result, is a substantial engineering achievement requiring metallurgy, aerodynamics, guidance work and propulsion development. Iran did it, and the resulting family is deployed at scale.

The second is that the interruption itself proved formative. Had the 1995 contract run to completion, Iran would have acquired a stock of missiles and no production capability. Because it was cancelled after partial delivery, Iran was forced to develop the capability and ended with something more valuable than the missiles it had ordered. This is the paradox that recurs throughout the history of the programme, and it deserves consideration by anyone designing denial policy: partial denial can generate the capability it seeks to prevent, because it converts a purchasing relationship into a development imperative while leaving the technical exemplar in the buyer's hands.

The third reason is the ceiling. The Noor is powered by the Toloue-4, an Iranian version of the French Microturbo TRI 60 turbojet.[33] A cruise missile requires a small, light, reliable air-breathing engine, and small turbojets of this class are among the more demanding items in aerospace manufacture, involving high-temperature alloys, precision turbine machining and balancing to fine

[30]CSIS, "Missiles of Iran."
[31]CSIS, "Missiles of Iran"; GlobalSecurity.org, "HY-2 C201 Silkworm/Seersucker."
[32]Iran Watch, "Missile Milestones"; Wisconsin Project, "Missile Milestones: 1985–2017."
[33]CSIS, "Missiles of Iran."

tolerance. That Iran's cruise missile programme rests on a domesticated version of a French engine design captures the pattern exactly: the airframe, the guidance integration and the production line are Iranian; the hardest single component traces to a foreign origin.

The anti-ship line also generated Iran's clearest instance of successful proxy transfer with strategic effect. In July 2006, Hezbollah struck the Israeli corvette INS Hanit off the Lebanese coast with a C-802-family missile, causing damage and casualties.[34] The event demonstrated that Iranian-supplied anti-ship missiles in the hands of a non-state actor could hold a modern warship at risk, and it materially altered naval risk assessment in the eastern Mediterranean and subsequently in the Red Sea.

Finally, the ballistic and cruise lineages have converged. In May 2014 the IRGC Aerospace Force unveiled the Hormuz-1 and Hormuz-2, anti-radar and anti-ship variants of the Fateh ballistic missile with ranges up to 300 kilometres, applying the solid-propellant ballistic airframe to the maritime targeting problem previously owned by cruise missile systems.[35] The organisational separation between the two lineages has eroded as the targeting problems have merged.

7. The Precision Turn, 2012–2023

A missile that lands within 500 metres of its aim point is a weapon against cities. A missile that lands within 30 metres is a weapon against aircraft shelters, command bunkers, radars and runways. The transition between those two conditions is the single most consequential change in Iranian capability of the past 15 years, and it is a guidance and control problem rather than a propulsion one.

A word on accuracy figures is required before they are used, because they recur throughout this report and are among its least certain quantities. A stated circular error probable may originate from an Iranian claim, from external modelling, from the interpretation of test footage, from satellite imagery of an impact, or from observed combat effects, and these are not equivalent in reliability. Accuracy also varies with configuration: the same airframe flown with a heavier payload or a different profile will not achieve its best-case figure. This report marks accuracy

[34] CSIS, "Missiles of Iran."
[35] Wisconsin Project, "Missile Milestones: 1985–2017."

figures by their provenance and, where no reliable estimate exists, uses a qualitative band rather than a spurious number.

With that caution in place, the trajectory is clear in direction if not in precise magnitude. The Emad, unveiled in 2015, was the first Iranian system openly presented as carrying a manoeuvring re-entry vehicle, a body that can adjust its trajectory in the terminal phase both to improve accuracy and to complicate interception.[36] The Khorramshahr, first tested in 2017, pairs a very heavy payload of 1,500 to 1,800 kilograms with substantially improved accuracy; the Jewish Institute for National Security of America (JINSA) credits the current variant with a circular error probable of approximately 30 metres, a figure that would make it a hard-target weapon if achieved in practice but which rests on assessment rather than on demonstrated combat performance.[37] The Kheibar Shekan, revealed in 2022, applied composite construction to reduce airframe mass and extend range for a given motor. The Fattah-1 of 2023 and the Fattah-2, discussed in detail in Section 8, represent the attempt to add terminal manoeuvre; their marketed hypersonic performance is a manufacturer's claim rather than an assessed capability.

[36] Elleman, "Iran's Ballistic Missile Program."

[37] Jewish Institute for National Security of America, Iran's Evolving Missile and Drone Threat (Washington, DC: JINSA Gemunder Center, February 2026), https://jinsa.org/wp-content/uploads/2026/02/Irans-Evolving-Missile-and-Drone-Threat.pdf. The accuracy figure is an external assessment, not independently verified in combat.

FIGURE 2: External Configuration of Principal Iranian Missiles

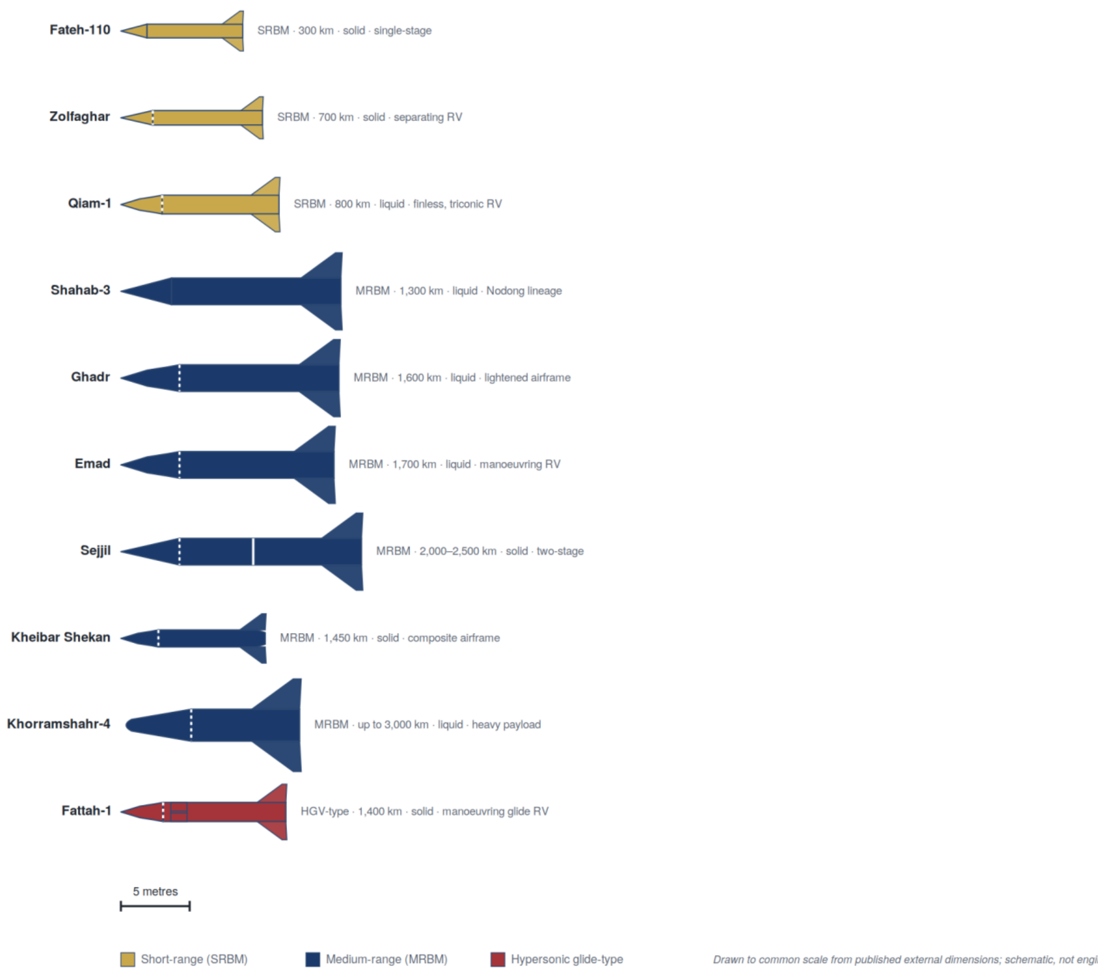

Figure 2. Comparative silhouettes drawn to a common scale from published external dimensions. Diameters are exaggerated relative to length for legibility, and the drawings are schematic rather than engineering representations. The externally observable evolution of the force is legible here: the transition from the blunt integral warheads of the Scud lineage to the triconic separating re-entry bodies of the Ghadr, Emad and Fattah; the shortening and thickening of solid-propellant airframes relative to liquid ones of comparable range; and the appearance of terminal control surfaces on the newest systems.

Externally observable design features track this evolution closely, which is why comparative configuration drawings are analytically useful rather than merely decorative. The Scud lineage carried an integral warhead: the entire missile body arrived at the target. The Qiam, Ghadr and Emad separate a re-entry body, which reduces radar cross-section during the terminal phase, removes the aerodynamic instability of a spent tank, and permits the triconic and biconic nose shapes visible on those systems. The presence of a separation joint and a triconic nose in a photograph is therefore diagnostic of a generational change in Iranian design practice.

The procurement implications of the precision turn are the reverse of what intuition might suggest. Improving accuracy did not reduce Iran's external dependency; it deepened it. Area-effect weapons tolerate crude inertial guidance. The 30-metre accuracy requires high-grade inertial measurement, which requires fibre-optic or ring-laser gyroscopes and precision accelerometers, which in turn require the semiconductor devices to process their output and the machine tools to manufacture them. This is precisely the category that appears with increasing frequency in enforcement actions from 2015 onwards. In November 2025, the US Treasury designated a vessel for delivering to Iran a computer numerical control machine specifically used to produce fibre-optic gyroscopes and guidance and control systems for ballistic missiles and unmanned aerial vehicles.[38] Iran was importing not the gyroscope but the machine that makes gyroscopes, which is the signature of a state attempting to climb one rung up the dependency ladder and still requiring external help to do it.

TABLE 1: Principal Systems by Class, Range and Propulsion

System	Class	Range (km)	Propellant	Accuracy (claimed / assessed)	Notes
Fateh-110	SRBM	300	Solid	high (assessed)	Tactical baseline of the solid line; many derivatives
Fateh-313	SRBM	500	Solid	high (claimed)	Composite-case development of the Fateh
Zolfaghar	SRBM	700	Solid	moderate–high	Separating re-entry body; used at Ain al-Asad
Qiam-1	SRBM	800	Liquid	low–moderate	Finless, triconic separating warhead; Scud-C conversion
Shahab-1 / -2	SRBM	350–500	Liquid	low (~450 m)	Scud-B and Scud-C lineage; largely superseded

[38] U.S. Department of the Treasury, "Treasury Disrupts Iran's Transnational Missile and UAV Procurement Networks," press release, November 2025, https://home.treasury.gov/news/press-releases/sb0313.

System	Class	Range (km)	Propellant	Accuracy (claimed / assessed)	Notes
Shahab-3	MRBM	1,300	Liquid	low (area)	Nodong-derived; foundation of the medium-range force
Haj Qasem	MRBM	1,400	Solid	moderate (claimed)	IRGC solid-propellant medium-range system
Fattah-1	MRBM (MaRV)	1,400	Solid	claimed high	Claimed manoeuvring/propelled RV; marketed hypersonic
Kheibar Shekan	MRBM	1,450	Solid	moderate–high	Composite airframe; used October 2024
Fattah-2	MRBM (claimed glide)	~1,500	Solid	claimed; unverified	Glide claimed; sustained glide not shown in open sources
Ghadr	MRBM	1,600	Liquid	low–moderate	Lightened Shahab-3 derivative; separating RV
Emad	MRBM (MaRV)	1,700	Liquid	~500 m (assessed)	First openly manoeuvring re-entry vehicle, 2015
Sejjil	MRBM	2,000–2,500	Solid	moderate (assessed)	Two-stage solid; strategic-range milestone, 2008
Khorramshahr-4	MRBM	up to 3,000	Liquid	~30 m (claimed)	1,500–1,800 kg payload; hard-target capable if accurate

Table 1. *Compiled from the CSIS Missile Defense Project, JINSA and Iran Watch entity profiles. Ranges are nominal maxima that fall as payload rises, so range and accuracy figures are not simultaneously achievable and vary with configuration and flight profile. Accuracy is marked "claimed" where the figure originates with Iranian sources and "assessed" where it reflects external analysis; a bare qualitative descriptor indicates that no reliable numerical estimate exists. The Fattah systems are entered by their assessed configuration (manoeuvring or claimed-glide re-entry vehicle), not by the marketing term hypersonic; see Section 8.*

8. The Hypersonic Turn: Fattah and the Footprint of Acquisition

The most recent and most contested addition to the Iranian arsenal is the group of systems Iran markets as hypersonic, and it deserves separate treatment both because Iran has advanced strong claims for it and because the question of how Iran acquired the underlying technology sits at the centre of this report's argument. This is the section in which the disciplined use of terms matters most, because loose language here has produced much of the public confusion about Iranian capability.

Five categories must be kept distinct. A ballistic missile travelling faster than Mach 5 during re-entry is hypersonic only in a trivial sense, since almost every medium-range ballistic missile satisfies that description; the speed is a consequence of the trajectory, not a distinguishing capability. A manoeuvring re-entry vehicle adjusts its trajectory in the terminal phase using aerodynamic surfaces, which improves accuracy and complicates interception but does not extend range or sustain flight. A powered or propulsion-equipped re-entry vehicle adds a motor to prolong or steepen that manoeuvre. A boost-glide vehicle is released from its booster to sustain a long, controlled atmospheric glide with significant cross-range, which is the demanding capability the term 'hypersonic weapon' properly denotes. And a quasi-ballistic missile flies a depressed, partly shaped trajectory throughout. These are materially different achievements, and only the boost-glide category represents the capability that the major powers have struggled to master. The report assesses the Iranian systems against this taxonomy rather than against the marketing label and reserves the term 'glide vehicle' for demonstrated sustained glide, which open sources do not yet establish for any Iranian system.

Iran unveiled the Fattah-1 on 7 June 2023, with the commander of the IRGC Aerospace Force, Amir Ali Hajizadeh, describing it as a precision-guided system of 1,400 kilometres range capable of penetrating all defence shields.[39] Assessed against the taxonomy above, the Fattah-1 is most cautiously described as a medium-range missile with a claimed manoeuvring or propulsion-equipped re-entry vehicle, rather than as a boost-glide weapon; Iran's assertion that it made the country the fourth hypersonic power is a claim, and North Korea and India would in any case

[39] "Iran Unveils New Missile with Hypersonic Glide Vehicle," Military Watch Magazine, November 20, 2023, https://militarywatchmagazine.com/article/iran-missile-hypersonic-glide-unveil. Iranian official and manufacturer claim, recorded as a claim rather than accepted as fact.

belong in that group.[40] The Fattah-2, unveiled in November 2023, was presented as integrating a hypersonic glide vehicle permitting manoeuvre in pitch and yaw and approaching from unexpected directions.[41] It may indeed resemble a glide vehicle, but open sources do not yet demonstrate the sustained atmospheric glide, significant cross-range or terminal performance that would distinguish a genuine boost-glide system from a manoeuvring re-entry body with a high terminal speed. In combat, Iran reported the first use of the Fattah during Operation True Promise III in June 2025, and Iranian sources released footage of the Fattah and, on 1 March 2026, of a first reported Fattah-2 launch during the current war.[42]

The performance figures should be read as what they are. Iranian claims of Mach 15 terminal speed and invulnerability to Iron Dome, Patriot PAC-3 and THAAD are manufacturer assertions, unverified and consistent with the pattern, noted throughout this report, of Iranian overstatement of missile performance.[43] What can be observed with more confidence is narrower: Iran has fielded terminally manoeuvring systems, has used them in combat, and has forced defenders to treat the threat as sufficiently real to accelerate the Arrow 4 interceptor in Israel and the Dark Eagle programme in the US.[44] That defensive response is evidence that the capability is credible; it is not evidence that the specific performance figures are accurate.

