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"IRAN'S ENDURING MISSILE THREAT: THE IMPACT OF NUCLEAR AND PRECISION GUIDED WARHEADS "

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Iran's Missile Threat

Iran has a wide variety of rockets and missiles that go from short-range tactical systems, like multiple rocket launchers, to short and medium range artillery rockets, to cruise missiles and-short and long-range ballistic missiles. Iran's types of I missiles are shown in **Figure 1 and Figure 2,** and their ranges are shown in **Map 1 and Map 2**.

Iran also has the potential capability to create far longer-range missiles and even ICBMs, but this presents major challenges in creating weapons with any real effectiveness. Any missile with a conventional warhead presents some danger and can be use to try to intimidate other states and as a terror weapon. Missile design becomes steadily more challenging, however, as complexity and range increase, along with real world accuracy and reliability. Longer missiles armed with even large conventional explosive warheads, anything but fully reliable precision guidance, lack the accuracy and lethality to be effective weapons.

This situation would change radically if they were armed with nuclear weapons or highly lethal biological weapons, but only if they were reliable and had predictable accuracy so that targeting could be assign to area targets on a predictable basis. It would also change if they had reliable precision guidance systems capable of hitting point targets with suitable predictability.

It should be stressed that it is far easier to postulate such capabilities – or claim them – than it is to achieve them. Iran would run extraordinary risks if it attempted to launch missiles it had note fully tested, and whose real world accuracy and reliability remained uncertain. It would face even more uncertainty in arming a missile with a nuclear warhead that was not a proven and tested design with suitable safety and reliability and a predictable yield and set of nuclear effects. These risks will also increase with missile range and reliability.

The other side of this risk is that if Iran moved to develop such programs and brought them to the point of possible deployment, other powers would be forced to deploy missile defenses and develop deterrent and retaliatory capabilities in response. On the one, this could impose a major burden in terms of cost. On the other hand, it could trigger a nuclear arms race that would pose a growing threat to Iran and probably take the form of countervalue or population targeting rather than some form of at least initial military or counterforce targeting.

Iran also cannot disregard the fact that its Arab neighbors now have advanced strike aircraft and are acquiring missile defenses. That Israel is a mature nuclear power with its own long-range missile forces and probably boosted or thermonuclear weapons. That Arab states will acquire their own nuclear armed forces and/or precision guided missile forces. That the US can offer its allies extended deterrence and missile defense, and the end result of creating such a force would be a much greater threat to Iran than now exists.

Getting access to full design data from a mature nuclear and missile power could reduce the design and development risks, and ease actual weapons production. Iran would still, however, need to verify its designs and weapons performance. Moreover, technology transfer could not reduce the risks of building up a far greater threat to Iran –not only in terms of deterrence and retaliation, but continued sanctions and isolation and preventive war.

The Strategic Value of Iran's Shorter Range Rockets and Missiles

Iran's family of artillery rockets and shorter-range missiles give Iran a wide mix of tactical capabilities, and as Israel has found from attacks from causes, and in assessing the threat from the Hezbollah, these can pose a serious threat to neighboring states and become a form of power projection when transferred to friendly non-state actors.

Iran's shorter-range systems include a family of artillery rockets that supplement its tube artillery forces, and provide a major increase in area fire capability in terms of both range and volume of fire. They could also compensate in part for Iran's limited close air support capability, particularly in a defensive mode.

There are varying reports on Iran's holdings of longer-range artillery rockets, but key types and their ranges include the Fajr 1-Type 63-BM-12 (8 kilometers), H-20 (unknown distance), Falaq 1 (10 kilometers), Oghab/Type 83 (34 -45 kilometers), Fajr 3 (43 kilometers), and Fajar 5 (75-80 kilometers).

Iran's shorter-range missile systems include a wide variety of systems, and again reports vary sharply as to types, numbers, and performance. Iran sometimes announces missile programs, names, and ranges that are questionable, but its short-range ballistic missiles (SRBMs) seem to include the Naze'at (100–130 km), Zelzal family (Zelzal-1 (150 km), Zelzal-2 (210 km), Zelzal-3 (200–250 km), Fateh-110 (200–300 km), Shahab-1, Scud B (350 km) Shahab-2, Scud C, Hwasong-6 (750 km), and Qiam 1 (700–800 km).

Iran's shorter-range artillery rockets can deliver mass fires against nearby tactical targets and Iran's longer-range artillery rockets can be used in harassment fire and as weapons of intimidation against targets across the Iranian border in Iraq and Kuwait. The longest-range systems artillery rockets could reach targets in nearby Southern Gulf states.

While many assessments of the Iranian missile threat focus on its longer-range systems, Iran's other missiles are a threat to America's Arab allies and other powers in the region, to the flow of world energy exports, and to the global and U.S. economy. To put Iran's missile ranges in perspective, any system with a range of 200 kilometers can strike from a position on Iran's Gulf coast at a target on the Southern Gulf coast that is immediately across from it. Iran can also disperse many of its shorter-range missiles away from positions directly opposite a target in the Southern Gulf and still fire from sites deliberately chosen to disperse its missiles. Iran's longer-range systems can be widely dispersed and still used against targets on the Southern Gulf Coast.

Such strikes would normally have serious limits. The limited lethality and accuracy of most of Iran's rockets and shorter-range ballistic missiles mean that most Iranian missiles cannot hit a point target and would not produce significant damage if fired into an area target. They lack advanced precision guidance systems or terminal homing capabilities that could make them more political weapons and sources of intimidation than effective war fighting systems – except for the systems Iran is beginning to equip with GPS guidance systems. Some experts feel, however, that less accurate and reliable systems might be used in large volleys against key area targets, and that Iran is developing the capability to use GPS guidance for the larger and long-range systems – improvements that would greatly increase their lethality.

The Lessons of the Threat from Gaza and the Hezbollah

Iran has shown that even short-range artillery rockets can have a strategic impact, and be used in irregular warfare and as an indirect form of power projection. Iran has played a major role in helping Hamas and the Palestinian Islamic Jihad create a major pool of steadily improving rockets that it can conceal, disperse and fire against Israel, and that Israel cannot easily seek out and destroy even in a land invasion.

Israel has responded with defensive systems like Iron Dome and is developing systems to deal with larger and longer-range rockets like David's Sling and improved versions of the Arrow. It has also steadily improved its IS&R capability and tactics and training to use air strikes and land raids to attack launch sites and missile storage facilities.

Israel, however, was not able to suppress the threat from Gaza in 2014. In spite of a massive air campaign and a land invasion, the IDF estimated that the Palestinians had fired some 3,000 out of 10,000 rockets they held before the fighting started, the IDF had destroyed a total of roughly 3,000-4,000 rockets in combat, and 3,000-4,000 remained. Moreover, the Palestinians had been steadily able to improve the range and payload of their rockets with outside aid during 2008-2014.

Iran and Syria have transferred far larger forces of rockets and guided missiles to the Hezbollah in Lebanon. Hezbollah claimed to have an inventory of 33,000 by 2006, fired some 3,970 rockets into Israel from southern Lebanon, killing 44 Israeli civilians and 118 soldiers.[1] US experts felt that Hezbollah had some 33,000 rockets and missiles as of July 2014. Israel's official estimate was some 40,000 largely short-range systems – and some Israeli experts put the total at 100,000, while sources like Iran tracker put the total at 40,000 to 50,000.[2]

Virtually all sources agree that the Hezbollah has significant holdings of rockets and missiles like the Zelzal 2 (Range of 100-300 kilometers, 600 kilogram warhead, solid fuel), possibly some Scud missiles, and 12 or more anti-ship guided missiles. There are also reports that Iran and Syria have transferred longer-range versions of the Iranian Zelzal like the Zelzal 2, and Syrian M300/M302 and M600, with GPS guidance to the Hezbollah, which would greatly increase Hezbollah capability to carry out lethal strikes against targets in Israel.[3]

The Danger of Even Short Range Precision

Uzi Rubin, a key developer of Israel's missile defense program warned in January 2014 that: "The Iranians took the Zelzal 2 and turned it into a guided rocket. The third generation of it contains a homing sensor and a GPS. The Syrians can have this capability, too, to create a fully guided M-600 rocket with a GPS…Hezbollah will seek to import such guided weapons. [4]

Ehud Barak warned on March 25, 2014 that, "We will continue to see many more missiles, a lot more accuracy, and within five years the missile will reach a maximum level of accuracy that will allow them to choose which building in Israel to hit. These means will proliferate, and will be cheaper for terror organizations like Hezbollah and Hamas in Gaza…In the future we will see terrorism backed by science and technology…Somewhere in a small lab, hostile elements sit planning the future weapon of mass destruction. This is an unprecedented terrorism potential…We can't wait until the threat is realized, as the gap will be difficult to close."[5]

The end result is that Iran has the ability to put pressure on Israel from two fronts without taking direct responsibility for its actions or a high risk of retaliation, and transfer a relatively low-cost

threat that forces Israel to purchase far more expensive missile defenses – with exchange ratios where Israeli's defensive missiles are far more costly than the systems held by Hamas and Hezbollah.

Iran's Medium and Long-Range Missile Systems

Iran's medium and long-range missile systems include a wide range of medium-range ballistic missiles (MRBMs) that can cover the range from Iran to targets across the Gulf, and throughout the areas near Iran's borders. There is no clear dividing line that defines the military role of such medium-range systems from Iran's longer-range or intermediate-range ballistic missiles IRBMs) that Iran it can use to attack strategic area targets.

The end result is that Iran is deploying a constantly evolving family of missiles that have the range to attack virtually any target in Israel, the Levant, the Gulf and Arabian Peninsula, Turkey, Pakistan and part of Central Asia, and targets in Southern Russia and Europe. These systems give Iran a longer-range strike capability that its aging air force largely lacks. Iran's combat aircraft have the potential range-payload to strike deep beyond the Gulf, but they lack the performance, numbers, and enablers to operate effectively in large numbers of sorties against the US and Southern Gulf mix of fighters, strike aircraft, enablers, and surface-to-air missiles.

Key Uncertainties

Iran has announced fewer tests and specific details regarding its missile developments over the last few years. As this report makes clear, there also are many are conflicting reports about the names and range of such missiles, and conflicting unclassified reports about key aspects of individual missile systems.

The key uncertainties involved are:

- Iran's testing of missiles and rockets and their accuracy and reliability, the operational realism of such testing, and Iran's perceptions of its progress versus the reality. Limited tests under "white suit" conditions can produce a greatly exaggerated picture of capability, particularly if success is exaggerated to the political leadership.
- The warhead and fusing design, of Iran's rocket and missile forces and the real world lethality of unitary high explosive warheads under operational conditions, and of any cluster munitions Iran may have for such systems. A unitary conventional missile warhead that relies on a near surface burst can have only 30-60% of the lethality of a bomb with a similar payload because the closing velocity vectors much of the explosive force upwards.
- The relative accuracy of the missile and targeting systems relative to high value targets and the ability to launch or "volley" enough systems to compensate for limited accuracy against point and area targets.
- The strength and quality of US, Gulf, Israeli and other missile defenses.
- Iranian perceptions of the risk of counterstrikes by Gulf and Israeli air forces, and US and Israeli missiles.
- The actual political, psychological, and retaliatory behavior of targeted countries and their allies.

Nevertheless, a wide range of reports indicate that Iran's missiles and missile developments now include a mix of solid and liquid-fuels medium range ballistic missiles (MRBMs) with names and ranges like the Ghadr-110 (2,000–3,000 km), Shahab-3 (2,100 km) (Iran), Fajr-3 (2,500 km) Ashoura (2,000–2,500 km), and Sejjil (2,000–2,500 km). Far more controversially, they also may include developmental systems like the intermediate range ballistic missiles (IRBMs) like the Shahab-5 or Toqyān 1 (3000–5000 km) and the Shahab-6 or Toqyān 2)(3000–5000 km).[6]

Most such systems still lack advanced guidance systems, do not seem to have had enough tests in their final configuration to establish a high level of reliability or an accuracy based on real-world tests, and have guidance systems present major problems in attacking point targets or high value parts of area targets without being armed with nuclear weapon. As a result, much of Iran's missile force is more a weapon of intimidation that a war fighting tool. Such missiles can, however, hit large area-sized targets, and disrupt military and economic operations, and civil life.

Yet, systems that rely on conventional warheads and lack high accuracy or terminal guidance still have military value. They present the constant risk of a lucky hit – which increase with multiple firings. The very fact Iran deploys such missiles forces states in the region to buy missile defenses, consider civil defense programs, and potentially halt petroleum exports and other economic activity from vulnerable area targets.

Accordingly, they can partly compensate for the fact that Iran has not been able to compete with the US and its Arab neighbors in modernizing its airpower and surface-to-air missile defenses. They also help compensate for the fact that Iran's land and naval forces also face many limits in terms of modernization, equipment strength, and readiness, but Iran's missiles and rockets give it added strike capabilities at every level for land and naval tactical warfare to the ability to threaten states throughout the region with long range missiles.

Strategic Leverage from ICBMs?

Iran's longer-range missiles and space developments missiles have political and strategic value as well. The inability to predict how and when Iran will use them, how quickly they will evolve into more accurate and lethal systems, and know their operational impact until they are used gives them both deterrent value and makes them weapons of intimidation.

Iran gains strategic leverage from developmental programs that could someday enable it to launch missiles that can strike the US, as well as all of Europe and Russia. It is still unclear that Iran actually intends to deploy a real ICBM or IRBMs that can cover all of Europe and Russia. Iran is, however, developing boosters for what it claims are space purposes that create the potential to deploy a future ICBM.

Any Iranian long-range IRBM or ICBM would require an extraordinarily effective guidance system and level of reliability to have any real lethality with conventional warheads, even if it could be equipped with a functional GPS guidance platform. It would probably require nuclear warheads in order to compensate for critical problems in accuracy, reliability, and warhead lethality.

Iran would also face problems in conducting anything approaching a suitable test program at the ranges involved. Iran can, however, still gain visibility and political leverage simply by assembling the components of an ICBM or a booster for a satellite launch vehicle. It can also potentially push the US into expensive additional investments in missile defense and preemptive strike capabilities.

One option would be to obtain technology and proven components from an outside power or experts such as those in China, the FSU, and North Korea – although North Korea's capabilities and the performance of its KN-08 are developmental and uncertain. There have been reports for decades from sources like the National Council of Resistance of Iran (NCRI) and MEK that Iran and North Korea cooperate in missile design.

The *New York Times* reported on November 28, 2010 that Wikileaks released U.S. State Department cable traffic indicating that that Iran has obtained advanced missiles like a North Korean BM-25, a copy of the Russian submarine launched R-27 that has a nominal range of 2,000 miles. It also reported that Iran might have tested a Safir booster stage in 2009 based on DPRK assistance – and one that had a 40% increase in lift over previous designs.[7]

Iran has tended to be much more quiet about its missile test and design data since the nuclear negotiations with the P5+1 began, but John Irish of Reuters reported on May 29, 2015 that the National Council of Resistance of Iran (NCRI) claimed sources inside Iran, including within Iran's Revolutionary Guards Corps, said a seven-person North Korean Defense Ministry team was in Iran during the last week of April, that this was the third time in 2015, and that a nine-person delegation was due to return in June. It also claimed that, "The delegates included nuclear experts, nuclear warhead experts and experts in various elements of ballistic missiles including guidance systems."

Reuters also reported that the NCRI had claimed that the North Korean delegation "was taken secretly to the Imam Khomeini complex, a site east of Tehran controlled by the Defense Ministry. It gave detailed accounts of locations and who the officials met. It said the delegation dealt with the Center for Research and Design of New Aerospace Technology, a unit of nuclear weaponization research, and a planning center called the Organization of Defensive Innovation and Research, which is under U.S. sanctions." The State Department said it could not confirm such claims.[8]

Reporting by Bill Gertz in the *Free Beacon* on April 15, 2015 indicated that,[9]

> North Korea supplied several shipments of missile components to Iran during recent nuclear talks and the transfers appear to violate United Nations sanctions on both countries, according to U.S. intelligence officials…Since September more than two shipments of missile parts have been monitored by U.S. intelligence agencies as they transited from North Korea to Iran, said officials familiar with intelligence reports who spoke on condition of anonymity.
>
> Details of the arms shipments were included in President Obama's daily intelligence briefings and officials suggested information about the transfers was kept secret from the United Nations, which is in charge of monitoring sanctions violations… One official said the transfers between North Korea and Iran included large diameter engines, which could be used for a future Iranian long-range missile system….U.S. officials said the transfers carried out since September appear to be covered by the sanctions….Other details of the transfers could not be learned. However, U.S. intelligence agencies in the past have identified Iran's Islamic Republic of Iran…Shipping Lines (IRISL) as the main shipper involved in transferring ballistic missile-related materials.

Some of this reporting is controversial, but many expert believe Iran and North Korea do continue to cooperate. There is less support for Israel reports that Iran actually displaced a functional ICBM design measuring 27 meters in length (88.5 feet) on a launch pad outside Tehran. It seems more likely that these reports refer to a facility has been under construction for several years and is designed for the Simorgh satellite launch vehicle (SLV) that Iran needs to lift heavier payloads into orbit.