The acquisition footprint is the analytically important question, and it must be built up from components of different evidentiary weight rather than asserted as a single conclusion. Four things can be separated. First, as documented history, Iran is assessed to have obtained manoeuvrable re-entry vehicle technology from North Korea in the 1990s, the same decade such vehicles were supplied to Syria for its Hwasong-9 missiles; the manoeuvring-warhead competence is, therefore, not new.[45] Second, as a matter of technical similarity, Iran's glide-vehicle claims postdate North Korea's first flight test of a hypersonic glide vehicle, the Hwasong-8 of approximately 1,800

[40] "Fattah-1 Hypersonic Ballistic Missile, Iran," Army Technology, https://www.army-technology.com/projects/fattah-hypersonic-ballistic-missile-iran/.

[41] "Iran Launches First Ever Hypersonic Glide Vehicle Strike: New Fattah-2 Missile," Military Watch Magazine, March 1, 2026, https://militarywatchmagazine.com/article/iran-launches-first-hypersonic-glide-strike-fattah2. Iranian claim, recorded as such; not independently verified.

[42] Army Technology, "Fattah-1"; Military Watch Magazine, "First Ever Hypersonic Glide Vehicle Strike." First use rests on an Iranian official statement; the released footage is unverified reporting.

[43] Performance claims summarised in "Iranian Fattah-2: Mach 15 Hypersonic," Speedo Science, April 2026, https://www.speedoscience.com/2026/04/iranian-fattah-2-mach-15-hypersonic.html; treated here as manufacturer assertion. Manufacturer performance claim; unverified.

[44] Speedo Science, "Fattah-2." Fielding and combat use rest on official statements and wartime reporting respectively; not independently verified.

[45] Military Watch Magazine, "First Ever Hypersonic Glide Vehicle Strike." Assessed history drawn from secondary reporting, not primary documentation.

kilometres, in September 2021.[46] Third, the two states have a four-decade record of missile transfer that makes further cooperation plausible. Fourth, and separately from all of the above, is the inference that a specific glide-vehicle transfer occurred.

That fourth step is the author's inference and should be weighed as such, not as an established fact. A North Korean test followed roughly two years later by an Iranian unveiling is consistent with transfer and adaptation, the pattern that describes much of the programme's history, but temporal sequence and technical resemblance do not by themselves demonstrate a transfer, and this report does not possess evidence of the specific interaction that would raise the claim above hypothesis. The defensible position is that recent North Korean assistance on glide technology is the most plausible single explanation available, while remaining unproven; alternative explanations, including a greater degree of indigenous development than Iran is usually credited with, cannot be excluded from the open record.

A parallel strand of reporting attributes hypersonic assistance to China and Russia directly, and this claim requires careful handling.[47] Both states field mature hypersonic systems, the Chinese DF-17 glide vehicle and the Russian Avangard and Kinzhal, and both have motive to see Western missile defences devalued.[48] But the evidentiary basis for direct Chinese or Russian transfer of glide-vehicle technology to Iran is weaker and more speculative than the documented North Korean lineage, and this report treats it as plausible but unproven, in contrast to the materials and intelligence contributions examined elsewhere, which rest on designation records. The most defensible statement is that Iran's hypersonic capability rests on an inherited manoeuvring-warhead competence, a glide-vehicle technology most plausibly of North Korean origin, and the same imported material and electronic inputs that every other part of the arsenal requires. A glide vehicle still needs precision guidance, high-temperature materials and a solid motor, and none of those dependencies is relaxed by the addition of manoeuvre.

The 2025 Khorramshahr-4, sometimes designated Kheibar, illustrates the convergence of the tiers. Reporting credits, it with incorporating hypersonic glide characteristics and advanced targeting alongside its heavy warhead and range beyond 2,000 kilometres, which would combine the hard-

[46]"Iran Escalates Ballistic Missile Program Revival as China and Russia Help Strengthen Air Defences," Military Watch Magazine, October 30, 2025, https://militarywatchmagazine.com/article/iran-escalates-ballistic-missile-revival-china.

[47]"Iranian Fattah-2," Speedo Science; Military Watch Magazine, "Iran Escalates Ballistic Missile Program Revival."

[48]"The Hypersonic Dilemma: GCC States and the Future of Missile Procurement," Small Wars Journal, October 9, 2025, https://smallwarsjournal.com/2025/10/09/gcc-hypersonic-defense-strategy/.

target payload of the liquid heavy tier with the penetration advantages of terminal manoeuvre.[49] Whether this reflects a genuine integration or an aspirational designation is not resolvable from open sources, and the claim is noted as a claim.

9. Space Launch and the Long-Range Question

No assessment of Iranian missile technology can avoid the space launch programme, both because the technologies overlap substantially and because that overlap has driven 20 years of intelligence assessment about Iranian intercontinental ambitions. The subject requires care, because the overlap is real but frequently overstated.

Iran operates a satellite launch capability built around the Safir and the larger two-stage, liquid-fuelled Simorgh, launching from the Semnan space centre and, from around 2013, a larger facility approximately 40 kilometres south-east of Shahrud with a larger pad, a horizontal rocket checkout facility and a 23-metre launch tower.[50] In February 2015 Iran orbited the Fajr satellite on a Safir-1B, a 21-metre, 26-tonne vehicle carrying a 52-kilogram payload.[51] The Center for Strategic and International Studies (CSIS) notes that US intelligence analysts have assessed that many Simorgh components could be repurposed for long-range ballistic missile development, and in July 2013 US military intelligence reported that the Simorgh could serve as a test bed for intercontinental ballistic missile technologies.[52]

The technical basis for this concern is genuine. A space launch vehicle and an intercontinental ballistic missile share their most demanding elements: large-thrust propulsion, staging and separation mechanics, guidance through a long-powered flight, and structural design for high mass fractions. A state that can place a satellite in low Earth orbit has demonstrated a substantial fraction of the energy management required to deliver a payload intercontinentally.

Three qualifications are equally genuine and are often omitted. The first is re-entry. An orbital payload is designed to remain in space; a ballistic warhead must survive re-entry into the atmosphere at high velocity, which requires thermal protection and a re-entry body design that space launch does not exercise. The second is operational practicality. The Simorgh is a liquid-

[49] "Iran's Hypersonic Missiles Summed Up in 4 Words," National Security Journal, June 15, 2025, https://nationalsecurityjournal.org/irans-hypersonic-missiles-summed-up-in-4-words/.
[50] Iran Watch, "Missile Milestones"; Wisconsin Project, "Missile Milestones: 1985–2017."
[51] Iran Watch, "Missile Milestones."
[52] CSIS, "Missiles of Iran"; Wisconsin Project, "Missile Milestones: 1985–2017."

fuelled vehicle prepared on an exposed pad over an extended period, which is a description of a satellite launcher and not of a survivable weapon. The third is the timeline. The 2013 assessment that Iran might test an intercontinental system by 2015 was not borne out, which should induce appropriate caution about extrapolating from technological adjacency to weapons intent.[53]

The more analytically productive observation concerns direction of travel within the weapons programme itself. Iran's operational missile force has moved decisively toward solid propulsion for the survivability reasons examined earlier, while its space launch programme has remained principally liquid. If Iran were pursuing an intercontinental weapon by the most direct route, the expectation would be scaling of the solid line, since that is the path other states have taken toward survivable long-range systems. The Sejjil demonstrated two-stage solid capability in 2008, and it is the trajectory of that line, rather than the Simorgh, that most usefully indicates long-range intent.

For this report's central question, the space programme matters chiefly because it generates the same input demands. Large solid motors need the same perchlorate, the same aluminium and the same binder; launch vehicle structures need the same carbon fibre and the same high-strength alloys; guidance needs the same class of inertial instrument. The Congressional Research Service records designations relating to Iranian efforts to develop domestic carbon fibre for intercontinental-class applications, which locates the dependency precisely in the same category identified throughout.[54]

10. From Deterrent to Instrument: The Combat Record

Iranian missiles were fired in anger against Iraqi cities from 1985 to 1988 and then, remarkably, almost not at all for nearly three decades. The arsenal existed as a deterrent and as an instrument of proxy supply rather than as a weapon Tehran used directly. That restraint ended progressively from 2017, and the sequence of engagements since then constitutes a record of increasing confidence, increasing scale, and increasing willingness to accept the risk of direct attribution.

The June 2017 strikes against Islamic State targets in Deir ez-Zor were the first Iranian ballistic missile launches outside its borders since the Iran-Iraq War. In January 2020, following the killing of Qassem Soleimani, Iran conducted Operation Martyr Soleimani against the Ain al-Asad and Erbil bases in Iraq, firing more than a dozen short-range ballistic missiles, including Zolfaghar and

[53]Wisconsin Project, "Missile Milestones: 1985–2017."
[54]Congressional Research Service, Iran's Ballistic Missile Programs.

probably Fateh-313 and Qiam variants. The CSIS records 10 missiles striking Ain al-Asad, one striking Erbil, and four failing in flight.[55] More than 100 US personnel sustained traumatic brain injuries. Analysis of the imagery by the Fondation pour la Recherche Stratégique found that a missile scored a direct hit on an aircraft hangar while doing comparatively little damage to it, an observation that captures the state of Iranian capability at that moment: accurate enough to hit, not yet lethal enough to destroy.[56]

January 2024 saw strikes into Iraq, Syria and Pakistan, the last of these a significant escalation against a nuclear-armed neighbour. But the decisive shift came in April 2024. Operation True Promise, launched in retaliation for the Israeli strike on the Iranian consular building in Damascus, involved approximately 170 one-way attack drones, more than 30 cruise missiles and over 120 ballistic missiles launched from Iran and coordinated with fires from Iraq, Lebanon and Yemen.[57] Israeli, American, British, French and Jordanian defences intercepted the overwhelming majority, and damage to Nevatim and Ramon airbases was slight. The operation was widely read at the time as a failure, on the ground that almost nothing reached its target. That reading captures the effect but understates the demonstration: the synchronisation of slow drones with fast cruise and ballistic munitions to achieve near-simultaneous arrival is a demanding staff and technical problem, which the Begin-Sadat Center assessed Iran to have solved at a scale it likened to the Russian opening strike on Ukraine.[58] Both readings are correct about different things. The near-total interception reflected the quality of an exceptional defending coalition and does not generalise to lesser-defended targets; the synchronisation reflected real command-and-control competence, and it does. What the operation did not demonstrate, and what its heavier interception makes clear, is decisive military effect, and the two should not be conflated.

October 2024 brought True Promise II, roughly 180 ballistic missiles in at least two waves, and this time including the newer Fattah and Kheibar Shekan systems.[59] A materially higher proportion

[55]"Iran's Options for Retaliating against Israel," Center for Strategic and International Studies, https://www.csis.org/analysis/irans-options-retaliating-against-israel.

[56]Stéphane Delory, Agnès Levallois, and Vincent Tourret, "Iranian Operations against el-Asad and Erbil Bases: What Can Be Learned from the Imagery?," Fondation pour la Recherche Stratégique, February 12, 2020, cited in Iran Watch, "Before the Bombardment: Revisiting Iran's January 2024 Missile Strikes on Syria, Iraq, and Pakistan," https://www.iranwatch.org/our-publications/articles-reports/bombardment-revisiting-irans-january-2024-missile-strikes-syria-iraq-pakistan.

[57]CSIS, "Iran's Options"; The Iran Primer, "Timeline of Attacks."

[58]Rubin, "Operation True Promise." Single-source assessment; not independently corroborated.

[59]The Iran Primer, "Timeline of Attacks."

penetrated. The 12-Day War of June 2025 escalated further, and Israeli counterstrikes on production infrastructure imposed the first serious industrial attrition the programme had suffered.

The war that began on 28 February 2026 with joint US and Israeli operations represents the fourth phase of what Tehran has continued to brand True Promise.[60] Its distinguishing feature is horizontal breadth. Rather than concentrating on Israel, Iran has distributed fires across the entire arc of US basing in the region, striking or attempting to strike installations in Iraq, Kuwait, Bahrain, Qatar, Saudi Arabia, the UAE, Jordan and Oman in addition to Israel. The strategic logic, which the scholar Robert Pape has characterised as horizontal escalation, is to widen the arena until the cumulative cost to Washington and its regional partners becomes intolerable.

FIGURE 3: Acquisition, Development and Employment, 1984–2026

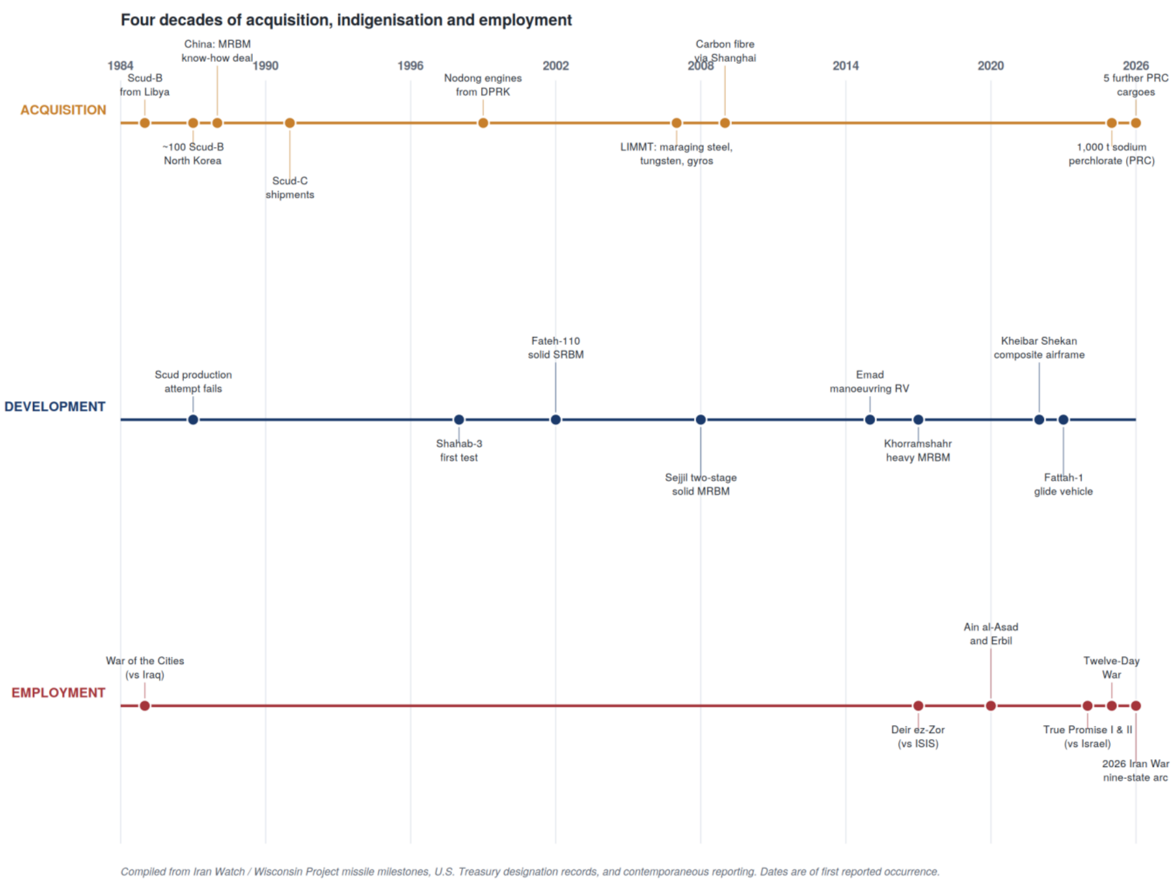

Figure 3. *Three parallel tracks over four decades. The acquisition track records external inputs, from the Libyan Scud-B of 1985 to the Chinese perchlorate cargoes of 2025 and 2026. The development track records indigenous milestones. The employment track records combat use. The visual relationship between*

[60]"Iran's Ballistic Missile Retaliatory Strikes and Escalation Dynamics," Politics Today, May 2026, https://politicstoday.org/irans-ballistic-missile-retaliatory-strikes-and-escalation-dynamics/.

the tracks is the report's central argument: indigenous development milestones consistently follow acquisition events, and the acquisition track does not thin out over time.