Jeremy Binnie, London and Sean O'Connor, Indianapolis of IHS Jane's Defence Weekly report that,[10]

> The Iran Space Agency announced in October 2014 that it planned to put three satellites into orbit using the Simorgh in the Persian year 1394, which starts on 21 March…The declassified version of the US Department of Defense's annual report on Iran's military power, released in January 2014, noted that "Iran

> has publicly stated it may launch a space launch vehicle by 2015 that could be capable of intercontinental ballistic missile ranges if configured as a ballistic missile".
> While the Simorgh is theoretically capable of ICBM ranges, it cannot deliver an effective warhead over such distances. Iranian media have reported that it will be able to lift a payload of just 100 kg into orbit.

No one can dismiss the possibility that Iran acquire an effective ICBM or get meaningful aid in doing so. The indicators it has a major effort, however, are still uncertain and until it has actually shown its capabilities in tests, guessing at its intentions, at is level of cooperation without outside state, and its future progress is just that – a guess. Moreover, reports from hostile opposition groups are not enough. These are areas where confirmation by US intelligence is critical.

Ongoing Cruise Missile Developments

Iran is also developing a family of cruise missiles, longer-range air-launched systems, and Unmanned Aerial Vehicles (UAVs) and Unmanned Combat Aerial Vehicles (UCAVs); that can supplement its ballistic missiles and provide targeting and damage assessment data. It is also seeking to develop satellite reconnaissance, targeting, and damage assessment capabilities, developing better mobile missile launchers, experimenting with missile shelters and silos, and creating less vulnerable and more secure command and control systems using optical fibers and land lines.[11] An estimate of its major developments is shown in **Figure 3**

US intelligence reports indicate that Iran is developing longer-range cruise missiles with a land attack capability. According to various reports, some of dubious veracity, it has had access to as many as three advanced cruise missiles that could pose a significant threat to US forces in the region, with one capable of carrying nuclear payloads. These three systems may include the Kh-55 or AS-15A, the SS-N-22 Sunburn, and the SS-N-26. All three were developed by the Soviet Union in the 1980s, the latter two to combat Aegis-equipped ships; if they have been properly maintained and are used correctly, in the confined waters of the Gulf they represent a threat to US ships.[12]

Twelve Kh-55 missiles may have been transferred to Iran by Ukraine in 2001.[13] Although the weapon was designed to carry a nuclear warhead, it could carry 410 kg of conventional explosive, enough to do substantial damage to a land target or naval vessel. With a maximum speed of Mach 0.8, a range of 2500 km, and inertial navigation and terrain matching guidance giving it a theoretical CEP of 25 meters. If it can actually approach this accuracy, it would be slower but more accurate than any of Iran's ballistic missiles.

The Kh-55 was designed as air-launched cruise missiles, and while Iran may have adapted them for ground launch, so far there have been no public demonstrations of these missiles. The system was designed as a ground-attack system and is unlikely to be effective against moving vessels unless Iran has upgraded its seeker system. Given Iran's difficulty fabricating parts for its ballistic missile program, and the need to develop suitable power plants and guidance packages, Iran is unlikely to have reverse-engineered this or any other cruise missile. There are no indications that Iran has test-fired a Kh-55 or any cruise missile with similar characteristics in recent drills.

If Iran could eventually make use of these systems or reverse engineer them, they could represent a serious threat. Their range would allow Iran to target Israel, the entire Gulf, and Southeastern Europe from bases well within Iran. While the missile was originally armed with nuclear weapons, it is unlikely that Iran would be able to develop a 410 kg nuclear device in the near future (see below). The Kh-55's main danger comes from precision and long range. Although it

may be more accurate than any ballistic missile currently in Iran's inventory, its relatively small payload (410 kg vs. 1000 kg for most SRBMs) and vulnerability to anti-missile weapons limits its effectiveness in hitting hardened and defended targets.

There are also unconfirmed reports that Iran received eight SS-N-22 Sunburns from Russia early in the 1990s.[14] The Sunburn is larger and heavier than the Kh-55, with a maximum speed of Mach 2.5 at high altitudes and 2.1 at low altitudes. It carries a 300-320 kg warhead and has a maximum range of 160 km. Its guidance package uses inertial navigation and data links for launch and mid-course flight, with the final approach controlled by the missile's radar. This weapon was designed to be a carrier-killer for Soviet bombers, and for its time would likely have been highly effective against US anti-missile defenses. It is unknown if Iran has managed to improve on these weapons or has only been able to refurbish its current stock, and with the exception of a 2006 image of a Sunburn-like missile being fired from an Iranian frigate, there are no public data on their current status.

The SS-N-26 is another system that is sometimes reported to be in Iranian forces. The SS-N-26 was designed to be a lighter, cheaper version of the SS-N-22. While some reports claim that it was publicly displayed in 1993, it is unknown if Iran has received any shipments of this missile. It has a longer range than the Sunburn but carries a lighter payload - 300 km vs. 160 km and 250 kg vs. 300-320 kg. It can be launched from submarines, surface ships, aircraft, and land batteries. If Iran actually has any SS-N-26s, they are likely stationed on mobile launchers around the Strait of Hormuz. With the exception of a passing reference in *Missile Threat*, however, there is no indication that Iran has access to these weapons and intelligence experts do not feel they are a current threat.

In addition to these cruise missiles, Iran has several hundred C-801, C-802, and SSC-3 missiles. These weapons have shorter ranges (50 km, 120 km, and 80 km), slower speeds (Mach .85, .85, and .9), and generally smaller warheads (165 kg, 165 kg, and 513 kg). All three carry some form of inertial guidance or autopilot combined with radar for the attack phase. All are based on designs that date from the 1960s or 1970s, although the Chinese production runs that Iran likely had access to from the 1980s and 1990s.

Iran claims to have upgraded its speedboats and patrol craft to launch more advanced cruise missiles, and to have used them in exercises.[15] Observers of recent naval exercises have not publicly verified such claims. The mounting of the C-700 and C-800 series of weapons on small vessels is confirmed, however, and presents a real threat. It is also one where US and allied navies and air forces must attack the moment such a missile launch becomes likely in order to minimize the threat of a successful strike on a US or allied ship.

Iran may have the Chinese HY-4 (C-601, Fl-4 Silkworm; NATO designation CSSC-7 Sadsack), although reports in this regard are unconfirmed. The HY-4 has a range of 135-150 km, a maximum speed of Mach .8, and a 513 kg warhead. It is a lighter version of the HY-2 Silkworm (2,000 kilograms versus 3,000 kilograms) with a turbojet sustainer with solid-fuel booster, a speed of Mach 0.8. There are reports that turbojet has had power and reliability problems.

According to Global Security, it has an, "autopilot for mid-course guidance and a J-band (10-20 GHz) monopulse active radar seeker for the terminal phase. A radio altimeter allows the cruise height to be adjusted between 70 and 200 m and the terminal phase involves a high angle dive attack. It is equipped with a 500 kg warhead, which is probably semi-armor-piercing."

It is normally air-launched, but a version is available that can be ship-launched. While it seems to be longer-range maximum range than the C-801, C-802, or SSC-3, none pose the same level of risk to military vessels that the SS-N-22 and SS-N-26 do. China is reported to have developed a longer-range version with an up to 300-kilometer range, but not to have put it into production.

In addition, a May 2015 study by IHS Janes's reports the discovery of a new cruise missile test site. According to satellite imagery, "the long-range Soumar cruise missile that Iran unveiled in March was tested on a range 40 km east-south-east from the city of Qom".[16] IHS Jane's analysts conclude that,[17]

- The satellite imagery lends credibility to the Iranian claim that the Soumar is now in serial production as it indicates that its test programme was completed by August 2014. There are, nevertheless, lingering doubts about the capabilities of Iran's long-range cruise missile.
- The test footage showed missiles being launched by their solid-fuel booster motors, but did not show them flying in their cruise phase using their air-breathing engines.
- While the Iranian Ministry of Defence released photographs showing five Soumars painted just in primer, suggesting they had recently emerged from a production facility, their engines could not be seen.
- Unusually, Iranian officials did not give a range figure for the missile. This may indicate that the Iranians have failed to acquire the small turbofan engines they need to replicate the 2,000-2,500 km range of the original Kh-55 and have been forced to use a less efficient turbojet engine instead.
- Uncertainties persist over the range of Iran's Soumar cruise missile. Due to shortcomings in Iran's engine development, "the assumption that Iran's Soumar cruise missile has a range of 2,500 km almost certainly overstates the weapon's performance," according to IHS Jane's.

In any case, Iran is developing the capability to produce and deploy long-range cruise missiles, and to have enough long-range cruise missile technology and production capability to deploy such systems in the future. In fact, Iran has already claimed it is going to deploy a new long-range land attack missile. The *New Straits Times* reported on April 1, 2013 that,[18]

> Iranian Deputy Defense Minister Mehdi Farahi announced that a new domestically manufactured cruise missile with a range of 2,000 kilometers will be unveiled in the near future, Iran's Mehr News Agency (MNA) reported. Farahi also said that the cruise missile, named the Meshkat (Lantern), can be launched from land-based and sea-based missile systems, adding that the missile can also be fired by fighter jets.
>
> In addition, he said that Iran has built or is building 14 types of cruise missiles, including Zafar, Nasr, Qader, and Ghadir missiles. Elsewhere in his remarks, Farahi said that in the field of missile technology, the Defense Ministry has focused its efforts on increasing the precision, radar-evading capability, and operational range of domestically manufactured ballistic missiles.
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> On the United States plan to build missile defense shields in the region, he said, "They are making some efforts and some claims, most of which are false, exaggerated, and have no basis in fact." He also said, "We hope that no incident will take place, but if a conflict occurs, they will see that their claims are ineffective."

This would be a far more ambitious cruise missile strike system that Iran has deployed to date. The Zafar missile is a short-range anti-ship cruise missile designed for mounting on speedboats and small craft. The Noor seems to be a larger anti-ship cruise missile with a range of 130 to 1270 kilometers.

The Qader or Ghadr is a system that has variously been reported as an upgrade to the Shahab 3, as an unpowered electro-optically guided 2,000 pound glide-bomb, as a cruise missile with a range of up to 200 kilometers that can be used against ships and land targets, and as identical to

the Meshkat - illustrating the problems in charactering Iran's forces using unclassified sources discussed earlier in **Chapter V**.

One problem that helps create some of this confusion is poor translation and transliteration of Farsi into English and Roman lettering. For instance, while poor transliteration may lead one to believe that the same name is being used to designate a 200km anti-ship cruise missile and a ballistic missile derived from the Shahab 3, a proper translation from the Farsi reveals that the anti-ship cruise missiles English name is "Capable" and the ballistic missiles name is "Intensity." Unfortunately for those who do not understand Farsi, those two Farsi words sound similar.

Some of the resulting uncertainties have already been discussed in **Chapter V**, but a land attack capable attack version of the Qader anti-ship cruise missile called does seem to be the same system that the US Director of National intelligence identified as a new land attack capability in April 2013. However, a similarly named Ghadr/Ghadir has been reported to be a smaller anti-ship cruise missile that can also be used against land targets, and the same name is used for midget submarines.

During the IRGC-ASF exhibition in May 2014, the IRGC also unveiled the "Ya Ali" land attack cruise missile, which has a reported range of 700km. IHS Jane's notes that it is similar to the Chinese YJ-62 (export designation C-602) and may use a version of the Tolou turbojet that is already in use with Iran's long range anti-ship cruise missiles. The wings do not retract into the missile body, suggesting that the missile cannot be launched from a container.[19] Little is known about the Ya Ali and it does not appear to have been shown outside of the May 2014 IRGC exhibition.

The Tasnim news agency reported that Rear Admiral Habibollah Sayyari, the Commander of the Iranian Navy, stated in late November 2013 that Iran planned to demonstrate new cruise missiles during military exercises in January 2014. He stated the Velayat-92 exercises would be Iran's largest yet, and would be held in northern part of the Indian Ocean and neutral waters, Tasnim news agency reported, "The newest cruise missiles will be tested during these exercises, aside from that, we will also test new weapons." He also talked about new unmanned aerial vehicles (UAV) and said that Iran would demonstrate a new phased array radar named "Asr."[20]

These statements came days after Iran had reached its nuclear agreement with the P5+1, but were tied to National Navy Day in Iran which occurs on November 28th, and celebrates Operation Morvarid of 1980, an Iranian Navy victory in the Iran-Iraq war. Sayyari also said that new military vessels and aircraft were planned to enter service, that the Navy would step up manufacture of the Sahand destroyer and that a 28th fleet of warships, comprised of Alborz and Bandar Abbas warships, along with the Younes/*Taregh*/Kilo-class submarine, had been sent on a 70-day mission to in the Indian Ocean and would go to the Gulf of Aden and the Red Sea, and would dock in a number of ports in India, Sri Lanka, and Oman. [21]

The Near-Term Impact of the Iranian Missile Threat

Iran's missile threat is currently severely limited by the inaccuracy of its conventionally armed missiles and lack of nuclear weapons and warheads. Iran's existing missile forces give it the capability to attack targets in the Gulf and near its border with conventionally-armed, long-range missiles and rockets. Iran can attack targets in Israel, throughout the region, and beyond with its longest-range ballistic missiles. However, the short-term risks posed by Iran's current conventionally armed rockets and missiles should not be exaggerated.

Most are relatively short-range systems, and have limited accuracy and lethality. They can be used as artillery, limited substitutes for air power, or as weapons of terror or intimidation. While Iran is deploying some systems with GPS guidance, most of Iran's are not accurate and lethal enough to play a substantial role in a conventional war, despite Iran's efforts to upgrade them.

The limited lethality of Iran's current warheads, the severe limits on the real world operational accuracy of most currently deployed systems, and the uncertain reliability of Iran's longer-range systems, now combine to limit the threat posed by anything other than large volleys of strikes to almost random hits somewhere in a large area. Even a lucky hit would only produce damage or casualties that would most probably be limited to those resulting from a single 1,000-pound unguided bomb.

Experts debate the extent to which Iran is developing missile systems with basic or advanced penetration aids, and the cumulative uncertainties in trying to estimate the effectiveness of current missile defense systems against Iran's current missile capabilities making any modeling effort highly uncertain. Israel, the Arab Gulf states, and the US are, however, steadily improving their missile defenses and shifting from point defense to wide area defenses.

In the near-term, this combination of real-world limits to the lethality of Iran's missiles and growing missile defenses sharply limits the military effectiveness of Iran's rockets and missiles as long as they are armed with conventional warheads:

- Iran would need to use large numbers of shorter-range rockets as artillery to achieve a major impact on military area targets. The seriousness of such threats will depend in part on Iran's ability to launch rockets and missiles in salvos and volleys, and in the ability to launch "stacked threats" of different types of weapons that complicate the use of missile defenses and suppressive strikes.
- While it is beginning to deploy shorter-range systems with GPS guidance, it would need to use volleys or salvos of short-range missiles and long-range rockets to have even a moderate probability of hitting a high value building or facility in military bases and civil area targets. These are tactics Iran has exercised, but may not yet implemented effectively.
- Iran use of MRBM and IRBM strikes could not be massed effectively in large numbers against longer-range area targets, and they will remain weapons of intimation that can be used largely psychological or "terror" purposes until they either acquire far better guidance and terminal homing capability and/or terminal homing.

Nevertheless, Iran is making a major effort to deploy more accurate missiles, and there have also been indications that it is developing nuclear warheads and seeking to give its systems penetration aids to counter missile defenses. No nearby state can disregard the fact that Iran can use conventionally armed missiles long-range rockets as terror weapons, and strike against large area targets like petroleum export facilities and cities. No state can disregard the fact that Iran might escalate to the use of such systems because of a conventional war in the Gulf, in reaction to any military threat to its ruling regime, as a response to covert action against the state, or as a method of resolving domestic fissures.

If one considers the full range of Iranian missiles, it is also clear that any assessment of its current military and strategic capabilities must include the entire Gulf, Israel, and US bases in the region. Iran's can threaten every other regional state, including Turkey, Jordan, and Israel, and Iran has shown that it can develop additional threats by transferring longer-range or more precise rockets and missiles to "friendly" or "proxy" forces like the Hezbollah and Hamas or to new friendly state or non-state actors forces in countries like Yemen.

When it comes to assessing to overall military balance in the region, it is also important to note that Iran's rocket and missile forces blur the distinction between ground and air forces. The same is true of any distinction its sea and air-launched systems, and Iran's longer-range systems blur any distinction between missile and air power in both the offensive and defensive roles. There also is no clear separation between the impact of Iran's rocket and missile systems based solely on range. Like efforts to distinguish between "asymmetric" and "conventional" warfare, they are potentially useful in structuring an analysis but they have steadily less real world meaning in terms of both deterrence and warfare.

Putting Iran's Missile and Nuclear Programs in Perspective

The main focus of world attention is on the possibility that Iran will deploy nuclear-armed missiles, although the threat of missiles armed with weapons of mass destruction is also not restricted to nuclear weapons. While no outside source has produced clear indications that Iran has stockpiled anything other than unitary and cluster conventional warheads, Iran is a declared chemical weapons state that has never declared its actual holdings. It is possible that it has chemical warheads, and such warheads could have a major impact in increasing the terror and intimidation effect of Iranian missile strikes even if their real world lethality is limited. Iran also has all of the technology to produce advanced biological weapons, although no source has reported any major indicators that it is doing so.

It is difficult to predict how aggressive Iran would become in exploiting its nuclear capability if Iran acquired nuclear-armed missiles. Iran has so far been cautious in initiating any use of force that might threaten the survival of the regime. Its best strategy would be to limit its use of nuclear missile forces to pressure, deter, and intimidate.