TABLE 3: Combat Employment, 1985–2026

Date	Operation / event	Target set	Observed significance
1985–88	War of the Cities	Iraqi urban centres	First employment; imported Scud-B expended rapidly
Jun 2017	Deir ez-Zor strikes	Islamic State, Syria	First launches beyond borders since 1988
Sep 2019	Abqaiq / Khurais	Saudi oil infrastructure	Drone and cruise synchronisation; 5.7 m bpd disrupted
Jan 2020	Martyr Soleimani	Ain al-Asad, Erbil	10 of ~15 struck; 4 failed in flight; TBI casualties
Jan 2024	Regional strikes	Iraq, Syria, Pakistan	Escalation against a nuclear-armed neighbour
Apr 2024	True Promise I	Nevatim, Ramon airbases	~170 UAV, 30 cruise, 120+ BM; multi-axis synchronisation
Oct 2024	True Promise II	Multiple Israeli sites	~180 BM including Fattah and Kheibar Shekan
Jun 2025	Twelve-Day War	Israeli targets	First serious industrial attrition to production base
Feb 2026–	2026 Iran War	Nine-state arc	Horizontal escalation across US regional basing

Table 3: *Compiled from the Iran Primer timeline, CSIS analysis and Iran Watch reporting for the historical entries, and from wartime press reporting for 2024–2026. All figures from April 2024 onwards are provisional and derive substantially from belligerent and host-nation statements issued during active hostilities; munition counts, interception tallies and casualty figures in those rows should be read as claims of contested reliability rather than verified data and are current only to 21 July 2026.*

Read against the acquisition record, the combat timeline yields an uncomfortable observation for those who expect sanctions to produce capability decay. Iranian employment has become more frequent, more complex and more accurate across exactly the period in which the international control architecture was most heavily elaborated. That does not demonstrate that controls failed, since the counterfactual is unknowable and the programme might have advanced faster without them. It does demonstrate that controls as designed did not prevent the accumulation of a militarily consequential force.

11. The 2026 War: An Operational Assessment

The war that opened on 28 February 2026 with joint US and Israeli strikes deserves separate treatment, both because it is the largest test the Iranian missile force has faced and because it is the source of most of the observational evidence in this report. Any assessment written while a war continues is provisional, and the figures below are current to late July 2026 and will move.

The opening of the war was designed to decapitate. The strikes killed the Supreme Leader and much of the senior command, and subsequent operations targeted the missile complex directly, including propellant production and solid motor manufacturing sites, alongside launch infrastructure at Tabriz, Khorgo, Hajiabad and north of Kermanshah. The theory of victory was straightforward: destroy the industrial base, suppress the launch nodes, and the retaliatory capability collapses.

It has not collapsed, and the reasons illuminate the force's design. The dispersal of launch infrastructure across the Zagros and Alborz means that no single node is decisive, so suppression of anyone produces a local and temporary effect. The migration to solid propulsion means launch crews are exposed for minutes rather than hours, which sharply reduces the value of persistent surveillance. And the reconstitution of propellant stocks through externally supplied precursor means industrial attrition can be offset by import, provided the maritime route remains open. Each of these is a design choice made years earlier for reasons that have proved sound.

The most operationally significant Iranian innovation in this war has been the geographic distribution of the target set rather than any new weapon. Instead of concentrating on Israel, Iran has struck or attempted to strike installations across nine states: Al Dhafra in the UAE, the naval support activity hosting the US Fifth Fleet in Bahrain, Prince Sultan air base and energy infrastructure in Saudi Arabia, Al Udeid in Qatar, Ali Al Salem in Kuwait, Muwaffaq Salti and Azraq in Jordan, Ain al-Asad and other positions in Iraq, assets linked to the US in Oman, and multiple targets in Israel. The logic, which Robert Pape has characterised as horizontal escalation, is to widen the arena until the cumulative political and material cost becomes intolerable to Washington and its partners simultaneously.

FIGURE 6: The Theatre: Dispersed Launch Belt and Regional Target Set

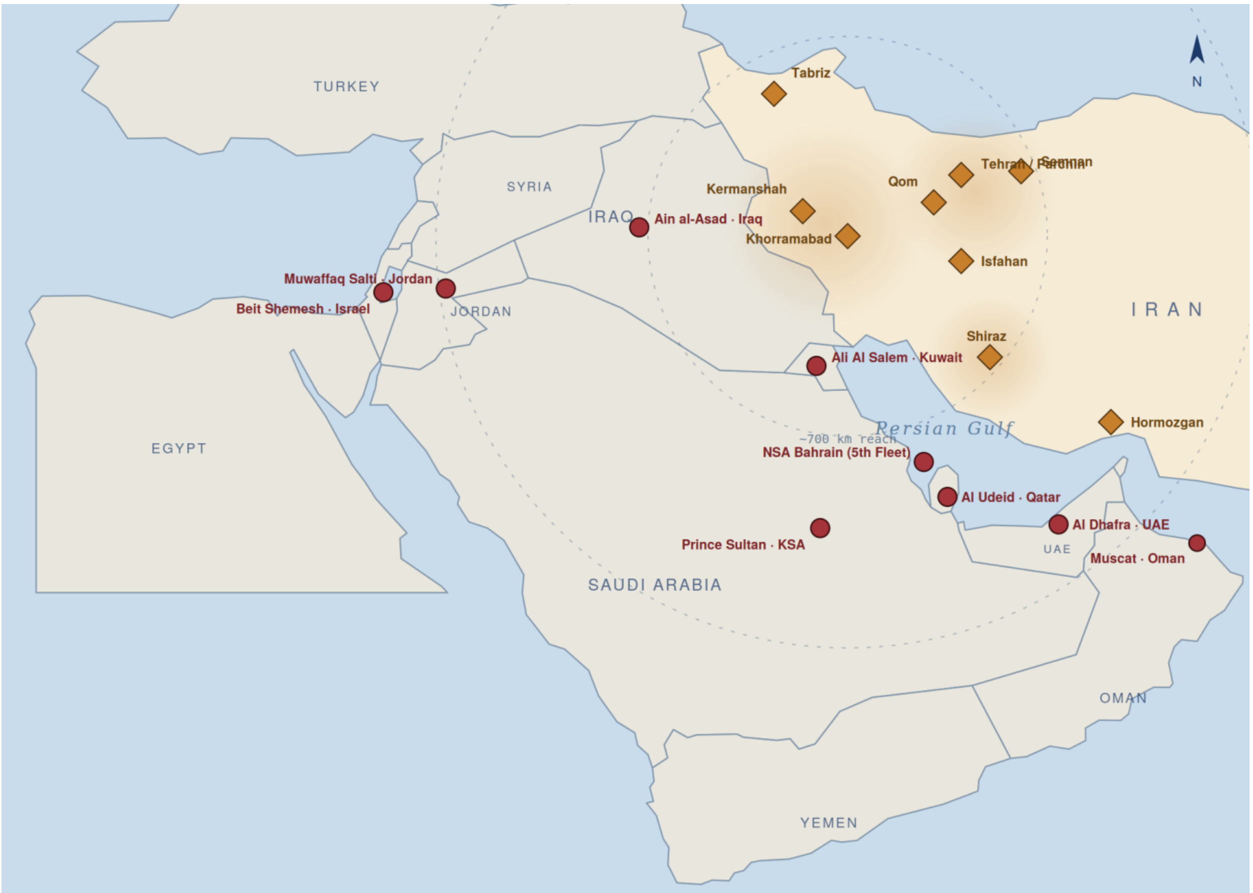

Figure 6. *The reported launch belt, plotted against the regional target set. Most Gulf installations lie within two hundred to seven hundred kilometres of the western belt, inside short-range and lower medium-range reach, whereas Israeli targets at roughly one thousand to twelve hundred kilometres require the medium-range tier. Markers denote reported base regions drawn from published cartography, not verified firing coordinates.*[61]

The effects have been substantial without being decisive. Host-nation claims, which are claims rather than audited figures, indicate very large engagement volumes: the UAE reported intercepting 500 and 37 ballistic missiles, more than 200 drones and 26 cruise missiles by early April, and Bahrain reported destroying 75 missiles and 123 drones.[62] Assessments of damage to US installations across the theatre indicate at least 17 are reporting damage, 13 rendered near-

[61] Alma Research and Education Center, underground missile infrastructure assessment; JINSA, Iran's Evolving Missile and Drone Threat; regional strike reporting per Al Jazeera, "Gulf States Come under Iranian Fire as US Strikes Intensify," July 17, 2026, https://www.aljazeera.com/news/2026/7/17/gulf-states-come-under-iranian-fire-as-us-strikes-intensify.

[62] Al Jazeera, "Gulf States Come under Iranian Fire"; Al Jazeera, "Iran Attacks Kuwait and Bahrain in Response to US Strikes," June 28, 2026, https://www.aljazeera.com/news/2026/6/28/iran-attacks-kuwait-and-bahrain-in-response-to-us-strikes .

uninhabitable, and approximately 40,000 personnel have been repositioned away from primary sites.[63] Two US service members were killed at Muwaffaq Salti on 17 July.[64]

Three analytical observations follow, each of which must be stated with more caution than wartime commentary usually allows. The first concerns the interception ratios. Very high proportions of incoming munitions have been reported as engaged successfully, and a high interception rate can coexist with meaningful disruption, so physical penetration alone does not establish either failure of the defence or strategic success for the attacker. The correct measure of a base's condition is not whether some missiles leaked through but whether it can still generate sorties, which depends on runway availability, sortie rates, logistics, redundancy and repair capacity, and those particulars are not reliably visible from open sources during the war. The defensible formulation is that the defence has performed well tactically while leakage against a sustained multi-month campaign has imposed serious and repeated disruption on major installations; whether specific bases were rendered lastingly unusable, as some reporting asserts, cannot be confirmed here and is stated as a claim rather than a finding.

The second concerns the drone-to-missile ratio. The engagement figures show drones outnumbering ballistic missiles by roughly four to one in the Emirati tally, and the Treasury noted in April that Iran was increasingly relying on Shahed-series drones as its ballistic inventories were depleted.[65] This is the cost-exchange logic operating in real time, and it indicates a force adapting its composition to its supply constraints.

The third concerns the supply chain, which has been the decisive variable and remains so. The US imposed a naval interdiction campaign explicitly intended to sever the flow of components and precursors. Its partial failure is documented: five Iranian-owned vessels loaded at Gaolan port in Zhuhai and delivered cargoes assessed as sufficient for approximately 785 additional missiles, one of them departing China a week before the campaign opened and arriving in late March.[66] A blockade that cannot interdict state-owned shipping carrying an unlisted commodity from a permissive jurisdiction is a blockade with a hole in it, and that hole has determined the war's attritional arithmetic.

[63] "US Bases Uninhabitable: Iran Missile Strikes and CENTCOM Force Posture in the 2026 War," Defence Security Asia, https://defencesecurityasia.com/en/us-bases-uninhabitable-iran-missile-strikes-centcom-force-posture-2026-war/.
[64] Al Jazeera, "Gulf States Come under Iranian Fire."
[65] Treasury, "Economic Fury Targets Iranian Missile and UAV Procurement Networks."
[66] gCaptain, "Suspected Chemical Shipments."

The provisional judgement, offered with appropriate caution while the fighting continues, is that Iran's missile force has performed better than pre-war Western assessment expected and worse than Iranian rhetoric claimed. It has not achieved any decisive military effect. It has imposed serious and continuing costs and forced a significant repositioning of US forces. Two stronger claims that appear in wartime commentary should be qualified rather than adopted. That the regional basing architecture is "no longer survivable" overstates what the evidence shows; the more defensible statement is that fixed, forward basing within reach of a dispersed precision-strike complex now carries costs and vulnerabilities that were previously assumed away, which is a matter of degree rather than a demonstrated obsolescence. And the claim that Iran "sustained itself industrially" through the war should be held open, because it cannot be established from open sources whether missiles fired late in the conflict were manufactured after hostilities began or drawn from substantial pre-war inventory; sustained firing is consistent with either, and only the former would demonstrate wartime industrial resilience. What can be said is that Iran maintained a high firing rate for months under concentrated attack, which is itself a considerable result for a state under four decades of technology denial, and that its ability to do so depends on a supply chain running through Chinese ports.

PART III: CHEMISTRY AND PROPULSION

12. Storable Liquid Propulsion and the Scud Inheritance

The propulsion chemistry Iran inherited from the Soviet Union by way of Libya, Syria and North Korea is a storable hypergolic bipropellant system. Two liquids are carried in separate tanks and injected into a combustion chamber, where they ignite on contact without an ignition source. The oxidiser in this family is an inhibited red fuming nitric acid, a nitric acid solution containing dissolved nitrogen dioxide with a corrosion inhibitor added to permit contact with the tank material. The fuel is a hydrocarbon or hydrasine derivative, historically a kerosene-type fuel in the earliest Scud variants and unsymmetrical dimethylhydrazine or similar in later derivatives.

The word "storable" carries considerable operational weight. Cryogenic propellants such as liquid oxygen must be loaded immediately before launch and boil off continuously thereafter, which is acceptable for space launch and unacceptable for a weapon. Storable propellants can be held as liquids at ambient temperature, which permits a missile to be fuelled and held for a period. But storable is not the same as stored. Red fuming nitric acid is aggressively corrosive and attacks tank materials, seals and plumbing over time; the hydrazine derivatives are acutely toxic and carcinogenic. In practice, missiles of this family are fuelled shortly before launch, and that operation is the tactical vulnerability of the entire class.

The consequences propagate through the force structure. A liquid-fuelled missile requires a fuelling vehicle and crew alongside the launcher, which enlarges the signature of a launch site. It requires the launcher to remain stationary during the fuelling operation, which may occupy a substantial period. It requires trained personnel to handle materials that will injure them if mishandled. Against an adversary conducting persistent surveillance with prompt strike, each of these is an opportunity. The observed pattern in which Iran fires liquid-fuelled systems from hardened or concealed sites, rather than from dispersed mobile launchers in the open, follows directly from this chemistry.

There are compensating advantages, which explain why the liquid systems have not been retired. Liquid engines can be throttled and shut down, permitting more precise velocity control at burnout and therefore, in principle, better range control. The propellant mass fraction achievable in a liquid stage is favourable, which is why Iran's heaviest payloads, notably the Khorramshahr with its

1,500-to-1,800-kilogram warhead, remain in this family. And the manufacturing base is mature: Iran has built engines of this type since the 1990s through the Shahid Hemmat Industrial Group and its subordinate Shahid Rastegar Industries, which the Department of State identifies as responsible for the development and production of liquid-propellant ballistic missile engines.[67]

The liquid tier therefore persists as the heavy end of the arsenal rather than as its cutting edge. The Shahab-3, Ghadr, Emad and Khorramshahr are all of this lineage. The accuracy spread within the tier is instructive even allowing for the uncertainty in the underlying figures: the Emad is assessed at a circular error probable near 500 metres, while the upgraded Khorramshahr is credited with roughly 30 metres.[68] If those assessments are even approximately right, the difference is striking, because both use fundamentally similar propulsion, and it would follow that the improvement is attributable almost entirely to guidance and terminal control rather than to the motor. That inference reinforces the report's recurring theme that Iranian capability growth has concentrated in the electronics rather than the chemistry, though it depends on accuracy assessments that have not been independently verified in combat.

13. Composite Solid Propellant: The Current Tier

Iran's newer systems use a composite solid propellant, which is not a single substance but a cast polymer matrix in which oxidiser and metallic fuel are suspended. The three functional constituents are an oxidiser, a metallic fuel, and a polymeric binder that also serves as a fuel and gives the grain its mechanical properties.

The oxidiser is ammonium perchlorate. It is the dominant constituent by mass, typically around 70 per cent in formulations of this class, and it supplies the oxygen that permits combustion within a sealed motor case with no atmospheric intake.[69] The metallic fuel is aluminium in powder form, generally in the region of 15 to 20 per cent, which raises the flame temperature and the density of the propellant and therefore the specific impulse and the total impulse available from a given case volume. The binder is a hydroxyl-terminated polybutadiene, a synthetic rubber, cured with a

[67] Department of State, Procurement Advisory.

[68] JINSA, Evolving Missile and Drone Threat; range and accuracy figures compiled from the CSIS Missile Defense Project as reported in "Iran's Ballistic Missiles: Why the Terror Failed," Militarnyi, https://militarnyi.com/en/articles/iran-ballistic-missiles-terror-failed/. Accuracy figures are external assessments, not independently verified in combat.

[69] Joseph Trevithick and contributors, "What Is Iran Doing with 1,000 Tons of Sodium Perchlorate from China?," The Diplomat, February 2025, https://thediplomat.com/2025/02/what-is-iran-doing-with-1000-tons-of-sodium-perchlorate-from-china/.

suitable curative and modified with plasticisers to control the mechanical behaviour of the finished grain across the temperature range the missile must tolerate.

The engineering significance of the binder is easily underestimated. A solid motor is not a container of powder, but a single cast body of rubbery material bonded to the case, and it must not crack. A crack presents an additional burning surface, which raises chamber pressure above design, which destroys the motor and the missile. The grain must therefore retain its mechanical integrity through storage, through transport over rough ground on a launcher, through thermal cycling in a desert environment, and through the acceleration of launch. Achieving that is a materials and process problem rather than a chemistry problem in the narrow sense, and it is the reason solid-propellant programmes are difficult to establish even when the formulation is public knowledge.

FIGURE 4: Propellant Chemistry and the Precursor Chain

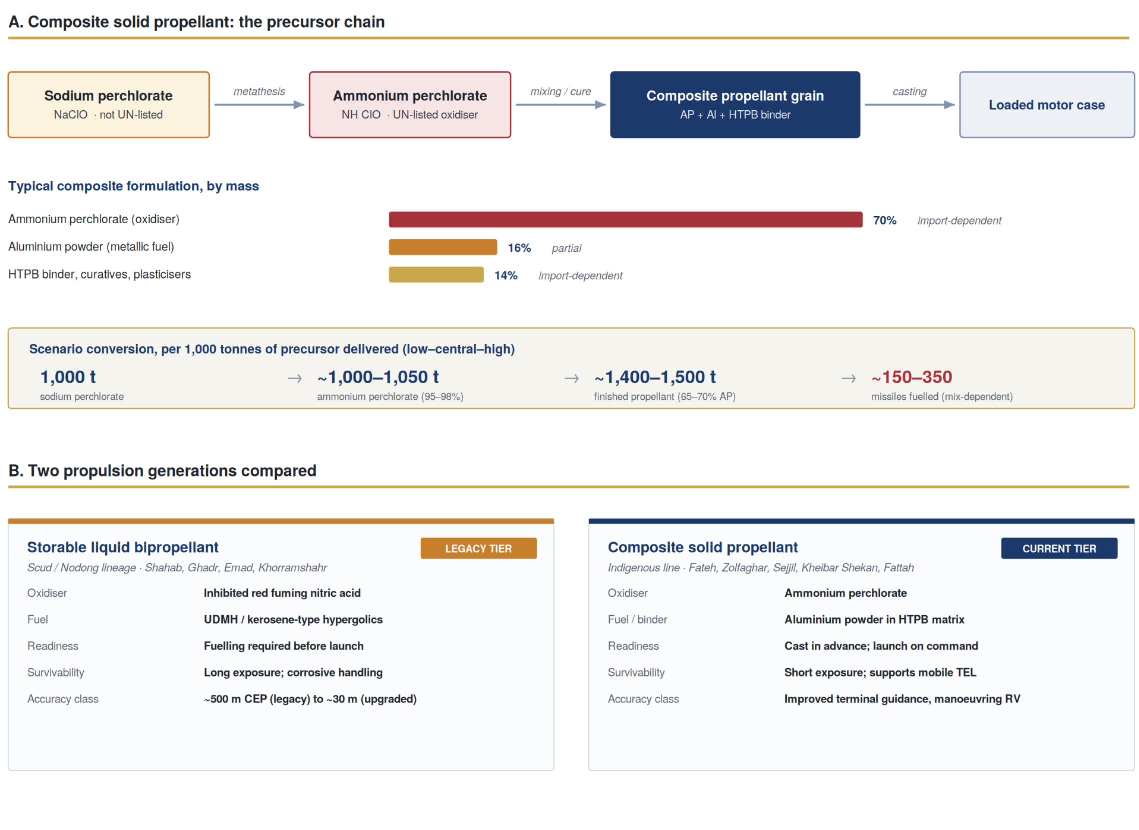

Figure 4. *Panel A traces the conversion chain from sodium perchlorate through ammonium perchlorate to a cast composite grain, with the approximate constituent proportions and a worked conversion for a 1,000-tonne precursor delivery. Panel B compares the two propulsion generations across the operational*

characteristics that matter for survivability and readiness. The analytical point of Panel A is the leftmost box: the chain begins with a substance that international instruments do not list.[70]

The operational payoff of the transition is substantial. A cast-solid motor is manufactured, inspected and stored complete. The missile is fired on command with no propellant handling at the launch site. Exposure time collapses from a lengthy fuelling operation to the minutes required to erect and align. This is what makes a genuinely mobile, dispersed, survivable missile force possible, and it is why Iran's dispersal doctrine and its solid-propellant programme are the same story told from different angles. It also explains the observed pattern of the 2026 war, in which Iran has sustained firing from a distributed base structure under continuous air attack.

There is a further consequence that bears on the report's central question. Liquid propellants can, at a stretch, be produced from a domestic chemical industry: nitric acid production is a widespread industrial capability, and hydrazine derivatives, while demanding, are within reach of a state with a petrochemical base. Ammonium perchlorate is different. It requires perchlorate chemistry, which requires either a substantial electrochemical production capacity or the import of a precursor. Iran's transition to solid propulsion, undertaken for sound military reasons, therefore had the effect of substituting one dependency for another and concentrating it in a single, highly visible, easily tracked commodity.

14. The Precursor Chokepoint

Of all the dependencies examined in this report, the perchlorate chain is the clearest, the best documented, and the most instructive about the design of international controls. It merits detailed treatment.

Ammonium perchlorate is a listed and prohibited item for transfer to Iran under the relevant international instruments. Sodium perchlorate, from which ammonium perchlorate is produced by a routine metathesis reaction with an ammonium salt, is not named in the same instruments.[71] The chemical relationship between the two is close, the conversion is well established and industrially undemanding, and the yield is high. The regulatory relationship between them, however, is a discontinuity, and Iran and its suppliers have exploited that discontinuity systematically.

[70]Conversion arithmetic follows The Diplomat, "1,000 Tons of Sodium Perchlorate"; propulsion comparison compiled from JINSA, Evolving Missile and Drone Threat, and Department of State, Procurement Advisory.

[71]Robertson and Polglase, "Western Intelligence Says Iran Is Rearming."

The documented flow is substantial. In January and February 2025, two vessels of the Islamic Republic of Iran Shipping Line, the Golbon and the Jairan, loaded approximately 1,000 tonnes of sodium perchlorate in the Taicang port area and carried it to Iran.[72] Converting a cargo figure into a missile count is analytically useful, but it must be presented as a scenario with explicit assumptions rather than as a single number, because the result is sensitive to several quantities that open sources do not fix. The conversion yield from sodium to ammonium perchlorate, the proportion of oxidiser in the propellant formulation, manufacturing losses, and, above all the mass of propellant per missile, which varies by severalfold between a short-range and a heavy medium-range system, all move the answer materially.

A transparent calculation therefore produces a range, not a point. Taking a conversion yield of 95 to 98 per cent, an oxidiser fraction of 65 to 70 per cent, and a propellant load per missile spanning the arsenal from lighter medium-range systems to heavy ones, 1,000 tonnes of precursor supports on the order of 1,400 to 1,500 tonnes of finished propellant, which fuels perhaps 150 missiles at the high-mass end and 350 or more at the low-mass end, with a central planning figure in the region of 250.[73] The point that survives the uncertainty is not any specific count but the order of magnitude: a single bulk shipment corresponds to a militarily significant quantity of solid propellant, in the low hundreds of missiles rather than the tens or the thousands.

One caveat is essential and is frequently omitted when this arithmetic is cited. Possessing enough oxidiser for a given tonnage of propellant does not demonstrate the capacity to manufacture the same number of complete missiles. A finished missile also requires aluminium powder, binder, a motor case, an airframe, a guidance unit and a warhead, each with its own supply constraint, and it requires the casting, integration and test capacity to assemble them. The perchlorate figure is therefore an upper bound on propellant availability, not a production forecast. It tells us how many missiles Iran could fuel, not how many it can build, and the binding constraint may lie elsewhere in the chain.

The flow did not stop. Following the 12-Day War, European intelligence sources reported that shipments totalling 2,000 tonnes began arriving at Bandar Abbas from 29 September 2025,

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[72] The Diplomat, "1,000 Tons of Sodium Perchlorate."

[73] The Diplomat, "1,000 Tons of Sodium Perchlorate"; see also House Select Committee on the Strategic Competition between the United States and the Chinese Communist Party, letter to Secretary Marco Rubio and Director John Ratcliffe, February 3, 2025, https://democrats-selectcommitteeontheccp.house.gov/sites/evo-subsites/democrats-selectcommitteeontheccp.house.gov/files/evo-media-document/2025-02-03%20Letter%20on%20China-Iran%20Missile%20Propellant%20Shipments.pdf.

purchased specifically to rebuild stocks depleted in that conflict, and arriving after the snapback mechanism had been triggered.[74] In 2026, during the active phase of hostilities, five further Iranian-owned vessels loaded at Gaolan port in Zhuhai, one of the largest liquid chemical storage complexes in China and a facility that had featured in earlier Iranian procurement cycles. One of them, the Hamouna, departed China on 19 February 2026, roughly a week before the joint US and Israeli air campaign opened, and reached Bandar Abbas on 26 March. Analysts estimated the combined cargo of the five vessels sufficient for approximately 785 additional missiles.[75] Applying the same scenario logic as above, that single-figure estimate should be read as a central value within a band that plausibly runs from roughly 450 to over 1,000 depending on the missile mix assumed and, again, as a measure of propellant available rather than of complete missiles that can be built and fielded.

Two features of this record deserve emphasis. The first is the transparency of the argument available to the supplying state. Because sodium perchlorate is not itself listed, China has been able to characterise the trade as normal commercial activity and to note that the material has civil applications in pyrotechnics and signal flares.[76] That characterisation is legally defensible and analytically hollow. As Professor Andrea Sella of University College London observed, there are very few alternative uses for the chemical at this scale beyond rocket propellants.[77] A thousand tonnes is not a fireworks order. Jeffrey Lewis of the Middlebury Institute has noted that China has been a primary source of sodium perchlorate for Iran's missile programme dating at least to the mid-2000s, which establishes that this is a long-running relationship rather than an aberration.[78]

The second is what the episode reveals about control design. Enforcement was not absent: the US sanctioned Iranian and Chinese entities and vessels involved in the propellant procurement network in April 2025, and the House Select Committee on the Chinese Communist Party sought a classified briefing on the shipments in February of that year.[79] But enforcement acting on an

[74]Robertson and Polglase, "Western Intelligence Says Iran Is Rearming." Attributed to European intelligence sources; not independently confirmed.

[75]"Suspected Chemical Shipments from China to Iran Raise Concerns over Potential Missile Expansion," gCaptain, April 2026, https://gcaptain.com/suspected-chemical-shipments-from-china-to-iran-raise-concerns-over-potential-missile-expansion/. Analyst estimate, subject to the assumptions set out in the text; not independently confirmed.

[76]gCaptain, "Suspected Chemical Shipments."

[77]Andrea Sella, quoted in gCaptain, "Suspected Chemical Shipments."

[78]Jeffrey Lewis, quoted in gCaptain, "Suspected Chemical Shipments."

[79]House Select Committee, letter of February 3, 2025; Behnam Ben Taleblu, "Ship Carrying Chemical for Missile Development Docks in Iran," Foundation for Defense of Democracies, February 25, 2025, https://www.fdd.org/analysis/policy_briefs/2025/02/25/ship-carrying-chemical-for-missile-development-docks-in-iran/.

unlisted precursor is enforcement acting one step too late in the chain, and it must rely on discretionary designation rather than on categorical prohibition. The lesson is that control-list architecture, rather than enforcement resourcing or political will, is the binding constraint. A regime that prohibits the product while permitting the precursor has built a door into its own wall.

For an analyst of Iranian capability, the perchlorate chain also offers something rare: a quantitative handle on production. Missile inventories are opaque, but bulk chemical shipments are visible to ship-tracking and satellite imagery, and the conversion arithmetic from precursor tonnage to missile count is straightforward. Tracking the chemistry is, at present, the single most reliable open-source method of estimating the rate at which Iran can reconstitute its solid-propellant force.

PART IV: SUBSYSTEMS AND THE STRUCTURE OF DEPENDENCY

15. Structures, Materials and the Airframe

A missile airframe must be as light as possible while withstanding launch acceleration, aerodynamic loading and, for the re-entry body, severe thermal flux. Every kilogram of structure is a kilogram not available as payload or propellant, so structural efficiency translates directly into range and warhead mass. The materials that deliver that efficiency are among the most tightly controlled items in the international system.

The US Department of State's procurement advisory enumerates the material categories that Iranian entities have been documented seeking. The list includes ultra-high-strength and corrosion-resistant steel, high-grade aluminium alloy and aluminium tubing, titanium sheet, carbon fibre and aramid fibre, glass fabric, epoxy-based adhesives and resins, thermal insulation, seamless steel tubes, graphite cylinders, tungsten metal powder, tungsten-copper alloy plates and tungsten-coated graphite.[80] Each entry corresponds to a specific structural function. Maraging steel and comparable ultra-high-strength alloys are used for motor cases that must contain high chamber pressure at minimum wall thickness. Carbon fibre, wound onto a mandrel and cured, produces cases lighter still, and the Kheibar Shekan's composite construction is the visible result. Tungsten and tungsten-coated graphite serve in the highest-temperature positions: nozzle throat inserts, jet vanes and nose tips, where materials must retain strength in a rocket exhaust stream.[81]

The enforcement record demonstrates sustained Iranian procurement across this category over two decades. The LIMMT prosecution in New York documented the sale of 25 tonnes of maraging steel by a Dalian entity, alongside tungsten powder and graphite cylinders.[82] SBIG purchased five tonnes of carbon fibre through a Shanghai intermediary in 2009.[83] Most recently, in May 2026, the Treasury designated the China-based firm Hitex Insulation Ningbo for supplying, or attempting to supply, millions of dollars' worth of carbon fibre, honeycomb fabric and other aerospace-grade

[80] Department of State, Procurement Advisory.
[81] Wisconsin Project, "Chinese Exports to Iran."
[82] Wisconsin Project, "Chinese Exports to Iran."
[83] Iran Watch, "SBIG."

raw materials to a designated Iranian procurement entity, ultimately for the IRGC Aerospace Force Self-Sufficiency Jihad Organisation.[84]

Iran has invested in closing this particular gap. The Congressional Research Service notes that United States designations have targeted Iranian efforts to develop carbon fibre materials domestically.[85] That Iran is pursuing indigenous carbon fibre production is itself evidence of the constraint's significance, and the fact that it continues to import while pursuing domestic production indicates the gap remains open. Carbon fibre manufacture at aerospace grade is a demanding continuous process requiring precise control of precursor polymerisation, oxidation and carbonisation, and it is one of the clearest examples of a capability that cannot be reverse engineered from a sample.

16. Guidance, Navigation and Control

If the propellant chain is the most quantifiable dependency, the guidance chain is the most strategically consequential because it governs the transition from area weapon to precision weapon that defines the modern Iranian arsenal.

A ballistic missile navigates principally by inertial measurement. Accelerometers sense acceleration along three axes, and gyroscopes sense rotation; integrating these quantities from a known starting position and orientation yields a continuously updated estimate of position and velocity without reference to anything outside the vehicle. The virtue of inertial navigation is that it cannot be jammed. Its vice is that errors accumulate: a small bias in a sensor integrates into a growing position error over the flight, so terminal accuracy depends directly on sensor quality. The difference between a 500-metre and a 30-metre circular error probable is, to a first approximation, the difference between commodity-grade and precision-grade inertial instruments, together with whatever external update or terminal correction the system can apply.