Iran, however, is clearly involved in an active competition with the US and with its Arab neighbors in an effort to win strategic influence and leverage. Iran faces US and Arab competition for influence and control over Iraq, the emerging threat of ISIL, and growing uncertainty over the future of its alliance with the Assad regime in Syria and the Hezbollah in Lebanon. Iran also still seems to see American influence behind all of these steadily growing pressures.

Iran has long sought to develop asymmetric military capabilities and forces that can challenge US encroachment in "its" region. Iran has threatened in the past to use such forces to "close" the Gulf, and has carried out major exercises targeted against the US and less directly at the GCC states. It has also described many of its exercises as a response to Israeli or American threats and "aggression".

While Iran has normally been careful to avoid any major threats and military incidents, to avoid provocative military steps, and to limit the risk of military confrontation; it is not clear that Iran would show the same restraint in using its full range of asymmetric warfare capabilities if it could arm its missile forces with nuclear weapons or if its missile forces developed a precision strike capability. Iran might then be more willing to take risks in using its other irregular warfare capabilities to try to force more favorable compromises, persuade the Iranian people they do face real foreign enemies, show how serious the impact could be on the global economy, or simply punish other powers.

Military history is also a warning that restraint in peacetime does not necessarily last in a crisis or limited conflict. The history of war is not the history of rational bargainers. Tempers can grow

short, given units can overreact, situations can be misunderstood, and one nation's view of how to escalate rarely matches another's once a crisis begins. Iran could escalate to major rocket and missile strikes because of miscalculations on both sides of a future clash or lower level conflict.

The Iranian missile threat is also likely to become far more serious in the future even if Iran never does arm its missiles with weapons of mass destruction. Left to its own devices, Iran would probably deploy both nuclear-armed missile and highly accurate missiles with conventional warheads. Iran has powerful military incentives to deploy nuclear weapons, and Iran's missile forces give it the potential ability to develop a major nuclear strike force.

The Challenges to Iran if it Does Deploy a Nuclear-Armed Missile Force

Even if the P5+1 nuclear arms talks with Iran fail, Iran faces technical challenges in creating and deploying nuclear-armed missiles and in ensuring they would not be subject to preemption or counterforce nuclear strikes. It will be vulnerable to preventive strikes during its development and initial deployment phases, and Iran might well have a very limited stockpile of nuclear weapons for some years after it first began to deploy such weapons, and creating a survivable and effective force would pose problems of a different kind.

Long before Iran could deploy a meaningful nuclear-armed missile force, Iran's efforts to acquire nuclear weapons could also lead to US or Israeli preventive attacks on both its nuclear and missile facilities and forces. If the current P5+1 talks fail, President Obama and other senior US officials have made it clear that US policy sees Iran's acquisition of nuclear weapons as "unacceptable." Both Israel and the US have repeatedly stated that they are planning and ready for military options that could include preventive strikes on at least Iran's nuclear facilities and, and that US strikes might cover a much wider range of missile facilities and other targets.

Such preventive strikes would present risks for the attacker as well as Iran. They might trigger a direct military confrontation or conflict in the Gulf with little warning. They might also lead to at least symbolic Iranian missile strikes on US basing facilities, GCC targets or Israel. At the same time, it could lead to much more serious covert and proxy operations in Lebanon, Iraq, Afghanistan, the rest of the Gulf, and other areas.

Furthermore, unless preventive strikes were reinforced by a lasting regime of follow-on strikes, they could trigger a much stronger Iranian effort to actually acquire and deploy nuclear weapons and/or Iranian rejection of the Nuclear Non-Proliferation Treaty (NPT) and negotiations. The US, in contrast, might see it had no choice other than to maintain a military over-watch and restrike capability to ensure Iran could not carry out such a program and rebuild its nuclear capabilities or any other capabilities that were attacked.

A preventive war, however, is only part of the threat Iran will face. As has been touched upon earlier, Israel is a mature nuclear power that already has a thermonuclear-armed missile forces with considerable counterstrike capability. Israel's ability to destroy Iranian cities and population centers already makes Israel an existing existential threat to Iran. At least initially, Iran could only secure is evolving forces by relying on launch-on-warning (LOW) or launch-under-attack (LUA). This, however, would push Israel into shaping a nuclear force posture designed to react to any Iranian use of nuclear forces – or even an Iranian threat – by launching an all-out nuclear attack with a force posture that would almost be designed to lead both sides to miscalculation or over-reaction.

It is far from clear that if Iran ever used nuclear weapons, it would not suffer far more than any nation or nations it attacked. Iran faces the grim fact that its missiles can make a war far more damaging and lethal, but it cannot win any arms race in which the US takes part, or any process of escalation that involves the US and Israel.

Simply possessing a few early nuclear devices and nuclear-armed missiles weapons does not mean they are effective. The risks to Iran in deploying nuclear-armed missile forces are increased by the fact that an Iranian effort to create survivable and effective nuclear-armed or precision strike missile forces would take years to deploy, and would present other kinds of challenges in the process. Iran cannot become a meaningful nuclear power overnight, and Iran does not exist in a "nuclear vacuum."

A "nuclear Iran" seems likely to trigger a constant regional arms race to develop larger nuclear forces, missiles with larger nuclear warheads, missiles with more accuracy and penetration aids, better missile defenses, less vulnerable basing and deployment systems and the ability to launch-on-warning (LOW) or launch under attack (LUA). What Albert Wohlstetter once called the "delicate balance of terror" between the US and USSR and NATO and Warsaw Pact could become the "unstable balance of terror" in the Gulf and Middle East.

A nuclear arms race already exists between Israel and Iran - albeit one where only Israel now has a nuclear strike capability. Iran's actions have almost certainly already provoked Israel into developing the capability to target thermonuclear warheads on every major Iranian city, creating an "existential" threat to Iran long before Iran will pose one to Israel. It seems certain that if Iran goes further, Israel will seek to create and maintain an even greater nuclear "edge" over Iran – if it does not launch preventive war. The practical problem this raises for Iran - and for stabilizing this arms race - is that Iran will face a possible Israeli first strike option until it can secure its nuclear armed forces.

This could push Iran towards a concealed or breakout deployment, followed by phase where it would have to launch on warning or under attack until it has a survivable force. Iran would then, however, have to compete with powers with far larger stockpiles and boosted and thermonuclear weapons until it can create a more sophisticated force of its own. This confronts Iran with the reality that it at least initially faces a high-risk arms race, and is then likely to become trapped in a steady race to increase its forces, find ways to secure them against counterforce strikes, find ways to compete in missile defense and still find itself confronting an escalating mix of Israeli, US, and Gulf nuclear and conventional strike capabilities superior to any force Iran can deploy.

If Iran moves from a threat to actually acquiring nuclear weapons, it seems likely to provoke a Gulf power like Saudi Arabia to seek nuclear-armed missiles, and any nuclear-armed neighboring state would almost certainly respond to any nuclear attack in kind. Saudi Arabia and the GCC states may well have the option of turning to Pakistan for nuclear-armed missiles, and senior Saudi officials have said Saudi Arabia has examined nuclear options.

A credible Iranian threat to use nuclear weapons against other regional targets also seems likely to lead the US to fully implement its past offer to provide "extended deterrence." The US has officially offered its regional friends and allies "extended deterrence" of the kind it once provided to Europe during the Cold War - essentially confronting Iran with an open-ended threat of US retaliation.

The end result would at best be a "delicate balance of deterrence" where deterrence might fail. While any form of nuclear preemptions or "bolt from the blue" seems unlikely, a nuclear exchange might grow out of escalation from the response to Iran's use of asymmetric warfare, a threat of some "takeover" of a given regional government or a state, or the risk of some "accident" or miscalculation. The worst moments in history rarely occurred because of accurate calculations by rational bargainers.

This is why successful negotiations between the P5+1 and Iran seem likely to be of significant strategic benefit to Iran. They would eliminate Iran's nuclear option, but the end result would do more to ensure Iran's overall security than Iranian nuclear-armed missiles. Once Iran tests a nuclear device or claims to have nuclear weapons, it will enter a very different world of risks. Iran's missiles will be seen by many Israelis as "existential" risks the moment Iran has – or even claims to have – nuclear weapons. It is Iran, however, that will face the most immediate threat from Israel of preventive war, preemption, or massive retaliation.

At the same time, the failure of such negotiations would have a negative impact on the US and its regional allies as well. The end result is that if the P5+1 negotiations – or some form of negotiations – fail, Israel, the US, and Arab states cannot choose between preventive war and containment. Unless Iran fundamentally changes its present course, the choice is between preventive strike and containment, or containment alone. Neither of which has favorable results for the US. Preventive strikes may be able to delay Iran for a given period of time, but if Iran seeks to rebuild it nuclear capabilities, Israel, the US, and the Arab countries will have to strengthen their missile and other defenses, develop great retaliatory capabilities and/or restrike every new Iranian effort to move towards nuclear weapons.

Containment alone also becomes much more difficult for the US and its Arab and Israeli allies should a the P5+1 fail to reach a settlement with Iran, because other powers—including some European allies—are interested in trading with Iran. The risk that important United Nations sanctions may be removed if the failure to reach a deal is perceived to be the responsibility of the United States. Disunion among the sanctions regime will make it much more difficult to contain Iran and prevent it from obtaining the necessary technology to build and construct an effective nuclear weapon.

Shaping the Future Threat: Nuclear Warheads vs. Precision Conventional Warheads

At the same time, Iran's search for precision guided conventional missiles could also pose another kind of major strategic threat. Reliable and effective precision guidance would make Iran's missiles far more lethal even if Iran rejects a nuclear option. Such systems could do sufficient damage to critical military and infrastructure targets to effectively replace "weapons of mass destruction" with "weapons of mass effectiveness."

If Iran is to make a major advances in missile lethality without arming its missiles with nuclear warheads, it must make advances in one of three other areas: (1) it must deploy missiles with precision guidance and terminal homing; (2) deploy missiles with chemical or biological weapons, or (3) greatly enhance its command and control to launch semi-accurate volleys – potentially in "stacked" arrays of different missiles from different launch sites.

Iran may be pursing options (2) and (3), but it is clearly taking steps to give its conventionally armed missiles far more accuracy. Iran is deploying short-range systems with GPS guidance and

has said publicly that it is seeking to provide its missiles with precision guidance and/or terminal homing warheads, and with countermeasures to ballistic missile defenses. It already has deployed at least one missile with GPS guidance and begun to experiment with cruise missiles.

Iran's current conventionally-armed missiles are already becoming somewhat more lethal as they are equipped with cluster munitions and better fusing. However, their lethality is still be limited by their range-payload limits, and a lack of accuracy if this remains the only area of improvement. Even substantial volleys of missiles and rockets with better conventional warheads against area targets would still be limited in real world lethality, and would be more terror strikes than strikes capable of quickly hitting and destroying key point targets.

If Iran succeeds in deploying forces with a truly reliable precision strike capability, however, its missiles will become capable of targeting key military, petroleum, power, and water facilities with enough accuracy to destroy them with a credible conventional payload. It would radically alter the lethality of Iran's longer-range systems against high value military targets and civil targets like key oil product facilities and desalination plants - creating the equivalent of "weapons of mass effectiveness." Iran would also run far less risk of catastrophic escalation in retaliation to either the threat of using its missiles, or carrying out limited strikes, if it could use missile forces with conventional warheads in strategic attacks rather than nuclear warheads.

There is no evidence as yet that Iran has such capabilities for most of its systems and no certainty that it can acquire them in the near future. Iran has, however, made claims that imply it already has such accuracy, and a number of Israeli experts believe it is developing such systems. A number of sources indicate that its systems with greatly improved guidance include production of the Zelzal-2 as a guided rocket, and development of the Ya Ali land attack cruise missile, the Zelzal-3 ballistic missile, and the Raad-301 precision guided bomb. Iran has also claimed to have demonstrated that it has a near precision strike capability by attacking a simulated airfield -- although satellite photos of the target area indicate it simulated at least some of its accurate missile hits by using explosive devices at the scene.

As for the second option, Iran does not seem to be arming it missile forces with other weapons of mass destruction. No key source has yet claimed that Iran is actively pursuing deploy chemical or biological warheads to give its missiles more lethality – although Iran did have short-range, chemically armed rockets in the past.

The value of this option to Iran option also needs to be kept in perspective. Chemical and biological missile warhead would have an immediate impact as terror weapons, but making them highly lethal is another story. It is easy to exaggerate the lethality of chemical missile warheads under real world operational conditions. Dispersing a chemical agent effectively is a major challenge, and chemical cluster weapons present serious timing and height of burst problems. Mounting chemical and biological weapons on longer ranged ballistic missiles also requires to warhead to survive the harsh re-entry environment that could degrade the effectiveness of the weapon if it is not shielded properly. It might well take a substantial volley of shorter-range rocket to have a major effect, and such a strike could remove all limits to a conflict and might still produce limited damage to critical targets.

Biological weapons can theoretically be as - or more - lethal than fission nuclear weapons and Iran has all of the technology and manufacturing capability needed to make such weapon. Effective dispersal is, however, even more difficult than with chemical weapons, and developing and testing such a warhead presents serious technical problems, could only have its lethality fully

validated by human or primate testing, and presents the political problem that such a threat might not be credible until Iran's capability was proven. Moreover, the very threat that Iran was arming its missiles with biological weapons could trigger massive preventive strikes and any use of such warheads would eliminate any barriers to counterstrikes with nuclear weapons.

The third option is difficult to implement simply because of the numbers required. The lethal radius of conventional warheads against many targets is so limited that it takes extremely large nuclear of conventionally armed missiles to have a significant probability of producing meaningful and lasting damage. Volleys using mixes of missiles might, however, allow Iran to saturate Gulf and US missiles defenses by mixing older and less accurate systems with more modern precision-guided systems

Missiles, Political and Psychological Warfighting, and Wars of Intimidation

Any discussion of lethality must also take account of the fact that the political impact of missiles can be as important in political and psychological terms as in military terms. Iran can already use its longer-range artillery rockets and missiles to copy Saddam Hussein's strategy in using missile attacks during the Iran-Iraq War and the first Gulf War 1991. Missile forces also have political dimensions that help Iran fight "wars of intimidation" even in peacetime.

At a minimum, Iran's growing missile forces already increase its deterrent and defensive ability to deter attack on Iran and compensate for its weaknesses in airpower. More broadly, Iran can use its missiles politically and strategically, and not simply to damage targets. Selective firings and "volleys" of conventionally armed, unguided long-range missiles and rockets can be used as political symbols or terror weapons.

Iran might use its missiles to strike Israel after an Israeli preventive strike, or to strike at Israel in some other contingency where it felt the political symbolism inside Iran and the Arab and Islamic worlds were worth the cost. Iran could hope that conventional missile strikes on Israel would lead to limited Israeli retaliation, leading in turn to political pressure on Arab states to reduce ties to the US. Strikes on Arab states would bring the costs of war home to populations that are ill prepared for conflict, raising the penalties for Gulf publics that have rarely had to face the personal risks stemming from regional instability.

As was demonstrated during the "war of the cities" during the Iran-Iraq war, by the use of the Scud missile during the Afghan War, and by the Iraqi Scud attacks on Israel and Saudi Arabia during the Gulf War in 1991, missile strikes can have a powerful propaganda impact that vastly exceeds their actual warfighting effect - at least initially. There were reports during the Iran-Iraq War of civilians and officials fleeing Tehran. Iraqis, Israelis, Saudis, and Coalition forces also routinely took shelter during missile attacks, and the Israeli press reported many cases of individuals that effectively panicked in 1991 - although perhaps more from fear that missiles might have chemical weapons than out of a fear of missiles or conventional warheads per se.

Even a few Iran missile strikes on either Israel or Saudi Arabia might also be seen by Arab states as a demonstration of Iran's willingness and capability to escalate even further, and growing future ability to strike with far more effectiveness. Iran could pick on one or a few Arab states, and seek to divide Arab states from each other. Moreover, Iran can use even token or failed missile strikes for internal political propaganda purposes.

Iran might also use missile strikes as a counter to any US, Gulf, or other conventional air or cruise missile strikes on Iranian military, civil, or infrastructure targets. Such a response might be deliberate, or escalate out of an incident in the Gulf or some other form of military clash. There are no clear boundaries between conventional and irregular/asymmetric warfare, and no clear steps on the escalation ladder that deter the use of one form of force against another, or the level and mix of land-air-sea-missile force that will be used. Iran has historically been a relatively cautious power focusing on regime survival, but history is a clear warning that even the most cautious power can suddenly become locked into a massively escalating conflict.

Regardless of the current limits to the lethality of Iran's missile forces, the psychological impact of Iran's ability to launch a sudden, massive missile barrage on regional population centers and military installations should not be underestimated. Neither should the possibility of a lucky hit producing enough casualties or highly visible damage to have a lasting psychological impact - what might grimly be called the "World Trade Center effect." Iran's ability to launch a large volume of missiles over a period of days with little warning before the first round of launches gives Iran leverage and makes such missiles a weapon of intimidation. Even if - and perhaps especially if - they are never used, Iran's missiles also have the capability to intimidate and leverage Iran's neighbors, and to force the US and its regional allies to devote resources to missile defense.

Missile and long-range rocket attacks can boost Iranian morale. In the face of limited, attrition-like conflict between Iran and the US and GCC, ballistic strikes provide Iran with the chance to show its public that it is prosecuting the war and inflicting casualties on the other side. Framed as retaliation for a combination of sabotage, assassination, sanctions, and potentially overt strikes, ballistic missiles demonstrate to the Iranian population that its government is capable of repaying the suffering it has undergone.

As the exports of Iranian artillery rockets and shorter-range missiles have shown, Iran's missiles also have a growing political, strategic and psychological impact outside Iran. Current Iranian doctrine seems to stress building up the risk and reality of allied and proxy attacks around the world, Hamas and Hezbollah rocket and missile strikes already have had a major impact on Israel's military posture, and "third party" missile strikes may be a growing problem for the US and its Arab allies in the future.

At the same time, it should be noted that many of the political psychological effects of ineffective missile strikes, however, wore off relatively quickly. There were not enough missile firings to sustain a high degree of popular fear, and people were soon reported to be going to their roofs at night to "watch the show." There is simply too much empty area in a given urban complex or large military base for largely random strikes to either produce critical damage or kill enough people to shock or intimidate the population. Limited by the number of TELs and static launching sites, Iran may be unable to continue a bombardment campaign for an extended period of time in the face of Arab or US airstrikes.

The Challenges from an Iranian Conventionally-Armed Precision Strike Missile Force

The outside response is likely to be far less threatening to Iran if it succeeds in deploying precision strike missile systems with conventional warheads than if it deploys nuclear weapons, but the end result would still be a regional arms race which Iran is unlikely to win. Once again,

Iran cannot act in a vacuum. As full analysis shows, outside powers have a major advantage in overall air warfare capability, combat aircraft, and surface-to-air missiles. Iran's target base is at least as vulnerable as that of its Gulf neighbors. The Arab Gulf states already have missile defenses for many key targets, the US is deploying missile defense ships with wide area missile defense capability, and nations like the UAE and Qatar have already indicated that they may buy land-based wide area missile defenses like THAAD.

Unless Russia or China alter their polices to sell Iran virtually any advanced weapons technology it wants, the Arab Gulf states, Israel, and the US will have an overwhelming advantage in many areas of air and missile strike capability and missile and air defense. Every major Iranian improvement in its missile forces will trigger an overall set of counter efforts by the US and the other states in the region.

Iran may be able to gain some political leverage by exploiting the risk of a conflict, but it will progressively increase the probable damage to Iran if a conflict actually occurs. Iran will also then face a military situation where Israel retains a nuclear option and Iran does not. It seems unlikely that Israel would ever initiate the use of nuclear weapons against Iran in response to any probable scenario in a world where Iran did not deploy nuclear-armed forces, but Israel might well adopt a preemptive or launch on warning strategy if Iran did deploy nuclear weapons and showed any sign of actively preparing to use them.

The Impact of Retaliatory Threats and Retaliation

Regardless of how or why Iran uses its missile and other delivery system, Iran cannot operate in an environment where there will be no response. As has been discussed earlier, Iran faces far superior air strike forces and air and missile defense forces.

Israel has a wide range of retaliatory and escalatory options, including nuclear-armed ballistic and sea-launched cruise missiles. Saudi Arabia already has long-range, conventionally armed Chinese missiles that can strike area targets in Iran, and the UAE has some SCUD-B missiles (likely equivalent to Shahab-1s). There are questions about the status, reliability, readiness, and accuracy of the Saudi and Emirati missiles, but these same questions apply to Iran's forces. This raises the specter of any missile "war of the cities" of the kind observed between Iran and Iraq.

Iran faces the risk of steadily more capable retaliation by US strike fighters and bombers with "stealth capability and by the best air forces of the Gulf as states like Saudi Arabia and the UAE acquire steadily better strike fighters with may be less likely to initially have a terror impact on civilian populations, they provide a far more effective strike and targeting capability that Iran can do little to reduce. In the near-to-midterm, Iran's forces and critical infrastructure are is becoming more vulnerable to Southern Gulf air forces as they acquire missile defenses and become less vulnerable to Iranian missiles.

Any Iranian use of long-range missiles against another Gulf state also presents a serious escalatory risk to Iran. Even one such missile firing would effectively escalate to a level where the US would have no clear limits on its use of air and cruise missile power to strike at strategic targets in Iran. Iran's major cities are as vulnerable in terms of power, water, and fuel supplies as the cities of the southern Gulf, and Iran's refineries and certain key links in its ports and transport systems are highly vulnerable as well. Iran cannot possibly win a contest in escalation with its current conventional forces and conventionally armed missiles, and such a contest could spiral into an asymmetric or unconventional war that is costly and destructive for all sides.

Moreover, the first time Iran uses even a conventionally armed missiles, it may create conditions that lead to some form of US guarantees and "extended deterrence." The US has stated that it will not accept an Iran with nuclear weapons, but even if does, this scarcely offers Iran security or freedom from preemption and retaliation. Should Iranian nuclear efforts prompt Riyadh to develop its own nuclear program, as was mentioned previously, this would only increase the risks of escalation if Iran uses its ballistic missiles.

Iranian Missile Defenses

Iran currently has no missile meaningful ballistic defense capabilities, and Russia and China are Iran's only potential sources of direct sales of missile defense systems. Iran has shown in the past it is well aware that it would take major deliveries of a new integrated air defense system based around the S-300 or S-400 surface-to-air missiles to begin addressing Iran's strategic vulnerabilities to an aerial campaign. Until recently, however,, neither Russia nor China has proved willing to sell the Russian version or Chinese modified version of such systems.

Russia halted the sale of modern S-300PMU1 (SA-20 Gargoyle) long range SAMs in 2010, and has since refused since then to reopen the deal. Although a future shift in Russian policy – or Chinese sale of its version – represents a potential risk, this leaves a critical gap in Iran's conventional capabilities that reinforces its weakness in airpower.

Iran has claimed it is compensating by upgrading its S-200 missile series and by building its own equivalent of S-300/S-400 called the Bavar 373, but its claims to date seem to be sharply exaggerated:[22]

- "With the changes being made to this system by our experts, the S-200 will be able to deal with threats at medium altitudes in addition to (threats) at high altitudes." Brigadier General Farzad Esmaeili, commander of the Khatam-ol-Anbiya Air Defense Base, announced in late September s announced that Iran is upgrading the S-200 long-range surface-to-air missile system.

  He also said that after the upgrade of the missile system, it will be renamed because the system will undergo systemic and structural modifications and will be used as a medium-to-high altitude missile system. He stated this would eliminate the need to use medium-altitude missile systems, such as the Ra'ad (Thunder) air defense system, in the areas where the upgraded S-200 will be deployed.

  Esmaeili also said on September 7, 2012 Iran was building a missile system more advanced than the Russian S-300 missile system, and that missile system, named the Bavar 373 (Belief 373), would replace the need for the S-300 missile system. Tehran Times, September 28, 2012.

  http://tehrantimes.com/politics/101865-iran-upgrading-s-200-air-defense-system.
- The IRGC displayed its new, domestically designed Ra'ad air medium ranged air to surface missile system during the annual military parade on Friday, which it said was designed to hit US aircraft, and which it said can be equipped with 'Taer' (Bird) missiles, which can trace and hit targets 50km in distance and 75,000 feet in altitude. "The system has been built in a bid to confront US aircraft and can hit targets 50km in distance and 75,000 feet in altitude," Commander of the IRGC Aerospace Force Brigadier General Amir Ali Hajizadeh. September 21, 2012.

Open source intelligence suggests that Iran has only deployed limited upgrades of its Soviet-era SA-5/S-200 medium to high altitude long-rage surface-to-air missiles. The NPO Almaz S-200 Angara/Vega/Dubna (Russian Ангара\Вега\Дубна), is called the SA-5 or Gammon by NATO. Upgraded versions of the SA-5/S-200s have been tested since 2008, but there are few unclassified data to support ambitious, and probably grossly exaggerated, Iranian claims for either upgrading the SA-5/S-200 or building its own versions of the S-300/S-400.[23] While the

upgraded system may be more effective than the old SA-5/S-200, it is unlikely to pose a significant threat to American or Israeli aircraft as a long-range air-denial weapon.

As for the developmental Bavar-373 (Belief-373) system, Brigadier General Farzad Esmaili, a commander of the Iranian army's air defense force said to reporters in Tehran on the National Day of Air Defense on September 3, 2012. He stated that the said the system was "30 per cent complete" and that Iran could execute the project without foreign assistance.

> "We are through with developing the threat-detection capability of the system, and its sensitive parts have been manufactured in Iran….we have no problem with supplying the missiles needed for this system."

Esmaili went on to say that he hoped the system would be finished by the end of the Iranian year, which would be March 2013, or by March 2014, and would be a "*powerful rival*" to the Russian surface-to-air system. Iran would deploy up to three different types of missiles, with "*higher capabilities than the S-300 in detecting, identifying and destroying targets*."

Other Iranian officers and officials have made similar claims:

- "We are through with developing the threat-detection capability of the system and its sensitive parts have been manufactured in Iran. We have no problem for supplying the missiles needed for this system.

  With this powerful system in our hand, we would not think of S-300 anymore.

  Bavar 373 system is an important and completely indigenous achievement that can be a powerful rival for S-300." – Brigadier General Farzad Esmayeeli, Commander of Khatam ol-Anbia Air Defense Base, September 3, 2012.

- "Manufacturing Bavar (Belief) 373 Missile System is in progress and all production needs have been supplied domestically.

  This project will soon enter its final stage (of production) and it will be much more advanced than the S-300 missile system.
  The flaws and defects of the (Russian) S-300 system have been removed in the indigenous version of the system and its conceptual designing has finished." – Brigadier General Farzad Esmayeeli, Commander of Khatam ol-Anbia Air Defense Base, September 22, 2011.

- "It is now several years that our defense industries researchers and experts have been designing a system whose capabilities are way beyond the S-300 missile system.

  The system has been designed based on our own operational needs." – Colonel Mohammad Hossein Shamkhali, Deputy Commander of Khatam ol-Anbia Air Defense Base for Research and Self-Sufficiency Jihad, September 22, 2011.

- Defense minister Ahmad Vahidi told Iranian media at Sept. 22. 2010 that they will develop a similar domestic system by themselves: "We have planned to build a long-range air defense missile system similar to S-300. By God's grace and by the Iranian engineers' efforts, we will reach self-sufficiency in this regard."

- "If they do not deliver S-300 defensive system to us, we have replacements and we can supply our operational requirements through innovative techniques and different designs." – General Hassan Mansourian, Deputy Commander of Khatam ol-Anbia Air Defense Base for Coordination, July 6, 2010.[24]

To put such statements in context, Iran has made many claims for systems it later did not deploy, only deployed in token numbers, or deployed in forms that lacked anything like the capability claimed – such as a radarless version of a supposed SA-6 clone. It is far from clear Iran has the production base required to build a robust air defense network. Moreover, anecdotal unclassified reporting indicates that Iran lacks effective test and evaluation methods and has politicized its technology to the point that it sometimes believes its own rhetoric. Exaggerated claims are a sin

common to all weapons developers and military powers, but there are signs that Iran sins more than most.

It is also not clear that they are still relevant. The growing tensions between Russia and the United States and Europe over the Ukraine, and P5+1 negotiations over Iran's nuclear programs, led Russia to announce on April12, 2015 that it would now sell the S300 to Iran. Russian President Vladimir Putin signed a decree ending the ban on delivering the S-300 anti-missile rocket system to Iran, and potentially allowing a $20 billion sale that had been halted in 2014 to go forward. Reuters quoted Deputy Foreign Minister Sergei Ryabkov as saying that, "I wanted to draw your attention to the rolling out of the oil-for-goods deal, which is on a very significant scale." In exchange for Iranian crude oil supplies, we are delivering certain products. This is not banned or limited under the current sanctions regime.25

Russian Deputy Foreign Minister Sergey Ryabkov soon made it clear that there would be no quick delivery of the S300,and no details were provided about the exact package of arms involved in the sale. The US had, however, strongly objected to the Russian decision and – as is discussed in Chapter VII – the sale of even the air defense versions of the S300 could be a major game changer in altering the air balance. There are at least four versions of the S-300: TheS-300P (SA-10); S-300V (SA-12A/B Giant/Gladiator); S-300PMU-1/2 (SA-20A/B Gargoyle) and S-400 (SA-21). A more advanced system called the S-500 is said to be under development.26

All are far more advanced air defense systems than any of Iran's present surface-to-air missiles, and four have some missile defense capability: The S-300PMU1 and PMU2 can intercept SRBMs, and Russia claims the S-300V and S-400 Triumf systems can intercept a multiple IRBM attack by IRBMs as advanced at the DF-21. The S-300V/SA-12 is a large, high altitude interceptor and while there are no reliable data on its exact capabilities, it seems to be a highly capable system. The S-400 may still be in development along with a new SV300 (S-X-23) that is also reported to be an export version as well. Wikipedia reports that it,[27]

> is an upgrade to the S-300V. It consists of a new command post vehicle, the 9S457ME and a selection of new radars. These consist of the 9S15M2, 9S15MT2E and 9S15MV2E all-round surveillance radars, and the 9S19ME sector surveillance radar. The upgraded guidance radar has the Grau index 9S32ME. The system can still employ up to six TELARs, the 9A84ME launchers (up to 4 × 9M83ME missile) and up to 6 launcher/loader vehicles assigned to each launcher (2 × 9M83ME missile each). An upgraded version, dubbed S-300V4 will be delivered to the Russian army in 2011
>
> Complex «Antey-2500» it is the export version of the developed separately from the family of s-300 but could this comes in Venezuela, the estimated export price for 1 billion dollars, the system has 1 type missiles in 2 versions, basic and amended sustainer stage double range (up to 200 km, according to other data up to 250 km), can simultaneously engage up to 24 aircraft or 16 ballistic targets in various combinations.
>
> - Became the first system in the world capable of in part 1 of complex simultaneously bruise and aerodynamic and ballistic targets. It also contains a private sector radar for the opening of the areas affected by interference (and does not use external elements of the system of special troops. The range of the developed overloads aim to 30 units.
> - Different versions of the Giant missiles S-300V4 have a speed of 7.5 m and a range of 400 km or 9 M speed and range of 350 km. It is easy to destroy maneuvering targets even at very large-scale heights. Gladiator rockets significantly less.

There is no way to determine the actual air and missile defense capability of a Russian "S300" sale to Iran until the full specifics of the system are announced. Like many other arms sellers,

Russia also has a long history of exaggerating the performance of its systems while not fully disclosing the full nature of actual sales.

An April 2015 report from *IHS Jane's Defence Weekly* stated that Iranian Defense Minister Hossein Dehghan claimed that new long-range SAMs would be operational in a year. "The long-range air defence missile system Bavar-373 will be built by the end of this year and will be deployed in specific regions," according to Iranian Defense Minister Dehghan.[28] Previously Dehghan had stated, "Talash defence system was designed and built to detect and intercept targets for the Sayyad-2 missile." The Defense Minister's comments are in line with those of Brig Gen Esmaili, who stated that the long-range Talash system "will be brought into operation by the end of this year".[29]

However, an April 2015 statement by senior Iranian military officer, Brigadier General Mohammad Mahmoudi, contradicted those claims. IHS Jane's reported BG Mahmoudi said "the long-range air defence system that is being indigenously developed is not operational yet".[30]

Iranian Counters to Missile Defenses

It is clear that missile defense technology is becoming a key aspect of rocket, ballistic missile, and cruise missile warfare and can have a major impact on Iran's capabilities. Just as giving Iran's conventionally armed missiles terminal guidance or sufficient accuracy for small volleys to be used in precision strikes can be fundamental game changers, missile defense can radically alter the impact of rockets and missiles on containment, deterrence and warfighting at every level of combat. Missile defenses also create a highly uncertain duel in terms of future warfighting since real world exchange outcomes between missiles and missile defense systems are unproven in major combat, involve systems with limited real world testing, and involve weapons and technology that is constantly evolving.

At the same time, all of the rocket and missile defenses that have just been discussed present the problem that they are vulnerable to some degree to countermeasures ranging from tactics as simple as oversaturation of the defensive system to highly sophisticated penetration technology. Some Israeli experts also believe that Iran is developing penetration aids for its surface-to-surface missiles. Some analyses of the Shahab 3 indicate that Iran has taken serious steps to reduce the vulnerability of its missiles to missile defenses – although much of the following analysis of the Shahab is speculative and based on uncertain data,[31]

> …the Shahab-3B differs from the basic production variant. It has improvements to its guidance system and warhead, a few small changes on the missile body, and a new re-entry vehicle whose terminal guidance system and rocket-nozzle steering method are completely different from the Shahab-3A's spin-stabilized re-entry vehicle.
>
> The new re-entry vehicle uses a triconic aeroshell geometry (or 'baby bottle' design) that improves the overall lift to drag ratio for the re-entry vehicle. This allows greater range maneuverability that can result in better precision. The triconic design also reduces the overall size of the warhead from an estimated 1 metric ton (2,200 lb.) to 700 kg (1,500 lb.).
>
> The rocket-nozzle control system allows the missile to change its trajectory several times during re-entry and even terminal phase, effectively preventing interceptor guidance via trajectory prediction by early warning radar - a method nearly all long range ABM systems use. As a high-speed ballistic missile and pre-mission fueling capability, the Shahab-3 has an extremely short launch/impact time ratio. This means that the INS/gyroscope guidance would also remain relatively accurate until impact (important, given the fact that the gyroscopes tend to lose accuracy with longer flights). The CEP is estimated to be at 30–50 meters

> (98–160 ft.) or less.[9] However, the accuracy of the missile is largely speculative and cannot be confidently predicted for wartime situations.[10]
>
> These improvements would greatly increase the Shahab-3B's survivability against ABM systems such as Israel's Arrow 2 missile as well as being used for precision attacks against high value targets such as command, control and communications centers

If, as some Israeli and US experts report, Iran is using relatively simply technologies to make the path of its warheads less predictable to missile defenses, this may have some effectiveness in both reducing the area coverage of missile defenses and their effectiveness even if the warhead is closer to the missile launcher. At the same time, such developments can increase the risk that the warhead will miss its target or tumble in ways that can affect its reliability.