The Department of State advisory's electronics list maps this problem closely: inertial sensors, cryogenic accelerometers, fluxgate compass modules, field-programmable gate arrays, complex programmable logic devices, digital signal processors, microcontrollers, power amplifiers and

[84] U.S. Department of the Treasury, "Economic Fury Disrupts Networks Supplying Weapons and UAV Components to Iran," press release, May 2026, https://home.treasury.gov/news/press-releases/sb0496.

[85] Congressional Research Service, Iran's Ballistic Missile Programs: Background and Context, IF13035, https://www.congress.gov/crs-product/IF13035.

transistors, pressure transducers, circuit card assemblies, specialised connectors, and microelectromechanical systems components.[86] These fall into two functional groups. The first is the sensing group, the instruments that measure the vehicle's motion. The second is the processing group, the semiconductor devices that filter sensor output, run the navigation and guidance algorithms, and command the actuators.

Iran has been documented procuring both groups over an extended period. Gyroscopes and accelerometers featured in the LIMMT transactions of 2007 and 2008.[87] A Turkish government report obtained by the Associated Press documented Iranian-owned companies based in Türkiye importing goods from suppliers across Europe and North America under a false Turkish end-user declaration and transferring them onwards, including gyroscopes purchased from France and delivered to Iran in 2004 that could be used to improve the sensitivity of missile guidance systems.[88] The Jerusalem Post reported that Beijing has sold Iran precision machine tools and guidance components, including gyroscopes and accelerometers.[89]

The most analytically revealing recent case concerns machinery rather than components. In November 2025, the Treasury designated a vessel whose registry details had been altered, it assessed, to obscure the delivery to Iran of a computer numerical control machine specifically used to produce fibre-optic gyroscopes and guidance and control systems for ballistic missiles and unmanned aerial vehicles.[90] The significance lies in the direction of travel. A state that imports gyroscopes is dependent on a supplier for every unit. A state that imports the machine that makes gyroscopes is attempting to convert a recurring dependency into a one-time one. That Iran is making this attempt indicates strategic intent to indigenise; that it must import the machine to do so indicates the attempt is incomplete.

External navigation augmentation forms a second strand. Satellite navigation can bound the accumulating error of an inertial system, and China's BeiDou constellation provides positioning and timing services across the region. It is important to characterise this precisely, because commentary frequently overstates it. BeiDou is a navigation system, not a weapon and not a

[86]Department of State, Procurement Advisory.

[87]Iran Watch, "SBIG."

[88]"Report: Missile Parts, 'Dual-Use' Materials Illegally Shipped to Iran through Turkey," Associated Press, reporting on a Turkish customs inspection report dated May 12.

[89]Seth J. Frantzman, "A Ceasefire Won't Stop Iran's Military Industry," Jerusalem Post, April 2026, https://www.jpost.com/defense-and-tech/article-892689.

[90]Treasury, "Disrupts Iran's Transnational Missile and UAV Procurement Networks."

missile; its signals are broadcast and available to any receiver. The more consequential Chinese contribution documented in the current war lies elsewhere, in commercial satellite reconnaissance imagery and machine-learning-assisted target identification. In May 2026, the US sanctioned Chinese commercial satellite firms for supplying imagery and automated target tagging covering aircraft, shelters, fuel storage and radar installations across the region.[91] Precision requires not only a missile that can hit a designated point but also knowledge of which point to designate, and that is an intelligence function. Conflating the two obscures where Iran's dependency actually lies.

17. The Sensor and Navigation Layer: Satellites and External Intelligence

The preceding section examined the guidance instruments carried inside the missile. A distinct and, in the current war, decisive layer sits outside the missile entirely: the satellite navigation, positioning and reconnaissance architecture that tells the weapon where it is and, more importantly, tells the operator what to aim at. This layer is where Iranian dependency is at once most consequential and most frequently mischaracterised, and it is where the contributions of China and Russia are most visible.

Two functions must be kept distinct, because conflating them is the single most common error in commentary on this subject. The first is positioning, navigation and timing, the service a satellite constellation broadcasts to any receiver, which a missile can use to bound the accumulating drift of its inertial system. The second is intelligence, surveillance and reconnaissance, the imagery and analysis that identify and locate targets before a missile is ever fired. The first improves the accuracy with which a designated point is struck; the second determines whether the right point was designated. A precise missile aimed at an empty revetment achieves nothing, which is why the intelligence function is the more significant of the two.

On the positioning function, the evidence is suggestive rather than documentary. Following the June 2025 war, Iranian missile accuracy improved markedly, and intelligence analysts, including the former French external intelligence director Alain Juillet, assessed that Iran had likely been granted access to China's BeiDou satellite navigation system, whose regional accuracy exceeds

[91] "Iran, China and Russia: Satellite Intelligence and the Defeat of US Patriot and THAAD Missile Defence," Defence Security Asia, 2026, https://defencesecurityasia.com/en/iran-china-russia-satellite-intelligence-defeats-us-patriot-thaad-missile-defense-2026/.

what Iran could achieve unaided.[92] The US–China Economic and Security Review Commission subsequently stated that BeiDou had been used by Iran to direct attacks across the region.[93] Reporting indicates that Iran transitioned substantially from Western Global Positioning System reliance to BeiDou, framed by Tehran as technological sovereignty and reflecting Chinese concern that Western systems could be exploited for surveillance or targeting.[94] It bears repeating that BeiDou is a navigation utility, not a weapon; its contribution is real, but it is the lesser of the two satellite functions.

On the intelligence function, the evidence is documentary and specific, because it culminated in sanctions. On 8 May 2026 the United States Department of State designated three Chinese commercial satellite firms for providing Iran with imagery and geospatial intelligence used to monitor and target US and allied positions during Operation Epic Fury, alongside Iran's Ministry of Defence Export Center.[95] The detail in that designation is what makes it analytically valuable. Meentropy Technology, operating as MizarVision, was assessed to have used machine-learning algorithms trained on commercially sourced imagery to tag aircraft, hardened shelters, fuel storage and radar systems across the region automatically, and its imagery reportedly tracked the carrier strike groups of the USS Gerald R. Ford and the USS Abraham Lincoln and followed a US Navy P-8A Poseidon from Bahrain into the Arabian Sea.[96] The Earth Eye, also identified as Beijing Mumei Starry Sky Technology, supplied satellite imagery directly to Iran and was linked to the TEE-01B reconnaissance satellite built with Chang Guang Satellite Technology.[97] Chang Guang, operator of the Jilin-1 constellation of more than one hundred imaging satellites and already under

[92] Alain Juillet, cited in "Could Iran Be Using China's Highly Accurate BeiDou Navigation System?," Al Jazeera, March 11, 2026, https://aljazeera.com/features/2026/3/11/could-iran-be-using-chinas-highly-accurate-beidou-navigation-system.

[93] United States–China Economic and Security Review Commission, cited in "China in the 2026 Iran War," summarising USCC findings on BeiDou use.

[94] Reporting on Iran's transition from GPS to BeiDou following the June 2025 war; framed by Tehran as technological sovereignty.

[95] U.S. Department of State, "Disrupting Iran's Overseas Military Procurement Networks," May 8, 2026, https://www.state.gov/releases/office-of-the-spokesperson/2026/05/disrupting-irans-overseas-military-procurement-networks.

[96] "Iran's Missiles Are Learning: How China's Satellites and Russia's Intelligence Are Defeating US Air Defenses," Defence Security Asia, https://defencesecurityasia.com/en/iran-china-russia-satellite-intelligence-defeats-us-patriot-thaad-missile-defense-2026/.

[97] Defence Security Asia, "Iran's Missiles Are Learning."

US sanctions since December 2023, was designated for collecting imagery of US and allied facilities in response to Iranian requests.[98]

This is the mechanism behind the war's central tactical surprise, the ability of Iranian salvos to place warheads on specific, occupied, hardened aim points in the face of Patriot and THAAD. The US Defense Intelligence Agency assessed that the IRGC actively exploited these commercially sourced datasets to refine both missile and drone targeting.[99] The Iranian missile did not become dramatically better between 2024 and 2026; the Iranian targeting picture did, and it did so through an externally supplied commercial reconnaissance architecture that no missile-production sanction can reach.

The Russian contribution to this layer is narrower and less well documented but consistent in kind: intelligence, surveillance and reconnaissance support during the salvos of 2024 to 2026, complementing the Chinese imagery with additional sensor coverage and, reportedly, assisting the accuracy of specific systems.[100] The pattern across both suppliers is the same. Iran supplies the missile and the launch decision; China and Russia supply, in differing measure, the picture of the battlespace that makes the missile effective.

The table below sets out the principal satellite and external-intelligence systems on which this layer depends, distinguishing navigation from reconnaissance, identifying origin and operator, and assessing why each is difficult to interdict. The recurring feature is dual-use commercial character: a navigation signal is broadcast to the world, and a commercial imaging firm sells to many customers, so the same asset that serves civil mapping serves military targeting without modification. That is precisely what places this layer beyond the reach of the export-control architecture examined in Part V, which was built to stop the transfer of hardware, not the sale of a data product or the reception of a broadcast signal.

[98] "US Sanctions Three Chinese Satellite Firms," The Defense News, May 13, 2026, https://www.thedefensenews.com/news-details/US-Sanctions-Three-Chinese-Satellite-Firms-Accused-of-Providing-Iran-Intelligence-During-Operation-Epic-Fury/.

[99] Defence Security Asia, "Iran's Missiles Are Learning."

[100] Modern Diplomacy, "Iran's Ballistic Missile Capabilities"; Defence Security Asia, "Iran's Missiles Are Learning."

TABLE 4 : The Satellite and External-Intelligence Layer

System / provider	Origin	Function	Capability	Signature / naming	Bypass potential
BeiDou	China (state)	Positioning, navigation, timing	Regional PNT bounding inertial drift; sub-metre in-region	Broadcast GNSS signal; no per-user trace	High — open broadcast signal, not a transferable good
MizarVision (Meentropy)	China (commercial)	GEOINT target tagging	ML auto-tagging of aircraft, shelters, fuel, radars	Commercial imagery product; sanctioned May 2026	High — sold as data service, not hardware
The Earth Eye (TEE)	China (commercial)	Reconnaissance imagery	Direct imagery supply; TEE-01B recon satellite	Beijing Mumei Starry Sky; sanctioned May 2026	High — imagery delivered as commercial product
Chang Guang / Jilin-1	China (commercial)	Wide-area imaging	100+ satellite constellation; tasked to Iranian requests	Sanctioned Dec 2023 and May 2026	Medium — designated but continues operating
Russian ISR support	Russia (state)	Surveillance & reconnaissance	Sensor coverage; reported accuracy assistance	State-to-state; not commercially traded	Medium — opaque state channel, hard to observe
Carrier/aircraft tracking	China (commercial GEOINT)	Maritime domain awareness	Tracked Ford & Lincoln CSGs; P-8A from Bahrain	Attributed via DIA assessment	High — persistent commercial revisit

Table 4. *Navigation, positioning and reconnaissance assets on which Iranian targeting depends, distinguishing broadcast navigation from commercial reconnaissance. Compiled from the U.S. Department of State designation of 8 May 2026, Defence Security Asia reporting and USCC findings. "Bypass potential" denotes the difficulty of interdicting each asset under an export-control architecture built for hardware rather than data.*

18. Production Machinery and the Tooling Constraint

The category most consistently underweighted in public discussion of missile proliferation is machine tools. A design can be stolen, bought or reverse-engineered; a manufacturing capability cannot, because it resides in equipment, process knowledge and quality control rather than in drawings.

The Department of State advisory lists production and testing equipment as a distinct procurement category, including carbon fibre production equipment and filament-winding machinery.[101] Filament winding is the process by which a composite motor case is manufactured, laying resin-impregnated fibre onto a rotating mandrel in a computed pattern; the machine and its control software substantially determine the quality of the resulting case. Iran's documented procurement history includes a cold-flow milling machine sought by SBIG, environmental test chambers sought from a German supplier through a Dubai routing, computer numerical control machines and missile control computers, and electrical discharge machining equipment, for which the graphite cylinders in the LIMMT case were stated to be intended.[102] Electrical discharge machines are controlled precisely because they can produce complex forms to high accuracy in hard materials.

Test equipment belongs in the same category and is equally constraining. Environmental test chambers subject components to the temperature, vibration and altitude conditions they will encounter, and without them a manufacturer cannot qualify a design or maintain confidence in production consistency. The failure rate visible in Iranian combat firing, four of roughly 15 missiles failing in flight at Ain al-Asad in 2020, is consistent with a programme whose test and quality assurance infrastructure lags its design capability.[103]

This category is where interdiction has its greatest theoretical leverage, because tooling is expensive, low-volume, traceable and hard to substitute. It is also where enforcement is hardest, because machine tools have overwhelmed legitimate civil demand and the same five-axis machining centre serves an aerospace supplier, a medical device manufacturer and a missile programme without modification.

[101] Department of State, Procurement Advisory.
[102] Iran Watch, "SBIG"; Wisconsin Project, "Chinese Exports to Iran."
[103] CSIS, "Iran's Options."

19. Payload Integration, Arming and Fuzing

A warhead delivers effect only if it functions at the right moment, and the arming and fuzing chain that governs that moment is a distinct engineering discipline. This report treats the subject at the functional level appropriate to a policy assessment and does not attempt a component-level description, which would be neither source able from the open record nor responsible to publish.

Functionally, the requirement has three parts. The payload must remain inert through handling, transport, storage, and launch, which is a safety requirement. It must arm only after conditions unambiguously indicating flight have been sensed, which is a safety and reliability requirements jointly. And it must initiate at the point that maximises effect against the intended target, which for a hardened structure means after penetration and for a soft area target may mean before impact. The choice among these regimes is a targeting decision embodied in the weapon.

The observable evidence about Iranian practice in this area is behavioural rather than technical. The Fondation pour la Recherche Stratégique's imagery analysis of the 2020 Ain al-Asad strike found a direct hit on an aircraft hangar producing limited damage, which is consistent with a warhead and fuzing combination optimised for area effect rather than structural destruction.[104] Iran Watch's assessment that Iranian leaders have typically selected softer targets for ballistic missile strikes may, as that analysis suggests, reflect a tacit recognition of these limitations.[105] The introduction of the Khorramshahr with its very heavy payload and improved accuracy alters this picture, since payload mass and delivery accuracy together determine whether hardened targets are reachable.

On the procurement side, the relevant dependency is again electronic rather than energetic. Iran has a mature conventional explosives and ammunition industry through the Defence Industries Organization. What the fuzing function requires beyond energetics is sensing and logic, and those fall within the same imported microelectronics category examined above.

[104]Delory, Levallois, and Tourret, "Iranian Operations against el-Asad and Erbil."
[105]Iran Watch, "Before the Bombardment."

20. Launch Systems and the Ground Segment

The ground segment is the layer at which Iran is most nearly self-sufficient and examining why illuminates the whole pattern.

The Department of State identifies Shahid Kalhor Industries as the entity responsible for manufacturing and maintaining missile launchers and ground support equipment.[106] Transporter-erector-launchers are built on commercial or militarised heavy truck chassis with a hydraulic erector, levelling jacks, a fire control interface and power generation. Iran has a domestic heavy vehicle industry and long experience adapting commercial chassis, and while the components are unremarkable, the integration is demanding and Iran does it.

Fixed infrastructure is likewise indigenous. The hardened underground complexes that Iranian officials describe as missile cities are civil engineering projects exploiting the geology of the Zagros and Alborz ranges, and civil engineering is a domain in which Iran has considerable capacity. Analysis by the Alma Research and Education Center places the densest concentration along the Zagros belt of western Iran, around Kermanshah's Kenesht Canyon, the Panj Pelleh and Bakhtaran complexes, and Khorramabad in Lorestan, with further nodes near Tabriz, around Tehran, and along the southern coast of Hormozgan.[107]

One ground-segment element is not straightforwardly indigenous, and it is the one that matters most for accuracy. An inertial navigation system must be initialised with an accurate starting position and orientation, and errors in that initialisation propagate through the entire flight. Survey and alignment equipment therefore sits on the boundary between the ground segment and the guidance chain, and it belongs to the precision instrument category in which Iran is import-dependent. A state can build excellent launchers and still be limited by the quality of the instruments that tell those launchers where they are.