Iran is also claiming to develop missiles with a limited radar cross-section, reducing the reaction time available to anti-missile systems. Like other Iranian claims about improvements in its weapons systems, such an assertion may lack merit and should be treated cautiously. Given Iran's difficulties in producing indigenous rockets and the significant trouble it has had constructing missiles with a range over 2000 km, reliable integration of effective countermeasures is still likely some years away.

Test, evaluation, simulation, and limited exchanges in actual combat are all useful in sources of data for building understanding of could happen in a potential exchange between Iran's missiles and missile defenses. There still, however, is no clear way to estimate real world defense capabilities since there have been no operational cases of sufficient scale to show the relative effectiveness of the improvement in missile defenses versus Iran's missiles. Real-world success of Iran's efforts to improve its missile countermeasures to missile defenses is both classified and untested against Gulf and US missile defenses. While the US has had the opportunity to test its missile defenses against SCUD missiles similar to Iran's Shahab-1 and Shahab-2 weapons, Iran's modifications to these and its use of newer models renders the statistical relevance of these models insignificant.

No system is likely to be "leak proof," or free from vulnerability to saturation or the exhaustion of its stocks of anti-missile missiles - and any exchange would now be one between missiles and anti-missile which both have unproven and unpredictable performance - but Iran's missile threat grows steadily less credible as these missile defenses improve. Moreover, it is one thing to be threatened by the risk that one nuclear-armed missile gets through to a key target area, and quite another to face the risk a few far less lethal missiles get through.

Conventional or even CB-armed missiles will become steadily less credible as "terror" or psychological weapons as missile defenses improve. However, limited salvos and volleys of Iranian missiles, attacks with "stacks" of different missile systems, and attacks with steadily improved accuracy will further challenge missile defenses. Sheer numbers could overwhelm a nascent anti-missile system, and any leakers, even if highly inaccurate, would still have a propaganda or psychological impact.

If worst case estimates are right that Iran estimated possess nearly 1,000 rockets and missiles that could be fired across the Gulf (including shorter range Fateh-110s and Zelzals), defending states would require a massive investment in anti-missile missiles to reduce the number of successful attacks to an acceptable level.

Furthermore, as Iran arms its missiles with more effective conventional warheads, deploys missiles with accurate and reliable terminal guidance, and/or develops long-range cruise missiles

with such capabilities - this will also change such war fighting calculations. Key export, power, desalination, and military targets could then become targets or hostages even with extensive missile defenses – particularly if the Southern Gulf states continue to fail to integrate their missile defenses. Iran could target any gaps in effective coverage, target the missile defenses with the fewest reloads and area coverage, and target isolated defenses of more forward targets where stack attacks would do most to saturate any missile defenses.

Similarly, even the credible threat - much less use of - CBRN warheads might dramatically upset the regional balance. Such capabilities would provide Iran with a much more solid deterrent, and a greater capability to exercise a bolder and more aggressive regional foreign policy. Nuclear warheads could also potentially produce enough EMP coverage with airburst on the perimeter of missile defense coverage to seriously compromise both air defense and missile defense radar capabilities.

The Potential Threat from Iranian Nuclear Forces

Iran's efforts to create nuclear weapons remain uncertain and controversial, and its nuclear programs are now the subject of intense arms control negotiations with the US and other members of the P5+1. The outcome of these negotiations will play a critical role in shaping the regional military balance. If Iran does go nuclear, so will the overall balance of forces in the region. If it does not, the balance is likely to be far threatening, although the risk of asymmetric and conventional conflict will remain, along with the constantly shifting threat from non-state actors.

Iran's Uncertain Search for Nuclear Forces

Iran's leaders, including its Supreme Leader, have repeatedly said that Iran is not seeking nuclear weapons, talked about the horrors of chemical warfare during the Iran-Iraq War, and claimed that Iran no longer maintains stocks of chemical weapons. Yet, such denials could well be an effort to buy time for weapons development and some Iranians who attend various forums of "second track" diplomacy state that the world's indifference to Iraq's chemical weapons attacks on Iran during the Iran-Iraq War, the collapse of the Qaddafi regime after it gave up Libya's covert nuclear weapons programs, and Iran's tensions with many of its Arab neighbors and Israel are all warnings that Iran may need nuclear weapons.

As **Figure 3** shows, Iran has the missile capabilities to cover much of the region with nuclear attacks if its missiles are nuclear armed – although Israel's systems still have a substantial advantage in range and probably in accuracy.

The* International Atomic Energy Agency (IAEA) has raised serious question about a wide range of Iran's activities that seems to be weapons related and that Iran had failed to address as of April 2015. Iran has created significant nuclear facilities and the IAEA reports that it at least examined designs for nuclear weapons and nuclear missile warheads. The US intelligence community has said that it has evidence Iran had a major nuclear weapons program through at least 2003, and the International Atomic Energy Agency (IAEA) has raised a long list of questions about suspect Iranian activity that Iran has never resolved.

Iran's Strategic Goals and The Impact of Israel's Nuclear Forces

One of the potential motives for an Iranian nuclear program is Iran's hostility to Israel, and the risk that Iran could become an "existential threat" to Israel has been a key part of the debate over

Iran's nuclear programs and the arms control negotiations between Iran and the P5+1. At the same time, Iran is more likely to be deterred by Israel than threaten it, and Iran's constant propaganda attacks on Israel may be more an effort to make Israel the rationale for its military buildup against its Arab neighbors than a serious sign of Iran's hostility to Israel.

The exact status of Israel's nuclear forces is uncertain, but few experts doubt that Israel has steadily upgraded a long-range missile force originally based on French designs and that was upgrade significantly in range-payload capability during the 1980s. Israel is not a party to any major arms control agreement limiting its ability to deploy such forces, including the NPT, CTBT, BTWC, CWC or MTCR. Israel is believed to long have had nuclear weapons, and to have acquired extensive design and test data on such weapons, including boosted and thermonuclear weapons.

There are many different estimates of Israel's nuclear capability. One of the more convincing is an estimate by the Nuclear Threat Initiative that indicates that Israel is, "widely believed to have produced enough weapons-grade plutonium (at a nuclear reactor in Dimona) for 100 to 200 nuclear warheads… Most estimates of Israel's missile capabilities indicate that Israel possesses nuclear-capable medium-range ballistic missiles (MRBM); short-range sub-sonic cruise missiles with advanced capabilities such as non-line of sight targeting (NLOS) and midflight maneuverability; and significant defensive missile capabilities".

Other sources indicate that Israel may have 200-300 nuclear weapons or more, including possible smaller "tactical" designs and systems designed to hit mountain or underground targets.

The NTI assesses Israel's missile forces as including:[32]

- The Jericho-2 or YA-2 missile with a range of over 1,300 kilometers in tests conducted in 18=989, and that continued in development until test flights in 2001. It states that, "A Lawrence Livermore National Laboratory study speculated that a Shavit, if modified and deployed as a ballistic missile, could carry a 1,000 kg warhead 4,850 km or a 500 kg warhead 7,600 km. [54] Using similar analysis, and also assuming that the Jericho-2 performs comparably with the American Minuteman-2 missile of the 1960s, Steve Fetter proposed a 4000km range with an 800kg payload - a range that would encompass "the entire Arab world (plus most of Europe)."

- The Popeye (Have Nap) – a cruise missile designed for precision strike against high-value ground targets such as airfields, bridges, and bunkers. [60] Production began in 1989, and the Popeye has since become a versatile platform that has been modified both for various Israeli military applications and for international customers. "In the summer of 2000 French media reported that Israel's German-built Dolphin submarines had tested 1,500km cruise missiles near Sri Lanka. [63] Some speculate that Israel had tested an upgraded "Popeye Turbo," a missile capable of carrying a nuclear warhead that Israel previously proposed to the United Kingdom (Project "Kaeson"/"Keison"), and had reportedly performed design studies for as early as 1995. [64] The National Air and Space Intelligence Center declared the Popeye Turbo operational in 2002. [65] However, as of 2012 *Jane's* does not list the Popeye Turbo in Israel's missile inventory. "

- The Jericho-3 missile, with "an estimated maximum range between 4,800km and 6,500km, and a 1,000 to 1,300kg payload, would provide Israel with an intermediate-range nuclear strike capability. …Israeli Defense Radio and other sources reported a Jericho-3 test launch in January 2008…In early 2008, Israeli weapons expert and former Isaac Ben-Israel head of the Israel Administration for the Development of Weapons and the Technological Industry declared that "everybody can do the mathematics … we can reach with a rocket engine to every point in the world," thus appearing to confirm Israel's new capability…Israeli Ministry of Defense officials said that the 2008 launch represented a "dramatic leap in Israel's missile capabilities."

- *"Jane's* estimates that Israel deploys 50 to 100 Jericho missiles at the Zachariah airbase. However, IKONOS satellite images of Sdot Micha reveal only 23 to 50 missile shelters, implying that the total

> number of Jericho-1 and Jericho-2 missiles deployed at Zachariah cannot exceed 50….Globalsecurity.org further notes that satellite images have not detected any additional missile shelters in Israel, and that Israel's geographic constraints make construction of additional and more secretive land bases difficult and field deployment highly risky...These factors would imply a much smaller deployment of Jericho missiles than the estimates from *Jane's*. No further information about the Jericho-3 has followed the 2008 flight test and statements."

The NTI summarizes Israel's nuclear weapons holding as follows:[33]

> Throughout the 1970s Israel improved its operational nuclear arsenal both quantitatively and qualitatively, perhaps to the point of developing a two-stage nuclear weapon. …In 1975, news reports claimed U.S. intelligence analysts believed Israel to have produced more than 10 nuclear weapons, as well as the aircraft and missiles to deliver them. ..Israel had received 10 tons of uranium yellowcake under International Atomic Energy Agency (IAEA) safeguards from South Africa in 1965 and continued to receive regular shipments of yellowcake that were stored in Israel and subject to yearly inspections by the South African Atomic Energy Board...In 1976, the two countries reached an agreement to remove these bilateral safeguards – freeing an additional 500 tons of uranium for use in Israel's plutonium production reactor at Dimona – and South Africa sold an additional 100 tons of uranium to Israel in exchange for 30 grams of tritium. ..
>
> On 22 September 1979, a U.S. Vela satellite detected a double flash of light hundreds of miles off the eastern coast of South Africa. Double flashes are associated with nuclear detonations, where the initial fireball of a nuclear explosion is "rapidly overtaken by expanding hydrodynamic shock wave," which hides the fireball…A declassified U.S. National Security Council report from October 1979 stated that the intelligence community "ha[d] high confidence, after intense technical scrutiny of satellite data, that a low yield atmospheric nuclear explosion occurred."…There was no official consensus on who conducted the nuclear explosion, but some U.S. officials admitted that they privately believed that Israel was responsible…Avner Cohen argues that Israel, if indeed developing a thermonuclear weapon, had strong motivation to test in 1979, as development of a two-stage nuclear device typically requires testing in order to ensure the functioning of the trigger (or primary)…
>
> On 5 October 1986, the *Sunday Times* published Mordechai Vanunu's account of the nuclear activities at Israel's top-secret Dimona facility….The former Dimona technician's revelations challenged the steadfastness of nuclear opacity. Vanunu's claims reinforced some of the U.S. intelligence community's suspicions, such as the fact that Israel had expanded the cooling capacity of the Dimona reactor. His testimony also confirmed the existence of the long-suspected reprocessing plant, as well the layout of subterranean levels at Dimona….The credibility of Vanunu's account was strengthened by the 58 photographs he took of equipment, such as a full-scale model of a hydrogen bomb and glove boxes where plutonium discs were fashioned into pits….Based on his revelations, some experts estimated that Israel had built between 100 and 200 nuclear weapons of varying yields and complexity….

As has been noted in the previous Chapter, Israel has also deployed an extensive ballistic missile defense force using a system called the Arrow, and has continued to steadily upgrade its defenses in cooperation with the US, which may soon lead it to deploy the Arrow 3. It also is developing systems like David's Sling to deal with the threat posed by cruise missiles and short-range systems.

"Existential threats" are little more than a recipe for suicide when an opponent begins a nuclear arms race with a nuclear monopoly and the best possible outcome is mutual assured destruction. While Israel has never formally declared that it is a nuclear power, Iran and every Arab power have long seen its nuclear forces as a key – if undeclared – deterrent to any large-scale attack on Israel. Iranian planners and analysts have made it clear in second track diplomacy that they fully realize Israel can target Iran with nuclear weapons, and do it devastating – if not "existential" – damage. A nuclear-armed Iran missile force would help Iran deter any Israeli use of its present nuclear monopoly -- which now gives Israel nuclear-armed missiles with the range to strike at any target in Iran.

The most Iran can hope to do in countering Israel by going nuclear is to eventually create enough nuclear forces to confront Israel with the equivalent of mutual assured destruction. This will take years at a minimum, and Iran would initially run immense risk in confronting a mature nuclear power like Israel with what may be proven thermonuclear and boost weapons designs based on French test data with a few untested fission warheads. Even if Israel did not respond with preventive or preemptive attacks, it would almost certainly respond by steadily increasing the size and capability of its nuclear forces, and become deeply engaged in a nuclear arms race with Iran that Israel is very likely to win.

The Strategic value of Iranian Nuclear Weapons

Iran might, however, be able establish a nuclear monopoly relative to Arab states that it could maintain for years, continue to maintain an advantage in nuclear weapons holdings after Arab acquisition of nuclear weapons, and counter any US agreement to provide its Arab allies with "extended deterrence" with tangible nuclear threats.

The major risks involved to Iran in pursuing nuclear weapons, have been discussed in **Chapter VIII**, but they could give its missile forces far more deterrent capability, and possibly create a nuclear barrier to Arab Gulf and US air and cruise missile strikes at Iran. It is unclear that Arab Gulf states and the US would be deterred from attacking Iran's conventional and asymmetric forces, but this is possible.

It might limit the level at which either the Arab Gulf states and the US would take the risk of escalating in response to a given level of Iranian attack or use of force. It might well, however, help deter any Gulf Arab or US conventional air and missile strikes on Iran, and limit their retaliation against Iran's use of lower levels of force. It would certainly act as a deterrent to the already limited risk of outside invasion.

Iran also exists in a nuclear "neighborhood." Israel is not its only challenge, and Iran might well calculate that Pakistan would see any Iranian nuclear capability as a major increase in Iran's nuclear capabilities – a calculation that Iran again has little reason to publicize and where it may feel a focus on Israel will limit the Pakistani reaction as well as Turkish and Arab incentives to seek nuclear weapons.

Enrichment Issues

Part of the problem in assessing the impact of nuclear weapons on the balance is that much of the debate over Iran's capability has been over how soon it might get enough fissile material to assemble one weapon, and not over when it could assemble a meaningful force, what that force would look like, whether it would trigger preventive strikes against it, and how the Arab Gulf states, Israel, the US, and its other neighbors would react. One weapon does not make a nation a nuclear power, particularly an untested device.

Similarly, the negotiations over a potential arms control agreement focused on a relatively narrow range of issues relating to Iran's various nuclear enrichment efforts and its ability to acquire fissile material at the known facilities. These issues included potential limits, controls, and inspection arrangements dealing with

- The number of centrifuges,
- The development of more advanced centrifuges,
- The level of Uranium enrichment and the size of Iran's stockpiles,

- The potential use of the new reactor at Arak to produce Plutonium,
- How soon Iran could use any of these to get enough material to produce a nuclear device,
- The extent to which any agreement dealing with all of these issues is enforceable,
- How long an agreement will be in force, and
- The incentives to Iran for reaching an agreement, especially the extent to which UN, US, and EU sanctions will be lifted, and the timing of such action.

These are all important issues, but they are only part of the problem in ensuring that Iran does not acquire a meaningful nuclear weapons capability and inventory, and removing the incentives for other regional states to seek nuclear weapons in ways that could reshape the military balance. They also focus relatively narrowly on Iran's approach to an initial "break out" point in acquiring some form of fissile device, rather than its ability to actually produce and deploy nuclear weapons. In many studies or critiques, the focus has been so limited that it only dealt with how soon Iran could get enough fissile material to produce one major fissile event, and not Iran's ability to actually produce a meaningful amount of nuclear bombs and missile warheads.

Looking Beyond Enrichment and Plutonium

It is important to remember that the primary goal is not to roll back Iranian enrichment technology, but rather to prevent Iran from actually producing and deploying nuclear weapons. Any agreement that convincingly keeps Iran from building and deploying nuclear weapons would meet the security needs of the Gulf states, other regional powers, and the US and other members of the P5+1. An agreement – or continuing negotiation process that delays Iranian enrichment activity but allowed Iran to conduct centrifuge development and compete the design of a nuclear weapon would not.

The collapse of negotiations – or the conclusion that Iran is simply stalling and seeking to break out of sanctions – raises different issues. It would immediately raise the issue of how close Iran really is to developing, producing, and deploying nuclear weapons and a nuclear force? It would have to look beyond the issue of fissile material and consider the reaction time the US and its allies would have to use preventive strikes, create new defenses, and/or create a suitable deterrent.

In all three cases, the question arises as to how far Iran has moved towards a bomb, whether it would need to carry out a major fissile test or tests, how much covert research and development activity it still needs, and how well the US and its allies can detect such actions and future covert fissile material production efforts – key considerations in judging IAEA inspection and verification capabilities as well.

These are all issues that the US has never publically addressed and that are critical in assessing an agreement: how far has Iran gotten in nuclear weapons design, how much necessary development work could it covertly do in spite of any agreement, and what is the US estimate of how long Iran would need to develop and deploy nuclear weapons versus simply produce fissile material?

Key IAEA Findings on Iran's Nuclear Weapons Efforts

It is equally important to focus on what is and is not known about Iran's nuclear efforts, and how far Iran has moved towards the capability to design, assemble, and test a functioning nuclear weapon – as distinguished from simply producing some form of nuclear explosion in a test bed

device. The military annex to a critical IAEA report issued on November 8, 2011 raised critical questions about Iran's past weapons-related efforts that Iran has so far refused to address, and remains the best summary of the issues involved – issues that were largely ignored in the public negotiations over a possible arms control agreement.

This IAEA report was entitled *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran.* Its weapons annex summarized the key issues surrounding Iran's actual efforts to develop a nuclear weapon – issues that have never really formally surfaced in the public discussion of the P5+1 and Iran negotiations.[34]

In summary, the IAEA report: [35]

- Describes Iran's lack of cooperation with the IAEA regarding heavy water at the Iran Nuclear Research Reactor (IR-40) at Arak. Although the Agency was allowed access to the site on October 17, 2011, it has not been permitted access since then. According to Iran, operation of the IR-40 reactor is due to commence by the end of 2013. Although the Agency has not been permitted access to the Heavy Water Production Plant (HWPP) since August 17, 2011, satellite imagery has indicated that the HWPP appears to be in operation. Lastly, to date Iran has not allowed the Agency access to the heavy water stored at the Uranium Conversion Facility (UCF) to take samples.
- **P**rovides a description of the IAEA's knowledge of the Uranium Conversion Facility (UCF) as of October 18, 2011. It reflects that Iran is continuing enrichment and heavy water production at the site in contravention of international demands and regulations. It indicates that as of October 18, 2011, the Agency observed the ongoing installation of the process equipment for the conversion of UF6 (uranium hexafluoride) enriched to 20% into U3O8 (triuranium octoxide).
    - Provides an introduction and summary of the possible military dimensions of Iran's nuclear program. Importantly, it indicates that Iran has not engaged the IAEA substantively regarding the military dimensions of its program since August 2008, and it stresses the following:
    - Efforts, some successful, to procure nuclear related and dual-use equipment and materials by military-related individuals and entities.
    - Efforts to develop undeclared pathways for the production of nuclear material.
    - The acquisition of nuclear weapons development information and the documentation from a clandestine nuclear supply network.
    - Work on the development of indigenous nuclear weapon design, including the testing of components.

The report stated that the Agency had "serious concerns regarding possible military dimensions to Iran's nuclear program." It: [36]

- Provides a historical overview of the possible military dimensions of Iran's nuclear program. It reveals that the IAEA discovered that Iran's program has roots going back nearly 40 years, and that it has had ongoing undeclared R&D program for nuclear testing, experimentation, uranium conversion, enrichment, fabrication, and irradiation activities, including the separation of plutonium. Moreover, it reports that Iran admitted to engaging in undeclared activities at clandestine locations, and procured nuclear material via a clandestine supply network.
- Reflects what the IAEA believes to be the structure of Iran's nuclear production, which is thought to involve the participation of a number of research centers, government bodies, universities, and committees, all of which operate under the Ministry of Defense Armed Forces Logistics (MODAFL). Moreover, it indicates that the program's nuclear activity was consolidated under the AMAD Plan in the late 1990s and early 2000s, although it was halted in 2003.

- Provides the IAEA's knowledge of Iran's nuclear procurement activities relevant to nuclear weapons production, many of which were allegedly undertaken by private front companies. For instance, Kimia Maadan, a private Iranian company, was a company for chemical engineering operations under the AMAD Plan, while also being used to help with procurement for the Atomic Energy Organization of Iran (AEOI).

  Among the equipment procured relevant to nuclear weapons production include high-speed electronic switches and spark gaps (useful for triggering and firing detonators); high-speed cameras (useful in experimental diagnostics); neutron sources (useful for calibrating neutron measuring equipment); radiation detection and measuring equipment (useful in a nuclear material production environment); and training courses on topics relevant to nuclear explosives development (such as neutron cross section calculations and shock wave interactions/hydrodynamics).

- Describes the IAEA's knowledge of Iran's attempts to acquire nuclear material relevant to nuclear weapons production. It also emphasizes that Iran only declared a number of facilities once the IAEA was made aware of their existence by sources other than Iran. Taken with Iran's additional past efforts to conceal nuclear activity, this reality creates more concern about the possible existence of further undeclared nuclear facilities, material, and activities in Iran.

- Provides the IAEA's analysis of Iran's alleged ongoing efforts to acquire nuclear components for use in an explosive device. It reiterates that Iran received documents that describe the processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components, which are integral in the production of a rudimentary fission device. Additionally, the Agency indicates that during a 2007 interview with a member of Iran's clandestine supply network, it was told that Iran had been provided with nuclear explosive design information. Lastly, this portion of the report stresses that the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004.

- Discusses the IAEA's knowledge of Iran's R&D into and acquisition of "safe, fast-acting detonators, and equipment suitable for firing the detonators," an integral component to constructing an implosion type nuclear device. It indicates that the Agency discovered that Iran had developed fast-functioning detonators known as "exploding bridgewire detonators" (EBWs) during the period 2002-2003 as safe alternatives to previous detonator technology it had developed. Moreover, in 2008, Iran told the Agency that before the period 2002-2004, it had already achieved EBW technology. It also provided the Agency with a short, undated document in Persian, which was understood to be the specifications for a detonator development program, and a document from a foreign source that showed the example of a civilian application in which detonators fired simultaneously. Iran, however, has not explained its own need or application for such detonators.

- Describes development of a multipoint initiation system, which is used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density. As such, it is a vital component of a fission weapon. According to the Agency, Iran has had access to information on the design concept of a multipoint initiation system that can be used to initiate a high explosive charge over its surface effectively and simultaneously. This information was reportedly supplied to the IAEA by a Member State.

- Discusses Iran's efforts to evaluate the theoretical design of an implosion device using computer simulations, as well as high explosive tests referred to as "hydrodynamic experiments" in which fissile and nuclear components may be replaced with surrogate materials. According to information provided, Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten. Such experiments have also been linked to experiments involving the use of high-speed diagnostic equipment, including flash X-ray, to monitor the symmetry of the compressive shock of the simulated core of an explosive device. Such experiments would have little, if any, civilian application, and represent a serious source of concern regarding the potential weaponization of Iran's nuclear program.

- Provides an overview of the IAEA's knowledge of Iran's studies that focus on modeling of spheres, components, and neutronic behavior indicating investigation into a nuclear warhead. Moreover, the Cordesman/Gold Iran & The Gulf Military Balance 18.7.13AHC 80 Agency has acquired information that indicates Iran has conducted studies and done calculations relating to the state of criticality of a solid sphere

of uranium being compressed by high explosives. Such efforts provide an additional indication of the potential weaponization of Iran's nuclear program.

- Discusses Iran's research and development into neutron initiators, which, "if placed in the center of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction." Iran has yet to explain its objectives and capabilities in this field.
- Discusses what the IAEA perceives as Iran's efforts to "have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device." It also indicates that these efforts directly reflect those undertaken by declared nuclear-weapon states. These indicators could perhaps point to a potential Iranian nuclear weapons test in the future.
- Reflects what the IAEA perceives as a structured Iranian program to carry out "engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile." Such explorations into warhead development provide a key indicator that Iran's program is military in nature.
- Describes Iran's efforts at developing "a prototype firing system that would enable the payload [a nuclear warhead on a Shahab 3 missile] to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground." It presents further indication that Iran is at least considering the possibility of installing nuclear warheads on its existing arsenal of Shahab 3 missiles.
- **P**rovides an overview of the different bodies and projects that constitute the Iranian nuclear program.
- Provides an analysis of the likely payload of an Iranian missile, given the above indicators. It shows that Iran's R&D into its ballistic missile and nuclear programs reflect a probable effort to develop both nuclear warheads and an effective delivery vehicle thereof.
- The IAEA report also provides insight into the foreign sources that supplied Iran with nuclear equipment and technical know-how. One of these sources was referred as a "clandestine nuclear supply network," purported to be the now-disbanded A.Q. Khan network. According to the report, Iran admittedly had contact with the network in the late 1980s and early 1990s. The document also asserts that this network supplied Iran with technical know-how regarding the production of neutron initiators and spherical hemispherical enriched uranium metallic component, neither of which have any real civilian application.

Weapons Design Data

According to the IAEA, Iran did admit to having received a 15-page document that provided detailed instructions for the construction of components critical to building a nuclear device. This document, known as the "uranium metal document" was also provided to Libya, and is known to have been part of a larger package of information that includes elements of a nuclear explosive design. Given the circumstances surrounding Iran's acquisition of the document as well as the well-known role the A.Q. Khan network played in jump-starting nuclear weapons programs in Pakistan, Libya, and North Korea, it remains doubtful that Iran's program is purely peaceful.

The IAEA's report of November 8, 2011 also stated that there were, "…strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin."[37]

The Institute for Science and International Security (ISIS) later identified this individual as former Soviet weapons engineer Vyacheslav Danilenko. According to the IAEA, Danilenko worked in Iran from 1996 to 2002, returning to Russia in 2002[38] Moreover, given the small size

and sophistication of a multipoint initiation system the IAEA observed in Iran in 2004, it was likely to have been developed using Danilenko's expertise as a springboard. [39] Iran's strides in detonator technology are, in all likelihood, the result of Danilenko's technical expertise.

It has been years since the IAEA issued this report, but the IAEA did report in February 2015 that it had not received any serious clarification from Iran, or any meaningful updates from member countries that allowed it to fully update its military annex -- aside from data on a possible weapons simulation test site at Parchin

On November 7, 2014 – some three weeks from the deadline set for negotiating a comprehensive agreement between the P5+1 and Iran, the Director General of the IAEA was forced to issue a report on the *Implementation of the NPT Safeguards Agreement and Relevant Provisions of the Security Council Resolutions in the Republic of Iran* that stated that, "Iran has not provided any explanations that enable the Agency to clarify the outstanding practical measures, nor has it proposed any new practical measures in the next step of the framework of cooperation."[40]

Iran did not provide data on key weapons-related issues like its work on the initiation of high explosives that could be used in an implosion weapon or neutron transport calculations. The section on "Possible Military Dimensions" noted that in spite of the fact the IAEA had acquired some additional information since 2011 showing that Iran had a weapons program and/or weapons related activities – such as Iranian activity at Parchin – "In February 2012, Iran dismissed the Agency's concerns largely on the grounds that Iran considered them to be based on unfounded allegations." In August 2014, Iran again stated that, most of the issues (were) mere allegations and do not merit consideration."

As of March 2015, Iran had done nothing to refute or explain its actions relating to a weapons program or weapons related research and development, to set the stage for complying with this aspect of a permanent agreement, setting the stage for meaningful inspection, and providing a clear indication of how close it is to a working weapons design and planning for the actual deployment of nuclear weapons on its missile and aircraft.

While Iran's weapons development efforts are only one part of providing the necessary reaction time, they are clearly the area where the least is known at any public level, where Iran has done the least to comply, and where major questions remain as to whether any agreement could keep Iran from running a covert research and development and planning effort short of serious and clearly detectable fissile event.

The Uncertain Level of Iranian Progress: No News is No News

At least through May 2015, the US has also done comparatively little at the official level to set the stage for understanding Iran's progress and evaluating what is a critical aspect of any arms control agreement – as well as the ability to assess the consequences of a non-agreement. Previous Administrations had long since cancelled the annual Department of Defense unclassified summary of international proliferation activity, and had not reported regularly on Iranian missile development or the extent to which Iran's long range missile problem is dependent on nuclear warheads because of its inaccuracy and reliability problems.

The most the US did issue an unclassified nine-page summary of a *National Intelligence Estimate on Iran: Nuclear Intentions and Capabilities* on November 7, 2007. That document was issued under the Bush Administration and concluded that,[41]

- We judge with high confidence that in fall 2003, Tehran halted its nuclear weapons program; we also assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons.
- We judge with high confidence that the halt, and Tehran's announcement of its decision to suspend its declared uranium enrichment program and sign an Additional Protocol to its Nuclear Non-Proliferation Treaty Safeguards Agreement, was directed primarily in response to increasing international scrutiny and pressure resulting from exposure of Iran's previously undeclared nuclear work.
- We assess with high confidence that until fall 2003, Iranian military entities were working under government direction to develop nuclear weapons.
- We judge with high confidence that the halt lasted at least several years. (Because of intelligence gaps discussed elsewhere in this Estimate, however, DOE and the NIC assess with only moderate confidence that the halt to those activities represents a halt to Iran's entire nuclear weapons program.)
- We assess with moderate confidence Tehran had not restarted its nuclear weapons program as of mid-2007, but we do not know whet her it currently intends to develop nuclear weapons.
- We continue to assess with moderate-to-high confidence that Iran does not currently have a nuclear weapon.
- Tehran's decision to halt its nuclear weapons program suggests it is less determined to develop nuclear weapons than we have been judging since 2005. Our assessment that the program probably was halted primarily in response to international pressure suggests Iran may be more vulnerable to influence on the issue than we judged previously.

The US never fully updated this limited level of analysis since 2007. However, the Director of National Intelligence (DNI) issued an annual summary of threats to US national security that did provide some insights. The 2013 report stated that,[42]

> We assess **Iran** is developing nuclear capabilities to enhance its security, prestige, and regional influence and give it the ability to develop nuclear weapons, should a decision be made to do so. We do not know if Iran will eventually decide to build nuclear weapons.
>
> Tehran has developed technical expertise in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.
>
> Of particular note, Iran has made progress during the past year that better positions it to produce weapons-grade uranium (WGU) using its declared facilities and uranium stockpiles, should it choose to do so. Despite this progress, we assess Iran could not divert safeguarded material and produce a weapon-worth of WGU before this activity is discovered.
>
> We judge Iran's nuclear decision making is guided by a cost-benefit approach, which offers the international community opportunities to influence Tehran. Iranian leaders undoubtedly consider Iran's security, prestige and influence, as well as the international political and security environment, when making decisions about its nuclear program. In this context, we judge that Iran is trying to balance conflicting objectives. It wants to advance its nuclear and missile capabilities and avoid severe repercussions—such as a military strike or regime threatening sanctions.
>
> We judge Iran would likely choose a ballistic missile as its preferred method of delivering a nuclear weapon, if one is ever fielded. Iran's ballistic missiles are capable of delivering WMD. In addition, Iran has demonstrated an ability to launch small satellites, and we grow increasingly concerned that these technical steps—along with a regime hostile toward the United States and our allies—provide Tehran with the means and motivation to develop larger space-launch vehicles and longer-range missiles, including an intercontinental ballistic missile (ICBM).

> Iran already has the largest inventory of ballistic missiles in the Middle East, and it is expanding the scale, reach, and sophistication of its ballistic missile arsenal. Iran's growing ballistic missile inventory and its domestic production of anti-ship cruise missiles (ASCM) and development of its first long-range land attack cruise missile provide capabilities to enhance its power projection. Tehran views its conventionally armed missiles as an integral part of its strategy to deter—and if necessary retaliate against—forces in the region, including US forces.

The 2014 statement did not provide further data on Iran's research and development activity and progress in a nuclear weapons design. It did state, however, that,[43]

> We continue to assess that **Iran's** overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so. At the same time, Iran's perceived need for economic relief has led it to make concessions on its nuclear program through the 24 November 2013
>
> Joint Plan of Action with the P5+1 countries and the European Union (EU). In this context, we judge that Iran is trying to balance conflicting objectives. It wants to improve its nuclear and missile capabilities while avoiding severe repercussions—such as a military strike or regime-threatening sanctions. We do not know if Iran will eventually decide to build nuclear weapons.
>
> Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.
>
> Of particular note, Iran has made progress during the past year by installing additional centrifuges at the Fuel Enrichment Plant, developing advanced centrifuge designs, and stockpiling more low-enriched uranium hexafluoride (LEUF6). These improvements have better positioned Iran to produce weapons grade uranium (WGU) using its declared facilities and uranium stockpiles, if it chooses to do so. Despite this progress, we assess that Iran would not be able to divert safeguarded material and produce enough WGU for a weapon before such activity would be discovered. Iran has also continued to work toward starting up the IR-40 Heavy Water Research Reactor near Arak.
>
> We judge that Iran would choose a ballistic missile as its preferred method of delivering nuclear weapons, if Iran ever builds these weapons. Iran's ballistic missiles are inherently capable of delivering WMD, and Iran already has the largest inventory of ballistic missiles in the Middle East. Iran's progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including an intercontinental ballistic missile (ICBM).
>
> We assess that if Iran fully implements the Joint Plan, it will temporarily halt the expansion of its enrichment program, eliminate its production and stockpile of 20-percent enriched uranium in a form suitable for further enrichment, and provide additional transparency into its existing and planned nuclear facilities. This transparency would provide earlier warning of a breakout using these facilities.