[106] Department of State, Procurement Advisory.

[107] Alma Research and Education Center, assessment of Iran's underground missile infrastructure, https://english.noonpost.com/p/rans-underground-missile-cities-how.

21. The Drone Programme as a Parallel Case

Iran's one-way attack drones are frequently treated as a separate programme. They are better understood as the same industrial system operating under different constraints, and they illuminate the dependency argument because the dependency is, if anything, sharper.

The economics are different in kind. A Shahed-series airframe is a small, propeller-driven aircraft of simple construction, cheap enough to expend in quantity. This makes drones ideal for saturation, for imposing unfavourable cost exchange on defenders firing expensive interceptors, and for suppressing air defences ahead of a ballistic salvo. Their use has expanded correspondingly: the Treasury noted in April 2026 that as US operations depleted Iranian ballistic missile inventories, Iran was increasingly relying on Shahed-series one-way attack drones against US forces, allies and regional energy infrastructure.[108]

But cheapness in airframe terms does not imply independence in component terms, because the airframe is not where the value or the difficulty resides. The guidance and flight control of a one-way attack drone requires the same categories of item as a missile: inertial sensors, satellite navigation receivers, flight control processors, and reliable engines. Analysis by the Center for Security Policy (CSP) assesses those components of Chinese origin now account for as much as 60 per cent of parts in some Shahed variants, up from a minority share in earlier models, and that China produces or reverse-engineers the small engines used in these aircraft.[109]

That trend line is the significant finding. If the Chinese content share of Iran's most-produced strike system has risen rather than fallen as production has scaled, then scaling has deepened dependency rather than resolving it. Mass production intensifies input requirements, and a state that cannot make the input at all cannot make more of it. The enforcement record reflects this: the Treasury's designation of the network around Pardazan System Namad Arman targeted the procurement of electronic components for Iranian drone programmes through front companies in Iran, Malaysia, Hong Kong and China, and the action against the Hamed Dehghan network targeted covert procurement of technology and electronic components through Hong Kong intermediaries.[110]

[108] U.S. Department of the Treasury, "Economic Fury Targets Iranian Missile and UAV Procurement Networks," press release, April 21, 2026, https://home.treasury.gov/news/press-releases/sb0465.

[109] "Are the Chinese Helping the Iranians Build More Drones and Missiles?," Center for Security Policy, April 2026, https://centerforsecuritypolicy.org/are-the-chinese-helping-the-iranians-build-more-drones-and-missiles/.

[110] U.S. Department of the Treasury, "Treasury Sanctions Procurement Network Supporting Iran's UAV and Military Programs," press release, https://home.treasury.gov/news/press-releases/jy1423; and "Treasury Sanctions

TABLE 2: The Dependency Matrix

Category	Representative controlled items	Documented source	Status
Oxidiser chemistry	Ammonium perchlorate; sodium perchlorate precursor	China (bulk maritime)	**Dependent**
Metallic fuel	Aluminium powder; high-grade aluminium alloy	China; third-country brokers	**Partial**
Binder system	HTPB, curatives, plasticisers	Commercial suppliers	**Dependent**
Structural materials	Carbon fibre, aramid fibre, honeycomb, resins	China (Ningbo, Shanghai)	**Dependent**
High-strength metals	Maraging steel, titanium sheet, tungsten powder	China (Dalian network)	**Dependent**
Inertial instruments	Gyroscopes, accelerometers, fluxgate modules	China; Europe via Türkiye	**Dependent**
Microelectronics	FPGAs, DSPs, microcontrollers, connectors	Western OEM goods, diverted	**Dependent**
Production machinery	CNC centres, filament winders, EDM equipment	China; Europe via UAE	**Dependent**
Test infrastructure	Environmental test chambers, measurement rigs	Germany via UAE (attempted)	**Dependent**
Airframe assembly	Integration, mating, quality control	Domestic (SHIG, SBIG)	**Indigenous**
Launchers and TELs	Chassis, erectors, ground support equipment	Domestic (Shahid Kalhor)	**Indigenous**
Basing infrastructure	Hardened underground complexes	Domestic civil engineering	**Indigenous**

Table 2. *Item categories are reproduced from the U.S. Department of State Iran Ballistic Missile Procurement Advisory; sources are those named in Treasury designations, Department of Justice indictments and published investigations. Status assessments are the authors.*

Transnational Procurement Network Supporting Iran's Ballistic Missile and UAV Programs," https://home.treasury.gov/news/press-releases/jy2073.

22. Penetration, Countermeasures and the Defence Problem

A missile's military value is a function not of its range but of the probability that it arrives. Iran has faced, since 2024, the most capable integrated air and missile defence array ever assembled against a regional power, and the measures it has adopted to defeat that array constitute a distinct technological effort worth separating from the propulsion and guidance discussion.

The first and oldest measure is saturation. Interceptor magazines are finite, radar tracking capacity is finite, and engagement decisions take time. Launching more objects than a defence can engage guarantees leakage regardless of individual missile quality. Iran has used this method consistently, and the April 2024 operation, combining approximately 171-way attack drones, more than 30 cruise missiles and over 120 ballistic missiles, was its most elaborate expression.[111] The sophistication lay in timing: drones are slow and cruise missiles slower than ballistic ones, so achieving simultaneous arrival requires launching in a computed sequence over a period of hours. The Begin-Sadat Center characterised this synchronisation problem as comparable in complexity to the Russian opening strike on Ukraine.[112] That comparison should be read narrowly, as a statement about command-and-control and timing complexity, not about overall effectiveness. Operational sophistication is measured by more than weapon numbers and synchronisation: target selection, electronic warfare, suppression of enemy air defences, decoys, route planning, follow-on waves and, above all, achieved military effect all bear on it, and by those measures the April 2024 operation, whose munitions were very largely intercepted, was not equivalent to a broad combined-arms campaign. Iran demonstrated genuine command-and-control competence; it did not demonstrate that synchronised arrival alone produces a decisive effect.

The second measure is trajectory and signature management through re-entry body design. A separating warhead, which the Qiam, Ghadr, Emad and later systems all employ, presents a smaller radar cross-section in the terminal phase than an intact missile body and removes the tumbling spent airframe that would otherwise accompany it. A manoeuvring re-entry vehicle, first openly displayed on the Emad, complicates the interception problem further because an interceptor computes a predicted intercept point from an assumed trajectory, and a body that departs from that trajectory late in flight can defeat the prediction.

[111] CSIS, "Iran's Options"; The Iran Primer, "Timeline of Attacks."

[112] Rubin, "Operation True Promise." Single-source assessment of complexity, not of overall effect; not independently corroborated.

The third is velocity, which is the rationale for the Fattah line. A glide vehicle that manoeuvres at high speed compresses the defender's decision and engagement timeline toward the point at which no engagement is possible. Iranian claims for the Fattah-2's performance should be treated as claims, and the distinction between a genuine hypersonic glide vehicle and a manoeuvring re-entry body with a high terminal velocity is one that open sources cannot reliably adjudicate. What can be observed is the intent and the direction of development.

The fourth measure is not a missile characteristic at all, and it is the one that has mattered most in the current war. Defeating a defended target requires knowing what to aim at, and the quality of that knowledge determines whether a salvo is expended against empty revetments or against occupied ones. The US sanctions imposed in May 2026 on Chinese commercial satellite firms for supplying imagery and machine-learning target identification, covering aircraft, shelters, fuel storage and radars, identify the mechanism.[113] Iranian precision in this war is best understood as the product of an adequate missile combined with a good targeting picture, and the targeting picture is externally supplied.

This has a policy implication that follows directly. Efforts to degrade Iranian strike effectiveness by attacking missile production address only one term in the equation. A missile force with a degraded inventory but an excellent targeting picture may be more dangerous per round fired than a large force firing blind. The intelligence input is cheaper, harder to interdict, and more readily replaced than the missiles themselves.

On the defender's side, the exchange economics deserve emphasis because they are becoming the central issue. A one-way attack drone costs a fraction of the interceptor required to destroy it. An adversary able to produce such drones in quantity can compel a defender to expend expensive munitions indefinitely, and the Treasury's observation in April 2026 that Iran was increasingly relying on Shahed-series drones as its ballistic inventories were depleted indicates that Tehran understands this arithmetic perfectly well.[114] The defender's problem is not technical inadequacy but an unfavourable cost ratio that no amount of interceptor performance improvement resolves.

[113] Defence Security Asia, "Satellite Intelligence."
[114] Treasury, "Economic Fury Targets Iranian Missile and UAV Procurement Networks."

PART V: THE PROCUREMENT ARCHITECTURE

23. The Industrial Organisation

Understanding what Iran imports requires understanding who imports it, and the institutional map is unusually well documented because it has been extensively designated.

At the apex sits the Ministry of Defence and Armed Forces Logistics, which holds responsibility for defence research, development and production. Beneath it, the Aerospace Industries Organization is the leading industrial subsidiary and oversees missile production, reportedly under IRGC control.[115] AIO's principal subordinates divide the work by propulsion technology. The Shahid Hemmat Industrial Group is responsible for the liquid-propellant programme; the Department of State identifies its own subordinates, including Shahid Karimi Industries for structural components, Shahid Rastegar Industries for liquid-propellant engines, and Shahid Cheraghi Industries.[116] The Shahid Bagheri Industrial Group holds the solid-propellant portfolio, with Shahid Kharrazi Industries responsible for solid-propellant development and production; SBIG produces the Fateh-110 and the licensed Fajr rocket system, and developed the Sejjil.[117] Other groups cover adjacent domains: Samen Alaeme Industrial Group for cruise and anti-ship missiles, Ya Mahdi Group for anti-tank weapons and man-portable air defence, Shahid Ahmad Kazemi Industrial Group for air-launched missiles, and a Naval Defence Missile Industry Group.[118] Iran Electronics Industries develops gyroscopes, avionics and space systems, and Malek Ashtar University supplies the research base.

Alongside this ministerial structure runs a parallel IRGC structure. The IRGC Aerospace Force Self-Sufficiency Jihad Organisation conducts ballistic missile research and flight test launches, while the IRGC Research and Self-Sufficiency Jihad Organization handles development. Both have been designated under Executive Order 13382, and both appear on the Bureau of Industry and Security Entity List.[119] The naming is revealing: an organisation formally dedicated to self-

[115] "Aerospace Industries Organization (AIO)," Iran Watch, https://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio.

[116] Department of State, Procurement Advisory.

[117] Iran Watch, "SBIG."

[118] "Iran's Military-Industrial Complex: Weaponizing Constraints," Rabdan Security and Defence Institute, September 2025, https://rsdi.ae/en/publications/irans-military-industrial-complex-weaponizing-constraints.

[119] Department of State, Procurement Advisory.

sufficiency is simultaneously among the most active procurers of foreign goods, which is not hypocrisy so much as an accurate description of the task, since achieving self-sufficiency in production requires importing the means of production.

For the analyst, the value of this structure is that it converts a diffuse question into a tractable one. Because end users are named in designation documents, and because designations state what was procured for whom, the procurement record can be read as a map of the programme's internal division of labour. When Hitex Insulation Ningbo is designated for supplying carbon fibre ultimately destined for the IRGC ASF SSJO, the transaction locates both a material dependency and the organisational node that owns it.[120]

24. Suppliers Differentiated

Public commentary routinely groups China, Russia and North Korea as a single bloc supporting Iranian missile development. The record does not support that grouping. The three contribute different things, at different times, through different mechanisms and with different degrees of state direction and conflating them produces bad analysis and worse policy.

North Korea's contribution is primarily historical and primarily architectural. It supplied the Scud-B and Scud-C airframes that constituted Iran's first inventory, the Nodong engines that made a medium-range capability possible, production licences such as that for the Fajr system, and a design lineage that remains visible in the liquid-fuelled portion of the arsenal today.[121] The relationship was transactional and reciprocal, with Iranian finance supporting North Korean development in exchange for technology and purchase options.[122] Its significance is foundational rather than current: the Shahab, Ghadr, Emad and Khorramshahr family descends from that inheritance, but the flow of new North Korean content appears to have diminished as Iran's own design capacity matured.

China's contribution is the enabling layer, it is continuous across four decades, and it is by a considerable margin the most consequential. It began with the 1988 agreement on medium-range missile development equipment and know-how and the 1990 technology transfer agreement.[123] It

[120] Treasury, "Economic Fury Disrupts Networks Supplying Weapons and UAV Components."
[121] Iran Watch, "Long Range Missile Capabilities"; Iran Watch, "SBIG."
[122] Wisconsin Project, "History."
[123] Wisconsin Project, "Missile Milestones: 1985–2017."

runs through the specialty metals and chemicals supplied by China North Industries Corporation, the maraging steel, tungsten, graphite, gyroscopes and accelerometers of the LIMMT network, the carbon fibre from Shanghai and Ningbo intermediaries, and machine tools, including equipment for producing fibre-optic gyroscopes.[124] It includes the perchlorate precursor trade documented from the mid-2000s to the present. And in the current war it extends to commercial satellite imagery and machine-learning target identification.[125] The pattern is that China does not supply Iran with missiles; it supplies Iran with the capacity to make missiles, which is a more durable form of assistance and one considerably harder to interdict.

A necessary qualification attaches to Chinese state responsibility, and it is important enough to warrant a formal distinction, because treating "China" as a single strategic supplier is one of the commonest errors in this literature. At least six different things can be meant when Chinese assistance is asserted: deliberate central-government policy; the activity of a state-owned enterprise acting on commercial incentives; a purely private commercial export; procurement effected through a front company without the nominal supplier's knowledge of the end use; weak enforcement or deliberate state tolerance of a trade the government could stop; and the sale of a commercially available product, such as satellite imagery, to which any customer has access. These carry very different implications for state culpability and for policy, and Chinese origin does not by itself establish Chinese government knowledge of, or approval for, a military end use.

Applying that typology, the perchlorate trade sits closest to the tolerated-or-weakly-enforced category: conducted through state-linked shipping, characterised by Beijing as normal commerce in an unlisted substance, sustained across decades and through the active phase of a war, but not demonstrably directed from the centre on the open record.[126] The LIMMT case was a prosecuted private network. The satellite-imagery contribution is a commercial data service, albeit from firms with reported military links. Whether the pattern in aggregate reflects deliberate policy or the predictable behaviour of commercial actors under weak enforcement is a question the open record does not settle, and this report declines to assume the answer. The supplier matrix below disaggregates the principal channels on exactly these lines.

[124] Wisconsin Project, "Chinese Exports to Iran"; Iran Watch, "SBIG"; Treasury, "Disrupts Iran's Transnational Missile and UAV Procurement Networks."

[125] Defence Security Asia, "Satellite Intelligence."

[126] gCaptain, "Suspected Chemical Shipments." The Chinese government's official characterisation, recorded as such rather than accepted.

TABLE 5: Supplier and Channel Matrix

Entity / channel	Commodity	Ownership	Evidence type	State involvement	Assessment
DPRK (Changgwang)	Airframes, engines, design	State	Historical record	Direct	Foundational, now diminished
LIMMT / Dalian	Steel, tungsten, gyros	Private	Indictment	Tolerated / weak enforcement	Prosecuted network
Hitex Ningbo	Carbon fibre, honeycomb	Commercial	OFAC designation	Not established	Designated 2026
Perchlorate trade	Sodium perchlorate	State-linked shipping	Designation + tracking	Disputed; unlisted good	Persistent, deniable
MizarVision / TEE	Satellite imagery, GEOINT	Commercial (PLA-linked)	State designation	Contested	Sanctioned 2026
Russia (state)	Accuracy aid, ISR	State	Reporting	Direct	Narrow, recent, reciprocal
UAE / Türkiye fronts	Transshipment	Front companies	Designation	Facilitation	Recurring corridors

Table 5. *Suppliers disaggregated by ownership type and degree of state involvement, distinguishing deliberate state assistance from commercial activity, front-company procurement and tolerated or weakly enforced trade. Chinese origin does not by itself establish Chinese government direction; the final two columns separate what is documented from what is assessed.*

Russia's contribution is the narrowest and most recent. Reporting indicates assistance in upgrading the accuracy and lethality of the Khorramshahr, Iran's most accurate medium-range system, and intelligence, surveillance, and reconnaissance support during the salvos of 2024 to 2026.[127] The relationship has been reciprocal in a way the others have not, since Iran supplied Russia with drones and, reportedly, ballistic missiles for use in Ukraine. Russian assistance appears targeted at specific performance problems rather than constituting a broad industrial relationship.

[127] "Iran's Ballistic Missile Capabilities: Range, Precision and Reach," Modern Diplomacy, April 1, 2026, https://moderndiplomacy.eu/2026/04/01/irans-ballistic-missile-capabilities-range-precision-and-reach/; Defence Security Asia, "Satellite Intelligence."

FIGURE 5: From Supplier to End User: The Documented Procurement Architecture

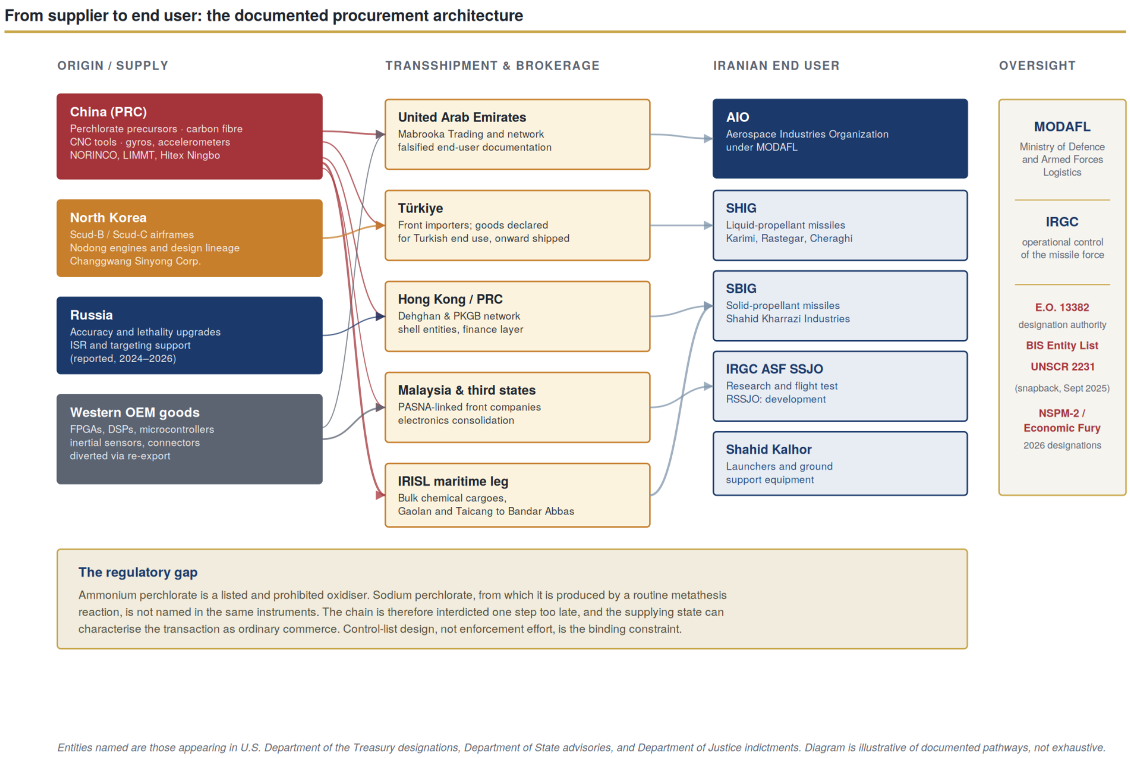

Figure 5. *Entities named are drawn from United States Treasury designations, Department of State advisories, and Department of Justice indictments. The transshipment column illustrates the intermediary geography through which goods have been routed, and the callout at the foot of the diagram states the structural problem that recurs throughout this report: the chain is interdicted one step later than the chemistry requires.*

The intermediary geography is as important as the source geography. Goods reached Iran through the UAE, where the Mabrooka Trading network was designated for obfuscating end users through third-country front companies; through Türkiye, where Iranian-owned importers declared Turkish end use and shipped onwards; through Hong Kong, where the Dehghan network and Pishtazan Kavosh Gostar Boshra operated secret procurement entities; and through Malaysia and other third states used for electronics consolidation.[128] The maritime leg for bulk chemicals runs on Iranian-flagged shipping from Chinese chemical ports to Bandar Abbas and Chabahar.[129] The 2026

[128] U.S. Department of the Treasury, "Treasury Sanctions Those Involved in Ballistic Missile Procurement for Iran," press release, https://home.treasury.gov/news/press-releases/jl0322; Treasury, "Transnational Procurement Network."

[129] gCaptain, "Suspected Chemical Shipments."

designations under the Economic Fury campaign targeted fourteen individuals, entities and aircraft in Iran, Türkiye and the UAE, indicating the persistence of these same corridors.[130]

25. The Enforcement Record and Its Limits

The international effort to constrain Iran's missile programme is among the most elaborate applied to any state, and assessing it honestly requires acknowledging both that it has imposed real costs and that it has not prevented the outcome it was designed to prevent.

The architecture is layered. Executive Order 13382 provides the designation authority against proliferators of weapons of mass destruction and their means of delivery, and the great majority of Iranian missile-related designations rest on it. The Bureau of Industry and Security Entity List restricts export licensing. The Iran, North Korea and Syria Non-Proliferation Act, the Arms Export Control Act, Executive Order 12938 and the Iran Freedom and Counter-Proliferation Act supply further instruments.[131] United Nations (UN) restrictions applied through the Security Council, with the snapback mechanism triggered at the end of September 2025. National Security Presidential Memorandum 2 directs the curtailment of Iran's ballistic missile programme, and the Economic Fury campaign has executed successive rounds of designations under it.[132]

The record of achievement is real. Networks have been dismantled and prosecuted, including the LIMMT case in New York. Procurement has been forced into costly, slow, and unreliable channels, which impose delay and price penalties. Publication of the procurement advisory has given industry the information needed to refuse suspicious orders, which is a form of enforcement that works through the private sector rather than against it.

The record of limitation is equally clear, and three structural problems recur. The first is control-list design, discussed above in relation to perchlorate: prohibiting a product while permitting its precursor produces a legal channel for a prohibited outcome. The second is dual-use ubiquity. Field-programmable gate arrays, digital signal processors, microcontrollers and precision machine tools have overwhelming legitimate demand, are produced in volume by many suppliers, and cannot be controlled at source without disrupting the civil economies that depend on them. The third is the intermediary problem: a network that has been designated can reconstitute under new

[130] Treasury, "Economic Fury Targets Iranian Missile and UAV Procurement Networks."
[131] Department of State, Procurement Advisory, annex on relevant U.S. sanctions and export control authorities.
[132] Treasury, "Economic Fury Targets Iranian Missile and UAV Procurement Networks."

names in the same jurisdictions, and the recurrence of the same transshipment geographies across twenty years of designations indicates that this is exactly what happens.

The most sobering evidence is the timing of the 2025 and 2026 perchlorate shipments. Cargoes arrived after snapback had been triggered, during an active war in which the US was conducting a naval interdiction campaign explicitly intended to sever this supply.[133] The conclusion is not that sanctions are futile. It is that sanctions have functioned as a tax on the programme rather than a barrier to it, and that a supply chain resting on an unlisted commodity carried in state-owned shipping from a permissive jurisdiction is not amenable to interdiction by designation alone.

26. Forensic Evidence and the Proxy Network

The evidence assembled in this report has come principally from designation records and official advisories. There is a second and independent evidence stream, and it deserves separate treatment because it provides physical corroboration of claims that would otherwise rest on government assertion: the forensic examination of recovered missile debris.

Iran has transferred missiles and missile technology to partners across the region for four decades, and those weapons have been fired, intercepted and recovered. Each recovery is an involuntary disclosure of Iranian manufacturing practice. When the Houthi movement struck targets in Saudi Arabia in November 2017, debris recovered from the attack carried the stamped organisational logo of the Shahid Bagheri Industrial Group.[134] That single physical artefact establishes the chain from an Iranian state manufacturing entity to a non-state actor firing across an international border, and it does so in a way that no denial can easily contest.

The forensic stream matters for this report's question in a specific way. Recovered debris can be examined for component markings, and component markings identify manufacturers. Where a recovered Iranian-supplied system contains microelectronics, sensors, connectors or engines bearing the marks of foreign manufacturers, that constitutes direct physical evidence of the import dependency that designation records describe indirectly. Investigations of this kind, conducted on debris from Yemen, from Ukraine after Russia's employment of Iranian-supplied drones, and from

[133] Robertson and Polglase, "Western Intelligence Says Iran Is Rearming"; gCaptain, "Suspected Chemical Shipments."
[134] Iran Watch, "SBIG."

Israeli territory after the 2024 strikes, have repeatedly identified components of foreign commercial origin in systems presented as wholly indigenous.

The transfer relationships themselves have expanded steadily. Iran sold Scud-B and Scud-C missiles to the Democratic Republic of the Congo in 1999, with Iranian officers and technicians present to assist assembly, which is an early indication that the export model included technical support rather than hardware alone.[135] It financed and facilitated a North Korean-built missile factory in Syria from 1991.[136] It has exported the Qiam to the Houthis.[137] Hezbollah's use of a C-802-family missile against INS Hanit in 2006 demonstrated transfer of the anti-ship line. And the supply of drones and, reportedly, ballistic missiles to Russia for use in Ukraine inverted the historical direction of the relationship, with Iran becoming a supplier to a major power rather than merely a recipient.

That inversion carries an analytical warning. A state exporting missile is a state whose production exceeds its own immediate consumption, at least at the moment of export. Iranian exports to Russia in 2024 preceded the heavy expenditure of 2025 and 2026, and reporting suggests Iran became more reluctant to conclude new export agreements once its own stocks came under pressure, which is consistent with a producer managing a constrained inventory.[138] Export behaviour is therefore a usable, if lagging, indicator of production margin.

A final observation concerns what the proxy network reveals about Iranian strategy. Distributing missiles to partners across Lebanon, Yemen, Iraq and Syria created a capability that could be employed with a degree of deniability and from multiple axes, and the April 2024 operation coordinated fires from Iran with launches from Iraq, Lebanon and Yemen.[139] The 2026 war has extended the same logic to the geography of the target set rather than the geography of the launch. In both cases the underlying principle is distribution: of launch points, of firing entities, of production nodes, and of the political attribution that follows an attack.

[135] Wisconsin Project, "Missile Milestones: 1985–2017."
[136] Iran Watch, "Long Range Missile Capabilities."
[137] Elleman, "Iran's Ballistic Missile Program."
[138] The Diplomat, "1,000 Tons of Sodium Perchlorate."
[139] CSIS, "Iran's Options."

27. What Iran Has Achieved

It is analytically necessary, and in a policy environment inclined to dismissiveness, it is also corrective to state plainly what Iran has accomplished. The failure to do so produces the recurring surprise that has characterised Western assessment of the programme.

Iran has achieved system design and integration at a level few states outside the major powers have reached. It conceives missile systems, specifies subsystems, manages the interfaces between airframe, propulsion, guidance and payload, conducts flight test campaigns, diagnoses failures and incorporates corrections into subsequent production. The Sejjil, Kheibar Shekan, Khorramshahr and Fattah are Iranian designs, whatever the provenance of their inputs.

It has achieved genuine mastery of composite solid propulsion at scale, having moved from tactical motors to two-stage strategic ones over roughly a decade. It has achieved a precision transition, closing the gap from a legacy 500-metre circular error probable to a claimed 30 metres on its most accurate system, which converts the arsenal from a terror weapon into a military one. It has achieved serial production in militarily meaningful numbers, with inventories credibly assessed in the low thousands.

It has achieved a survivable basing architecture, dispersing a hardened lattice across the Zagros and Alborz and along the southern coast, such that the loss of any node does not disable the force. It has achieved operational sophistication, demonstrated in the synchronisation of drones with cruise and ballistic munitions to produce simultaneous arrival across multiple axes.[140] And most impressively under the circumstances, it has achieved industrial resilience, sustaining firing and reconstituting stocks through months of concentrated air attack on its production infrastructure.

These achievements were made under four decades of the most comprehensive technology denial regime applied to any state in the modern period. Any assessment that treats Iran as merely an assembler of foreign parts fails to explain how the assembly was designed, integrated, tested and fielded.

[140] Rubin, "Operation True Promise."

28. What Remains Dependent

The dependencies are equally clear and, on the evidence assembled here, are not closing. Four categories recur across four decades of enforcement records.

Oxidiser chemistry is the sharpest. Iran's solid-propellant force, which is the modern and survivable part of the arsenal, rests on ammonium perchlorate produced from an imported precursor. The bulk, visibility and traceability of that trade make it the most quantifiable dependency and the one on which external leverage is greatest in principle, though the perchlorate chain demonstrates how a control-list gap can neutralise that leverage in practice.

Precision inertial instruments and their supporting microelectronics constitute the second. This dependency has deepened rather than eased, because the accuracy improvements Iran has pursued since 2015 raised the required grade of sensor and processor. That Iran now imports machines for making gyroscopes rather than only gyroscopes mark an attempt to escape it and simultaneously confirms it.

Aerospace structural materials, principally carbon fibre and ultra-high-strength alloys, form the third. Iranian efforts to develop domestic carbon fibre have drawn specific designation attention, and imports continue alongside those efforts, which is the signature of an unclosed gap.[141]

Precision production and test machinery is the fourth and, in some ways, the most fundamental, because it conditions all the others. A state that cannot manufacture to tolerance cannot indigenise the components it wishes to stop importing.

The pattern across these four is consistent and worth stating as a general proposition: Iran has indigenised the labour-intensive and knowledge-intensive parts of missile production while remaining dependent on the capital-intensive and materials-intensive parts. Design, integration, assembly, testing and operation are Iranian. The oxidiser, the gyroscope, the fibre and the machine tool are not.

That proposition must, however, be qualified by the distinction drawn in Section 2 between import dependence and strategic vulnerability, because the two are not the same and the difference determines how much leverage denial actually confers. Documenting that Iran imports an input does not establish that it could not produce a lower-grade domestic substitute, that it holds no

[141]Congressional Research Service, Iran's Ballistic Missile Programs.

stockpile, or that interruption would halt rather than merely slow production. The matrix below disaggregates each dependency along the dimensions that matter for that judgement: how reliably Iran must import it, how concentrated the supply is, how readily it could be substituted, and what would actually happen to the force if the supply were cut. The severity of a dependency is the product of these, not of foreign origin alone.

TABLE 6: Dependency Severity Matrix

Input	Import reliance	Supplier concentration	Substitutability	Effect if interrupted
Perchlorate oxidiser	Recurring, high	High (China)	Low near-term	Caps solid-motor output; bounds reconstitution rate
Aluminium powder	Partial	Medium	Medium	Degrades performance; partial domestic substitute likely
HTPB binder system	Recurring	Diffuse commercial	Medium	Slows grain production; formulation adjustable
Carbon fibre	Recurring, high	High (China)	Low	Blocks composite airframes; domestic effort unproven
High-strength metals	Recurring	Medium	Medium	Constrains motor cases; stockpiling plausible
Inertial instruments	Recurring, high	Medium (China, diverted West)	Low	Caps accuracy tier; deepest single dependency
Microelectronics	Recurring, high	Diffuse commercial	Low	Ubiquitous dual-use; hardest to deny, easiest to divert
Production machinery	Episodic, high-value	Medium	Very low	One-time chokepoint; conditions all other indigenisation
Satellite ISR / imagery	Service dependence	High (China)	Low	Degrades targeting picture; not a physical good

Table 6. *A disaggregation of import dependence into its component dimensions, as the reviewer of the evidentiary framework would require. "Import reliance" denotes observed frequency of procurement, not proof that domestic production is impossible; "substitutability" and "effect if interrupted" are the author's assessments and carry corresponding uncertainty.*

Read this way, the dependencies stratify rather than forming a uniform vulnerability. The perchlorate and inertial-instrument rows approach genuine strategic vulnerability, being high on reliance, concentration and consequence while low on substitutability. The aluminium and binder rows are softer, with plausible domestic substitution at some performance cost. The microelectronics row is peculiar: the dependence is deep and the consequence high, yet the ubiquity and dual-use character of the items make them the hardest of all to deny, so a high dependency coincides with low interdictability. The matrix is an analytical aid rather than a precise instrument, and its substitutability and consequence columns are the author's assessments carrying corresponding uncertainty, but it prevents the common error of reading every documented import as an equal point of leverage.