Similarly, the DNI's 2015 threat assessment statement to the Senate Armed Services Committee stated that,[44]

> We continue to assess that Iran's overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so. We do not know whether Iran will eventually decide to build nuclear weapons.
>
> We also continue to assess that Iran does not face any insurmountable technical barriers to producing a nuclear weapon, making Iran's political will the central issue. However, Iranian implementation of the Joint Plan of Action (JPOA) has at least temporarily inhibited further progress in its uranium enrichment and plutonium production capabilities and effectively eliminated Iran's stockpile of 20 percent enriched uranium. The agreement has also enhanced the transparency of Iran's nuclear activities, mainly through

> improved International Atomic Energy Agency (IAEA) access and earlier warning of any effort to make material for nuclear weapons using its safeguarded facilities.
>
> We judge that Tehran would choose ballistic missiles as its preferred method of delivering nuclear weapons, if it builds them. Iran's ballistic missiles are inherently capable of delivering WMD, and Tehran already has the largest inventory of ballistic missiles in the Middle East. Iran's progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including intercontinental ballistic missiles (ICBMs).

A careful reading of these words shows that they again focus on enrichment and fissile production, say nothing about Iran's current level of nuclear weapons design and production data, say nothing about the time it would take for Iran to deploy a meaningful nuclear force, and provide no basis for knowing whether the US intelligence community feels it can detect Iran weapons research and development activity outside the fuel cycle, or whether an agreement would give the IAEA a credible verification activity.

Iran's Weapons Break Out Capabilities

More broadly, the US has never publically addressed the question of Iran's real-world reaction time in moving from acquiring fissile material to actual weaponization and deployment. Some seven years after the last serious US estimate, the most the US has said in unclassified terms seems to be that it believes Iran has not reconstituted a large, visible effort. It has never said that Iran is not conducting covert nuclear weapons research and development activities under another guise, explained Iran's calculations in creating a missile program that currently can only be effective with nuclear weapons, or discussed the problems Iran would face in any conflict in the Gulf or the rest of the region using its obsolete conventional forces without nuclear threat. It also has never defined its estimate of how quickly Iran could actually go from creating fissile material to actually having a weapon.

Fissile Material Does Not Mean Weaponization

This is critical in evaluating both an actual agreement and the risks in continuing to negotiate. Even actual nuclear weapons designers cannot agree on just how difficult it now is to design and manufacture a reliable and deployable nuclear weapon. Reports that Iran may have received significant design data from a number of sources, and reports by the IEA that Iran has been working on the design and key components for fission weapons for years, do not mean that Iran has detailed design data of the kind that allows it to produce an effective implosion weapon. Neither does it mean that it can easily move to develop a family of different weapons ranging from small nuclear weapons to boosted weapons that can be deployed on missiles or as relative light bombs.

North Korea's uncertain tests of fission devices -- which seem to have involved devices far too large for warhead weaponization -- show that getting large yields from a test device remains a major challenge. For new proliferators, India and Pakistan have both made spurious claims about the yields of their tests to disguise what seem to have been at least partial design failures. Even the simpler forms of gun devices can present significant problems in terms of reliability and yield.

The US and Iran's neighbors may choose to assume that Iran could rapidly deploy a functioning nuclear weapon once it has sufficient fissile material, but such assumptions can exaggerate Iran's military capabilities, and it is unclear what kind of assumptions are actually correct. Bomb design also involves serious safety and reliability issues, as well as the need to be able to predict

yield, the ability to operate in spite of the stress of a missile or air launch, and the ability of fuzing systems to trigger the weapon at the desired height of burst.

It is difficult, however, to go from standard fission implosion weapons to boosted weapons that have much higher yields, potentially raising the explosive force from a purely fissile 20-kiloton weapon to boosted weapons with yield of 100 kilotons or more. These involve key design issues, which include the problems involved in handling tritium and deuterium or solid lithium deuteride-tritide, and the fact that such designs are normally associated with plutonium weapons, not the uranium-based weapons that Iran would construct if it were successful in building a weapon.

How Much Is Enough

Much of the unclassified analysis of how soon Iran could get a weapon is tied to weapons and warhead design issues. Many tacitly assume that Iran could assemble a gun device or even nuclear missile warheads without any practical testing or even a fissile event. They also fail to state the assumptions made regarding the amount of material needed per weapon, and the major uncertainties involved.

Such estimates also tend to focus on one estimate of the necessary fissile material without noting the uncertainties in any nominal estimate or the variation by weapons design. Unclassified estimates made in an article on nuclear weapons design by the Federation of American Scientists illustrate the scale of the uncertainties involved -- as well as some of the reasons effective weapons design is so difficult and uncertain without actual testing:[45]

> The minimum mass of fissile material that can sustain a nuclear chain reaction is called a critical mass and depends on the density, shape, and type of fissile material, as well as the effectiveness of any surrounding material (called a reflector or tamper) at reflecting neutrons back into the fissioning mass. Critical masses in spherical geometry for weapon-grade materials are as follows:
>
> | | Uranium-235 | Plutonium-239 |
> |---|---|---|
> | Bare sphere: | 56 kg | 11 kg |
> | Thick Tamper: | 15 kg | 5 kg |
>
> The critical mass of compressed fissile material decreases as the inverse square of the density achieved. Since critical mass decreases rapidly as density increases, the implosion technique can make do with substantially less nuclear material than the gun-assembly method. The "Fat Man" atomic bomb that destroyed Nagasaki in 1945 used 6.2 kilograms of plutonium and produced an explosive yield of 21-23 kilotons [a 1987 reassessment of the Japanese bombings placed the yield at 21 Kt]. Until January 1994, the Department of Energy (DOE) estimated that 8 kilograms would typically be needed to make a small nuclear weapon. Subsequently, however, DOE reduced the estimate of the amount of plutonium needed to 4 kilograms. Some US scientists believe that 1 kilogram of plutonium will suffice.
>
> ….In the gun device, two pieces of fissionable material, each less than a critical mass, are brought together very rapidly to forma single supercritical one. This gun-type assembly may be achieved in a tubular device in which a high explosive is used to blow one subcritical piece of fissionable material from one end of the tube into another subcritical piece held at the opposite end of the tube.
>
> Manhattan Project scientists were so confident in the performance of the "Little Boy" uranium bomb that the device was not even tested before it was used. This 15-kt weapon was airdropped on 06 August 1945 at Hiroshima, Japan. The device contained 64.1 kg of highly enriched uranium, with an average enrichment of 80%. The six bombs built by the Republic of South Africa were gun-assembled and used 50kg of uranium enriched to between 80 percent and 93 percent in the isotope U-235.

> Compared with the implosion approach, this method assembles the masses relatively slowly and at normal densities; it is practical only with highly enriched uranium. If plutonium -— even weapon-grade -- were used in a gun-assembly design, neutrons released from spontaneous fission of its even-numbered isotopes would likely trigger the nuclear chain reaction too soon, resulting in a "fizzle" of dramatically reduced yield.
>
> ...Because of the short time interval between spontaneous neutron emissions (and, therefore, the large number of background neutrons) found in plutonium because of the decay by spontaneous fission of the isotope Pu-240, Manhattan Project scientists devised the implosion method of assembly in which high explosives are arranged to form an imploding shock wave which compresses the fissile material to supercriticality.
>
> The core of fissile material that is formed into a super-critical mass by chemical high explosives (HE) or propellants. When the high explosive is detonated, an inwardly directed implosion wave is produced. This wave compresses the sphere of fissionable material. The decrease in surface to volume ratio of this compressed mass plus its increased density is then such as to make the mass supercritical. The HE is exploded by detonators timed electronically by a fuzing system, which may use altitude sensors or other means of control.
>
> The nuclear chain-reaction is normally started by an initiator that injects a burst of neutrons into the fissile core at an appropriate moment. The timing of the initiation of the chain reaction is important and must be carefully designed for the weapon to have a predictable yield. A neutron generator emits a burst of neutrons to initiate the chain reaction at the proper moment —- near the point of maximum compression in an implosion design or of full assembly in the gun-barrel design.
>
> A surrounding tamper may help keep the nuclear material assembled for a longer time before it blows itself apart, thus increasing the yield. The tamper often doubles as a neutron reflector.
>
> Implosion systems can be built using either Pu-239 or U-235 but the gun assembly only works for uranium. Implosion weapons are more difficult to build than gun weapons, but they are also more efficient, requiring less SNM and producing larger yields. Iraq attempted to build an implosion bomb using U-235. In contrast, North Korea chose to use 239 Pu produced in a nuclear reactor.
>
> To fission more of a given amount of fissile material, a small amount of material that can undergo fusion, deuterium and tritium (D-T) gas, can be placed inside the core of a fission device. Here, just as the fission chain reaction gets underway, the D-T gas undergoes fusion, releasing an intense burst of high-energy neutrons (along with a small amount of fusion energy as well) that fissions the surrounding material more completely. This approach, called boosting, is used in most modem nuclear weapons to maintain their yields while greatly decreasing their overall size and weight.

There are many different weapons designs Iran might choose from, many different levels of fissile material requirements, and many different levels of associated risk. Iran might take the risks of producing weapons without actual testing by trusting foreign design data and ignoring key safety and reliability issues. It is also possible that Iran might claim it has nuclear weapons without actually producing them or concluding that it has them in a truly usable form. However, Iran has been cautious in the past about taking any steps that threatened the existence of its regime. It seems equally or more possible that Iran would never seriously weaponize without either full design details or some form of underground or other active testing.

As noted earlier, the IAEA has reported that Iran has had many elements of an R&D and test program that examines the behavior of every other aspect of weapons performance by setting off bomb designs without fissile material and examining the result. The now dismantled facility Iran created at Parchin might well have been designed for the purpose of non-fissile testing on an entire weapons assembly.

A September 2014 report by the Institute for Science and International Security (ISIS) notes that activity at the Parchin facility had started again, raising concerns about Iran's suspected effort to develop a nuclear weapon:[46]

> Recent Digital Globe satellite imagery dated August 12, 2014 shows that some activity continues at the Parchin site. As figure 1 shows, new construction material or debris, as well as new dirt or water runoff, appear in front of three buildings in the southern part of the site. Also, light vegetation appears to be growing at the center of the site, including on the protective berm, and the construction material or debris previously identified in front of the suspected test building remains. Finally, the dirt or water runoff and some of the possible construction material that appeared in previous imagery is no longer present in front of the large building in the northern part of the site.
>
> A May 2014 ISIS Imagery Brief showed several signs of external activity at the site. ISIS noted that possible building material and debris appeared in front of two main buildings at the site. Two trucks or containers had been removed from the area surrounding the suspected high explosives test building, while a larger object, possibly a truck or large container, appeared slightly north of it. Dirt or water runoff was visible in front of the northern building and three vehicles were clearly visible at the south entrance.
>
> Previously, a February 2014 ISIS Imagery Brief confirmed IAEA reporting of possible building material and debris appearing at the site. All of this activity followed a period of lull at the site (second half of 2013) in which commercial satellite imagery showed no significant visible alterations.

Some experts feel that Iran might also seek to obtain additional design validation data in the future by using subcritical radioactive material in such a test program, a speculation some other experts discount on the grounds it might not produce a reliable indication of full scale fissile event performance.

This makes obtaining accurate estimates of how much design data Iran actually has a critical issue. The UN Panel of Experts report issued in June 2014 did, however, confirm earlier IAEA reports, and stated that,[47]

> There remain areas of concern regarding the Islamic Republic of Iran's nuclear program and its possible military dimensions. In its report of 20 February 2014, IAEA referred to its 2011 analysis of allegations that the Islamic Republic of Iran has carried out activities relevant to the development of a nuclear explosive device.
>
> Among the issues identified by IAEA in 2011 are concerns about "alleged studies" regarding "how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile"
>
> …IAEA recently noted that information regarding the Islamic Republic of Iran's development of a nuclear explosive device "is assessed by the Agency to be, overall, credible" and despite the country's insistence that the claims are unfounded, "the Agency has obtained more information since November 2011 that has further corroborated the analysis contained in [the annex to the Director-General's report of November 2011]"… It is not known whether the additional information addresses the integration of a nuclear payload on a delivery vehicle.

As work by Michael Eisenstadt notes that,[48]

> Iran's weapons design choices will also be influenced by the kind of foreign assistance it has received in the past, and could receive in the future. This includes a Chinese weapons design that it may have received from the AQ Khan network (reportedly a smaller, more advanced design than that the latter provided to Libya); useful insights it might have gleaned from flawed plans for a firing set that the CIA allegedly provided Iran in order to sabotage and delay its weapons program (i.e., Operation Merlin); and assistance it may have received in designing the initiation and conventional explosives system for a nuclear weapon from the Russian scientist Vyacheslav Danilenko. In light of this history, it would be prudent to assume that

> Iran's future weapons design efforts will continue to benefit from foreign assistance, despite best efforts by the U.S. and others to prevent it.

This leaves any effort to assess Iran's actual weaponization capability dependent on public data going back to the IAEA report in November 2011. As noted earlier, the Institute for Science and International Security summarized Vyacheslav Danilenko's contributions to the Iranian nuclear program, and gave some technical details regarding one aspect of Iran's nuclear weapons development.

The technical details in the ISIS report give a sense of the progress that Iran was able to make with external assistance:[49]

> The IAEA obtained additional information that adds credibility to the conclusion that Danilenko used his technical and practical knowledge and expertise to provide assistance to Iran's program to develop a suitable initiation system for a nuclear explosive device. The IAEA assessed that a monitoring, or diagnostic, technique described in one of his papers had a remarkable similarity to one that the IAEA saw in material from a member state about a hemispherical initiation and explosives system developed in Iran (see below). This system is also described in the IAEA safeguards report as a multipoint initiation system used to start the detonation of a nuclear explosive.
>
> The IAEA also obtained from member states details of the design, development, and possible testing of what is called in IAEA information the R265 shock generator system, which is a round multipoint initiation system that would fit inside the payload chamber of the Shahab 3 missile tri-conic nose cone. This device involves a hemispherical aluminum shell with an inside radius of 265 mm and wall thickness of 10 mm thick. Outer channels are cut into the outer surface of the shell, each channel one by one millimeter, and contain explosive material. Each channel terminates in a cylindrical hole, 5 mm in diameter, that is drilled though the shell and contains an explosive pellet. The geometrical pattern formed by channels and holes is arranged in quadrants on the outer hemispheric surface which allows a single central point of initiation and the simultaneous detonation of explosives in all the holes on the hemisphere. This in turn allows the simultaneous initiation of all the high explosives under the shell by one exploding bridgewire (EBW). If properly prepared, the R265 constitutes the outer part of an explosively driven implosion system for a nuclear device. The outer radius of the R265 system is 275 millimeters, or a diameter of 550 millimeters, less than the estimated diameter of about 600 millimeters available inside the payload chamber of a Shahab 3 (or the Sejjil-2 missile).

No credible unclassified data currently exist to show just how much outside warhead design data that Iran has received, and this highlights a much broader limit to any unclassified analysis. How much is actually known at the classified level about Iran's access to serious design data, test program, and test options is obviously uncertain. What, if anything, this says about Iran's plans and intentions is another issue. If – as seems likely – Iran has been slowly advancing a nuclear weapons program since the time of the Shah, how much have the US and other intelligence communities learned that they have not made public? Intelligence does need to protect key sources and sensitive methods, but it often uses security to conceal the fact that its analysis is almost all method and "guesstimate" and no source.

This uncertainty regarding public versus unclassified knowledge is also critical to any real world success in implementing a P5+1 agreement or dealing with its failure. Any effort to both halt and characterize Iran's programs will, after all, be part of an ongoing duel with Iranian efforts to conceal as much as possible. No unclassified analysis can really address this aspect of Iran's programs. No one can do more than speculate as to what, if anything, Iran has been able to conceal that is not known to either outside intelligence agencies or analysts of the Iranian program.

Judging the Success or Failure of a Final Agreement with Iran

Any meaningful arms control agreement must be based on the principle of "trust but verify." For all the reasons set forth in this analysis, there is no basis for trust in any aspect of Iran's weapons related activities. This will evidently be true whether an agreement is reached, whether the negotiations are extended, or whether the negotiations collapse.

At present, however, a successful negotiation would mean that these aspects of an agreement to some kind of classified and non-public annex and focus on fissile material production or rely on some future level of inspection and verification with no agreed baseline as to how far Iran has moved towards designing and being able to produce a nuclear weapon.

Delay would mean going forward with no picture of how far Iran has already gotten, how dependent it is on visible actions like actual fissile or weapons tests for success, and how long Iran would need to develop a meaningful nuclear strike capability. It also would mean going forward without any serious public US assessment of how dependent Iran's missile program are an deploying nuclear weapons or the extent to which a nuclear-armed force is critical to deterring preventive/preemptive strikes or US and Gulf escalation to major conventional strikes on Iran if Iran should conduct a major military action like using its asymmetric forces to try to bloc petroleum exports out of the Gulf.

At the same time, the lack of such data means that many judgments based solely on Iran's theoretical ability to acquire fissile material may grossly exaggerate the spend with which Iran can acquire a meaningful nuclear capability, and the need for preventive strikes.