29. The Nuclear-Capability Question

A question that necessarily arises from any survey of Iranian ballistic missiles is whether they can carry nuclear warheads. The answer requires care, because it joins a narrow technical fact to a live international-legal dispute, and the two are frequently confused.

The technical fact is that several Iranian medium-range systems have the throw-weight to carry a first-generation nuclear warhead. The determining variable is payload mass. A first-generation nuclear device is heavy, and delivering one requires a missile that can carry roughly a tonne or more to strategic range. The Shahab-3 family, with payloads assessed between 750 and 1,200 kilograms, the two-stage solid Sejjil, and above all the Khorramshahr, with its 1,500 to 1,800 kilogram payload, all fall within that envelope; assessments including those of the CSIS Missile Defense Project and JINSA judge that these systems could accommodate a nuclear warhead.[142] The Khorramshahr is the clearest case, since its combination of heavy payload and, in the upgraded variant, a circular error probable near 30 metres would make it a capable nuclear delivery system were a warhead available.[143]

Two qualifications must sit immediately beside that fact, because without them it misleads. The first is that capability to carry is a statement about payload mass and volume, not evidence that a warhead exists. Iran is not assessed to possess a nuclear weapon, and nothing in this report should

[142] "Shahab-3," Missile Threat, Center for Strategic and International Studies, https://missilethreat.csis.org/missile/shahab-3/; JINSA, Iran's Evolving Missile and Drone Threat.

[143] "Table of Iran's Missile Arsenal," Iran Watch, https://www.iranwatch.org/our-publications/weapon-program-background-report/table-irans-missile-arsenal.

be read to suggest otherwise; the missiles examined here have been employed exclusively with conventional warheads. The phrase 'nuclear-capable' describes the airframe, not the arsenal.

The second qualification is that delivering a nuclear weapon reliably requires more than lifting the mass. It requires a warhead engineered to survive launch and re-entry and the arming, fuzing and firing sequence appropriate to a nuclear device, which differs from its conventional equivalent. This is the significance of the assessment by the International Atomic Energy Agency (IAEA) that Iran, in the early 2000s, may have explored various fuzing, arming and firing systems to make the Shahab-3 more capable of reliably delivering a nuclear warhead.[144] That reporting concerns weaponisation research relevant to delivery, and it is the point at which the missile programme and the nuclear file intersect. It does not establish that such a capability was completed or retained.

The reason this technical question carries such weight is legal and political. The UN Security Council resolution 1929, which returned to effect through the snapback mechanism in September 2025, provides that Iran shall not undertake any activity related to ballistic missiles capable of delivering nuclear weapons, including launches using ballistic missile technology.[145] The operative phrase is 'capable of delivering, which makes the payload-mass judgement examined above the trigger for a legal prohibition. In consequence, the technical assessment that a Shahab-3 or a Khorramshahr can carry a tonne-class payload is not an abstract engineering observation; it is the finding on which the international restriction turns. The capability question and the compliance question are, in the framework of the relevant resolutions, the same question, and this is why Iran's missile programme has been treated as a proliferation concern even in the absence of an Iranian nuclear weapon.

The honest analytical position is therefore threefold. Iran fields missiles technically capable of carrying nuclear warheads, as a matter of payload mass. Iran is not assessed to have a nuclear warhead to carry. And the gap between these two statements, the weaponisation and delivery-integration step, is precisely the space that the nuclear file, the inspection regime and the relevant Security Council resolutions were designed to police. A survey of the missiles can establish the first point with confidence; it cannot resolve the second or third, which belong to the nuclear question proper and lie beyond the scope of this report.

[144] International Atomic Energy Agency assessment, cited in "Shahab-3," Missile Threat, CSIS.
[145] United Nations Security Council resolution 1929, restored via the snapback mechanism in September 2025, as discussed in Iran Watch, "Table of Iran's Missile Arsenal."

30. The Question of Hidden Reserves

The report is asked to address what Iran has not used, and the honest answer is that this cannot be established from open sources and that claims made with confidence in either direction should be treated with suspicion.

The case for a deliberate reserve is coherent. A rational belligerent in a protracted war husbands its scarcest and most survivable munitions, both to retain a residual deterrent against a decisive adversary move and to avoid revealing the performance envelope of its newest systems to an adversary that will use that information to build defences. Iranian statements indicating an intent to negotiate from strength rather than exhaustion are consistent with the maintenance of such a reserve. The newest Fattah variants and the most accurate Khorramshahr are the plausible candidates.

The difficulty is that the same observable evidence, sustained firing with a gradually shifting mix of systems, is equally consistent with a quite different explanation: that Iran is firing what it can produce and what survives, and that the mix shifts because production and losses shift it rather than because a reserve is being managed. Distinguishing these hypotheses requires knowledge of inventory that open sources do not provide. Precursor tracking offers a partial handle on production rate, as discussed above, but production rate is not inventory and does not reveal allocation decisions.

What can be said with confidence is narrower and more useful. Iran has demonstrated the capacity to reconstitute launchers and propellant stocks between waves under attack. The rate of that reconstitution is bounded by precursor supply, which is externally sourced and therefore, in principle, interdictable. The strategically significant variable is therefore not the number of missiles Iran is withholding, but the rate at which it can replace those it fires, and that rate is a function of the supply chain this report has mapped rather than of any decision taken in Tehran about reserves.

31. Comparative Perspective: Iran Among Missile Powers

Placing Iran's programme against others clarifies what is distinctive about it and corrects two opposite errors: treating it as uniquely threatening and treating it as a derivative curiosity.

Against North Korea, the contrast is one of trajectory. Both programmes began from the same Soviet Scud inheritance, and for a period they developed in partnership, with Iranian finance supporting North Korean work in exchange for technology and purchase options.[146] North Korea pursued range, culminating in intercontinental systems, and coupled the programme to a nuclear weapons effort that gave the delivery system its strategic meaning. Iran pursued numbers and, latterly, accuracy and has fielded a conventionally armed force whose deterrent value derives from the certainty of substantial conventional retaliation rather than from a nuclear threat. These are different theories of deterrence expressed through similar hardware, and analysts who assess Iran using North Korean benchmarks systematically misread it.

Against Pakistan and India, the contrast concerns the relationship between the missile force and a nuclear arsenal. In both South Asian cases, the ballistic missile programme exists principally as a nuclear delivery system, and doctrine, custody arrangements, command and control, and force structure all follow from that. Iran's force is the reverse: a conventional strike complex of considerable size that is not, on the available evidence, a delivery system for a weapon Iran does not possess. This has a consequence that is frequently missed. A conventional missile force must be large, accurate and continuously replenished to be militarily useful because each round produces a limited effect. A nuclear delivery force need not be so. Iran’s enormous inventory and its heavy dependence on a consumable oxidiser supply chain are both direct consequences of the conventional character of its deterrent.

Against the major powers, the contrast is industrial. The US, Russia and China each possess an integrated domestic base spanning semiconductor, aerospace materials, precision machine tools and energetic chemistry. Iran possesses none of these at the required grade and has assembled a capable force regardless by importing the inputs and supplying the integration. This is the genuinely novel feature of the Iranian case and the one with the widest implications, because it establishes that a complete industrial base is not a precondition for a consequential precision-strike capability.

The closest analogues are therefore not other missile powers, but other cases of asymmetric industrial assembly, and the appropriate comparison may be to the drone proliferation of the past decade, in which commercially available components have been integrated into militarily effective systems by actors with no aerospace industry at all. Iran occupies an intermediate position on that

[146] Wisconsin Project, "History."

spectrum: considerably more capable than an assembler of commercial parts, considerably less autonomous than an industrial power, and demonstrating that the intermediate position is sufficient to impose serious costs on the most technologically advanced military in the world.

That finding is the report's most transferable conclusion, and it is the reason the 2026 war will be studied by states with no interest whatever in Iran.

32. Implications

Four implications follow, in ascending order of durability.

The first concerns force posture. Fixed, forward-based installations within range of a dispersed precision-strike complex are now liabilities as much as assets, and the dispersal of US personnel away from primary sites during the current war is an acknowledgement of this. The variable that determines the value of a regional base is no longer its capacity but its survivability.

The second concerns air and missile defence. Layered interceptor systems have performed well against Iranian salvos when supported by a coalition of sensors and shooters and poorly when saturated by numbers combined with externally enabled targeting. The economics are unfavourable and worsening: intercepting an inexpensive one-way attack drone with an expensive interceptor is a losing exchange that an adversary can compel indefinitely. This is a procurement and doctrine problem rather than a technical one.

The third concerns export control design. The perchlorate case is the clearest natural experiment available on the architecture of non-proliferation controls, and its lesson is that listing products while omitting precursors creates a lawful pathway to a prohibited outcome. Control lists are technical documents with strategic consequences, and revising them is slow, unglamorous and considerably more consequential than additional designations of entities that will reconstitute under new names.

The fourth and most durable concerns proliferation generally. Iran has demonstrated that a medium power under comprehensive technology denial can assemble a strategically consequential precision-strike complex by combining indigenous design and integration with a transnational input base. That model does not require an advanced domestic semiconductor industry, an aerospace materials sector, or a perchlorate industry. It requires engineering talent, sustained political commitment, a tolerance for failure during development, and access to a global commercial market in dual-use goods that no control regime has succeeded in closing. Those conditions are not unique to Iran, and the states observing this war will have drawn the same conclusion.

The war's outcome remains undetermined, and the figures in this report will move. The proliferation lesson will not.

33. Sources, Method and Limitations

The evidentiary strategy of this report requires explanation because it departs from much of the published literature on Iranian missile capability and because its limitations should be visible to the reader rather than buried. This section sets out the grading system introduced in Section 2 in fuller detail, explains how sources were selected, states the cut-off date, describes how missile types and performance figures were identified, and makes explicit the assumptions behind the report's quantitative estimates.

The grading system

Every significant claim in this report has been assigned, where its provenance warrants, one of five grades, stated in the footnote that supports the claim rather than in the body text so that the evidentiary signal travels with the citation and does not interrupt the prose. 'VERIFIED' denotes a claim independently corroborated by multiple sources of differing provenance; it is the rarest grade, because a subject shaped by classification and wartime information control offers few such claims. 'OFFICIAL' denotes an official government assessment, designation, indictment or advisory: it is attributable and legally consequential but reflects one state's judgement and frequently rests on intelligence that cannot be independently checked. REPORTED denotes credible but unconfirmed reporting from journalists, analysts or research institutions. INFERENCE denotes the author's own reasoning, drawn from graded evidence but extending beyond what any single source states. 'CLAIM' denotes a belligerent or manufacturer assertion, recorded because the fact of the assertion matters, not because it is accepted. Where a claim carries no footnote, it is a matter of general record not in dispute, the connective analysis that binds graded claims together, or a statement whose standing the surrounding prose makes plain. The reader is entitled to discount any claim according to its grade, and the grades are applied to make that discounting possible rather than to conceal the report's reliance on contestable sources.

Source selection

The dependency argument rests principally on four categories of official record. The first is designation documentation issued by the United States Department of the Treasury under Executive Order 13382 and related authorities, which names entities, states what they procured, identifies the Iranian end user and supplies a date. The second is the Department of State's Iran Ballistic Missile Procurement Advisory, which enumerates the goods, electronics and production equipment Iranian entities have been documented seeking and which was published precisely so that industry could recognise and refuse such approaches. The third is judicial records, principally the prosecution of the LIMMT network in New York. The fourth is the entity documentation maintained by Iran Watch and the Wisconsin Project on Nuclear Arms Control, which compiles the foregoing alongside contemporaneous reporting.

Sources were selected to favour, in descending order of preference, judicial findings, formal government designations and advisories, established research institutions with a track record on the subject, and finally wartime press reporting, which is used chiefly where no better source exists and is graded accordingly. Iranian state media and official statements are used only as evidence of what Iran has claimed, never as evidence that the claim is true. Where this report relies on a single institution's assessment for a technical figure, that reliance is noted, because the recirculation of a small number of underlying assessments across many secondary outlets can create a false impression of independent corroboration.

These sources have a specific evidentiary virtue. A government that designates a named firm for supplying a named material to a named Iranian entity is making an attributable, legally consequential assertion that can be contested and which the designating authority must be prepared to defend. That is a substantially higher evidentiary standard than technical inference about how a component might function, and it is the reason this report is built on procurement forensics rather than on speculation about internal design. It is not, however, verification, which is why designations are graded OFFICIAL rather than VERIFIED.

Cut-off date and the treatment of an ongoing war

The evidentiary cut-off for this report is 21 July 2026. The war that began on 28 February 2026 remains active at that date, and the report is therefore an interim assessment. This has a specific methodological consequence: the historical and structural analysis, comprising the acquisition record, the chemistry, the subsystem architecture and the procurement network, rests on settled evidence and should prove durable, whereas the operational assessment of the 2026 war rests on provisional wartime information and should be treated as a snapshot subject to revision. The two bodies of analysis are deliberately not given equal confidence, and the reader should not transfer the reliability of the former to the latter.

How missile types were identified

Missile systems referred to in this report are identified from a combination of Iranian designations, external analytical catalogues, principally those of the CSIS Missile Defense Project and Iran Watch, and, for combat events, the identifications offered in contemporaneous analysis. Two hazards attend this. The first is that Iran applies designations inconsistently and sometimes presents a modest upgrade under a new name for presentational effect, so a named system may not represent a distinct technical development. The second is that identification of the specific system used in a given strike is frequently uncertain, resting on debris analysis or claimed responsibility rather than confirmed launch records. Where the identity of a system used in combat is uncertain, the report says so; where a designation may denote a rebranding rather than a new capability, as with elements of the Khorramshahr and Kheibar family, this is noted.

Assumptions behind the quantitative estimates

Two classes of quantitative estimate appear in this report, and the assumptions behind each are stated here so that the reader can vary them. The first is the conversion of perchlorate shipments into propellant and missile counts, set out in Section 14. That calculation assumes a sodium-to-ammonium perchlorate conversion yield of 95 to 98 per cent, an oxidiser mass fraction of 65 to 70 per cent in the finished propellant, and a propellant load per missile that varies several-fold across the arsenal; it is presented as a low-central-high band rather than a point estimate, and it bounds propellant availability rather than complete-missile production, because a finished missile requires many other constrained inputs. The second is the reporting of accuracy as a circular error probable, which this report treats as an assessed order of magnitude rather than a measurement marks by provenance and does not present to a false precision. Failure rates, where cited, derive from observed combat events such as the four-of-15 failure at Ain al-Asad in 2020 and are not generalised beyond the event observed.

Claims deliberately not made

Three specific claims common in the public debate have been deliberately withheld because the evidence does not support them. The first is any count of Iranian missiles held in reserve, which cannot be established from open sources in either direction; Section 30 sets out the reasoning. The second is any component-level description of an Iranian warhead, fuzing or initiation design, which would rest on speculation rather than record and lies outside the report's proper scope. The third is any confident attribution of intent to the Chinese state regarding the perchlorate trade: the transactions and their scale are documented, but whether they reflect deliberate policy, tolerated commerce or regulatory failure is left open, because the open record does not settle it and the supplier matrix in Section 24 disaggregates rather than resolves the question.

The overall posture of this report is that a subject this contested is better served by visible uncertainty than by false confidence. The grading system, the scenario ranges, the disaggregated matrices and the explicit separation of durable from provisional analyses are all instruments to that end. Readers are encouraged to consult the underlying sources, which are linked in the notes, and to revise the interim judgements as the war and the evidentiary record develop beyond the cut-off date.

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