Prevention, Deterrence, and Proliferation

Much depends on both whether an agreement is reached and whether it proves to be effective. An ongoing Iranian nuclear weapons effort could lead to Israeli preventive military strikes, or US preventive strikes under some conditions – radically changing the scenarios for combat in the region and the forces driving every aspect of the regional arms race and the military balance.

A clear indication that Iran was proceeding to develop and deploy nuclear weapons would lead to even more emphasis on missile defenses, might well lead Arab Gulf states to seek nuclear weapons, and might press the US into offering its allies the same kind of "extended deterrence" that it once offered its allies in Europe. At the same time, preventive strikes might end in driving Iran into far more intense covert nuclear weapons efforts, or to take reprisals in the form of asymmetric warfare, new efforts to win military influence in nations like Syria and Iraq, and new efforts to use the Shi'ite population in nations like Bahrain. Saudi Arabia, and Yemen to pressures those states.

Gulf Nuclear Weapons

It will be several years before Iran can develop and deploy a meaningful nuclear force, but even the possibility of a nuclear armed Iran has already helped persuade the GCC states and the US to developed better theater missile defenses, and led them to see Iran as far more of a potential threat, and consider preventive strikes. Some in the GCC have talked about creating their own nuclear enrichment cycles to support their nuclear power plants – a first step in creating the fissile material for nuclear weapons.

Prince Turki of Saudi Arabia has stated that Saudi Arabia has at least examined the possibility of building its own nuclear weapons or seeking to buy them from a nuclear weapons state like Pakistan. Some senior UAE officials have privately raised the possibility of acquiring nuclear weapons as well. Turkey might also seek nuclear weapons if it confronted a mix of nuclear-armed states like Israel, Iran, and Pakistan

The US Role in Extended Deterrence

The Gulf Security Dialogue (GSD) initiated by the Bush Administration has been sustained as Washington engages the region. There has been discussion indicating the possibility of US security guarantees or "extended deterrence" in an effort to protect these states against Iranian threats. Such efforts could reduce the possibility that some Gulf states would acquiesce to Iranian pressure and limit the threat of proliferation in the event that Iran actually equips its force with nuclear weapons.[50]

Senior US officials have already raised these possibilities in broad terms. Former Secretary of State Hillary Clinton told reporters during a trip to Bangkok that, "We want Iran to calculate what I think is a fair assessment that if the United States extends a defense umbrella over the region, if we do even more to support the military capacity of those in the Gulf, it's unlikely that Iran will be any stronger or safer because they won't be able to intimidate and dominate as they apparently believe they can once they have a nuclear weapon." [51]

It is far from clear what form of extended deterrence the US would offer, how conditional it would be on Arab Gulf state not pursing their own nuclear programs, and how such US actions would be seen by Iran and other regional states. What is clear is that the practical choices may be an effective agreement between the P5+1 and Iran, preventive war, or some form of sustained regional nuclear arms race.

Figure 1: Gulf Surface-to-Surface Missile and Long Range Rocket Launchers

Bahrain: 9 M270 MLRS artillery rocket fire units with 30 ATACMS missiles.

Egypt: 26 M270 MLRS artillery rocket fire units plus; 48 BM-24 240mm artillery rocket fire units in storage. Missile forces include 42+ launchers: 9 FROG-7, 24 *Sakr*-80 and 9 *Scud*-B.

Iran: (No accurate estimate exists, ***see Figure VIII.2***.) The IISS lists 50 *Arash*/*Hadid*/*Noor*; **240mm** 19: ε10 *Fadjr* 3; 9 M-1985; **330mm** *Fadjr* 5 artillery rocket launchers; and 30 CSS-8 surface-to-surface launchers (175 missiles); plus an unknown number of *Shahin*-1/*Shahin*-2; *Nazeat*; *Oghab* launchers in the Army. It does not provide any estimate for the Revolutionary Guards. It reports one brigade with *Shahab*-1/2 launchers and one battalion with *Shahab*-3 launchers in the Air Force, plus an unknown number of *Ghadr*-1 and *Sajjil-2* (in development) forces. These forces include 12+ *Shahab*-3/*Ghadr*-1 MRBM launchers and some *Sajjil*-2 launchers. It also lists 18 SRBM launchers, including some *Fateh* 110; and 12-18 *Shahab*-1/2 launchers with 200–300 missiles, plus *Zelzal* forces.

Iraq: 3 TOS-1/1A artillery rocket launchers

Israel: Israel is "widely believed" to have a nuclear armed missile capability – with 3 *Jericho squadrons with Jericho* 1 SRBMs and *Jericho* 2 IRBMs, and *Dolphin*-class SSKs with land-attack cruise missiles.

Jordan: 12 227mm HIMARS and 2+ 273mm WM-80 artillery rockets.

Kuwait: 27 9A52 *Smerch* artillery rockets.

Oman: N/A

Qatar: 4 ASTROS II Mk3 127mm artillery rocket launchers.

Saudi Arabia: 60 ASTROS II Mk3 127mm artillery rocket launchers. Ballistic missiles include 10+ DF-3 (CSS-2) IRBM fire units with 40 missiles, and some DF-21 (CSS-5 – variant unclear) MRBM fire units.

UAE: 20 227mm HIMARS and 6 9A52 *Smerch* artillery rockets.

Yemen: The following forces were reported before Saudi Arabia claimed to have largely destroyed them in its April 2015 bombing campaign: 12 FROG-7 launchers, 10 SS-21 *Scarab* (*Tochka*) launchers; and 6 *Scud*-B (33 missiles).

Source: Based on Chapter Seven: Middle East and North Africa," in *The Military Balance*, International Institute for Strategic Studies, 2015, p. 303-362, material form HIS Jane's as adjusted by the authors.

Figure 2: Major Iran Missile Forces – Part One

Hildreth Estimate 2010

	Shahab-1	Shahab-2	Shahab-3	Ghadr-1	Sejjil-2	Khalij Fars	Fateh-110	Zelzal-1/2/3
Range (km)	300-315	375-700	800-1300	1100-2500	1800+	300	200-400	125/200/ 150-400
Payload (kg)	1000	1000-730	1000	1000-750	1000	650	500	600
CEP (m)	450-1000	50-700	190-2500	1000	Unknown	<50	100-300	100-3000
Number in Service	200-300	100-200	25-100	25-300	Unknown	Unknown	Unknown; likely in hundreds	Unknown; likely in thousands
Launchers	18	18 (same as Shahab-1)	6-20	6-20 (same as Shahab-3)	Unknown	Unknown	Unknown	Unknown
Fuel	Liquid	Liquid	Liquid	Liquid	Solid	Solid	Solid	Solid

Source: Steven A. Hildreth, Iran's Ballistic Missile and Space Launch Programs, *Congressional Research Service R42849, December 6, 2012, p. 15*

Figure 2: Major Iran Missile Forces – Part Two

Israeli INSS Estimate 2013

Missile Type	Launcher Numbers	Missile Numbers	Comments
SS-1 (Scud B)	20	300	-
SS-1 (Scud C)	20	100	-
Shehab 2	-	-	Probably similar to Syrian Scud D
Shehab-3/3B, Ghadir	10	300	-
BM-25	-	18	Operational Status unknown.
Tondar-69 (CSS 8)	16	-	-
Qiam-1	-	-	Liquid fuel
Fateh-100	-	-	-
Shehab 3B/Ghadir development	-	-	Includes new RV, believed in production.
Ashura/Sejjil	-	-	Solid propellant.

Source: INSS, "Iran-Strategic", *Middle East Military Forces*, 2/1/2103, http://inss.web2.moonsite.co.il/uploadimages/SystemFiles/iran.pdf, p. 7.

IISS Estimate 2014

Iranian Army holdings of *Shahin*-1/*Shahin*-2; *Nazeat*; *Oghab*

IRGC Holdings of:

1 SRBM brigade with *Shahab*-1/2

- 18+ launchers: some *Fateh* 110; 12-18 *Shahab*-1/2 launchers (ε200–300 missiles)

1 MRBM brigade with *Shahab*-3; *Ghadr*-1; *Sajjil-2* (in development)

- 12+ launchers: 12+ *Shahab*-3/*Ghadr*-1; some *Sajjil*-2

Some units with Short-range Zelzal surface-to-surface missiles

Source: IISS, "Iran," Military Balance, 2014, pp. 319-320

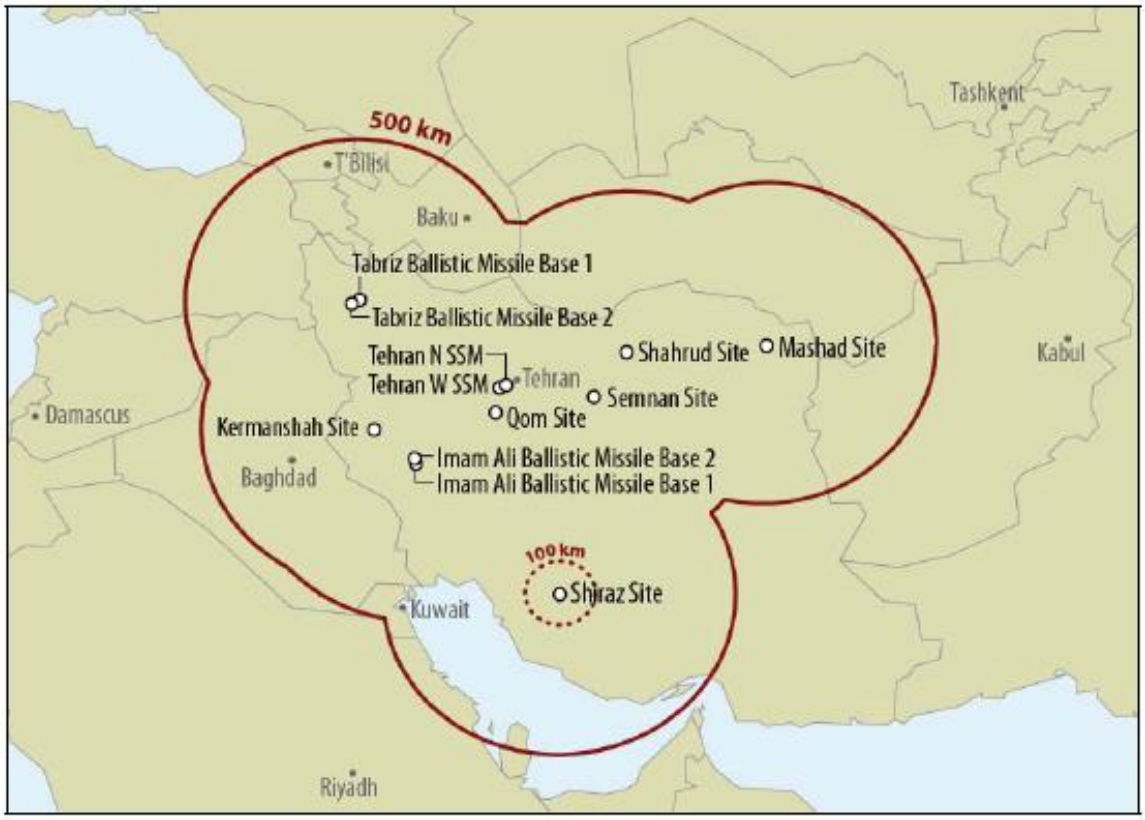
Figure 2: Major Iran Missile Forces – Part Three

IHS Jane's 2013

System	Number	Range (KM)	Mission and Comments
FROG 7 Rocket	250		battlefield rocket
Oghab	250		battlefield missile
Shahin-2	250		battlefield missile
Nazeat/Iran 130	500		battlefield missile
Fateh 110	na	200+	ballistic missile
Fateh A-110 (Mersad)	na	250	ballistic missile
Fateh-110-D1	na	250	ballistic missile
Tondar 69	200		ballistic missile
Shahab-1 (SS-1c 'Scud B')	250	300	ballistic missile, 1000 Kg warhead
Shahab-2 (SS-1d 'Scud C')	50	500-600	ballistic missile, 800 Kg warhead
Shahab-3 (No-dong 2)	25		ballistic missile
Shahab 3A	na	1,500-1,800	uncertain variant
Ghadr 1	na	1,800	uncertain variant
Shahab 3B	na	2,000-2,500	uncertain variant
Sejjil-2	na	2,000	developmental, 1000 Kg warhead
BM-25	18?		ballistic missile
Qiam 1	na	700	ballistic missile

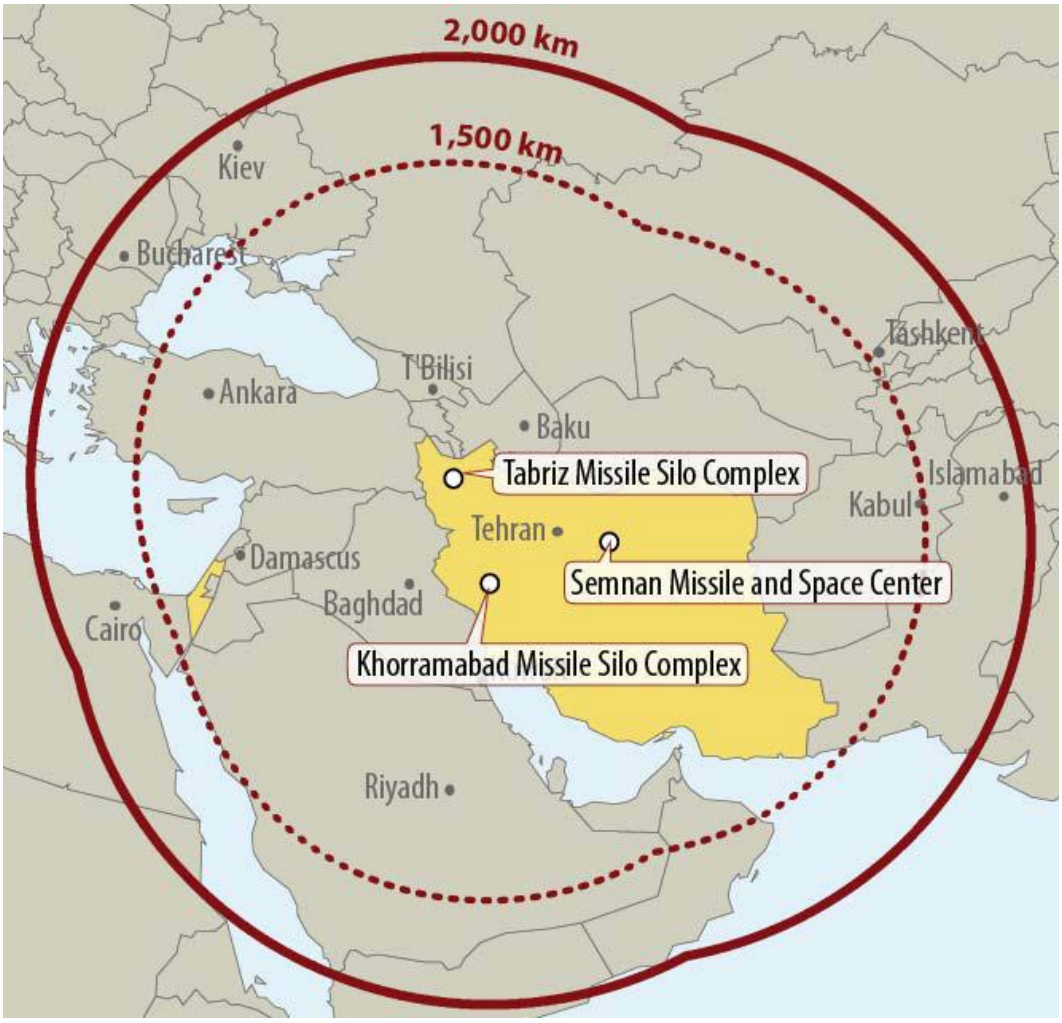
Source: IHS Jane's "Iran, Strategic Weapons," *Sentinel Series*, 2013, pp. 6-9

Map.1: Estimated Range of Iranian Shorter-Range Missile Forces



Source: Steven A. Hildreth, *Iran's Ballistic Missile and Space Launch Programs, Congressional Research Service R42849,* December 6, 2012.

Map 2: Estimated Range of Iranian Long-Range Missile Forces



Source: Steven A. Hildreth, *Iran's Ballistic Missile and Space Launch Programs, Congressional Research Service R42849*, December 6, 2012.

Figure 3: Estimated Capability of Iranian and Israeli Long-Range Missile Forces With a Nuclear Warhead

Nuclear Missile Delivery Capability for a 1,000 kg Warhead Weight

Iran Ballistic Missiles	Status	Missile warhead radius (cm)	Max weight of a nuclear device that could fit the missile (kg)	Max warhead deliverable range (km)	Missile range required to reach main targets (km)	Nuclear missile delivery capability
Shahab 1	In Service	44	750 - 1,310	285	>350	No
Shahab 2	In Service	44	750 - 1,310	370	>350	Marginal
Shahab 3	In Service	62.5	2,030 - 3,200	910	>500	Yes
Shahab 3M	In Service	62.5	2,030 - 3,200	1,150	>500	Yes
Safir	Under Development	62.5	2,030 - 3,200	1,910	>1,000	Yes
Seijil	Under Development	62.5	2,030 - 3,200	2,160	>1,000	Yes
Israel Ballistic Missiles						
Jericho 2	In Service	78	3,880 - 5,720	1,510	>1,000	Yes
Jericho 3	Development/In Service	78	3,880 - 5,720	3,500	>1,000	Yes

Source: Dr. Abdullah Toukan, April 29, 2015.

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