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# IRANIAN WEAPONS OF MASS DESTRUCTION

## Capabilities, Developments, and Strategic Uncertainties

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# I. Introduction

Iran's first efforts to acquire nuclear weapons technology were detected in the early 1970s, while the Shah was still in power. While Iran seems to have halted such efforts during the initial period of the Khomeini regime in the early 1980s, it changed its policies after Iraq began to use chemical weapons and long-range missiles during the Iran-Iraq War. By the mid 1980s, Iran was actively developing chemical weapons, acquiring ballistic missiles, and resumed its efforts to acquire nuclear technology with nuclear weapons applications.

## Iran's Steadily Less Convincing Efforts at Denial

Iran continues to deny that it has a nuclear weapons program, but has declared that it has chemical weapons as part of its obligations as a signatory to the Chemical Weapons Convention (CWC). Iran has never made a secret of its development of steadily larger and longer-range ballistic missiles, and for nearly a decade it has failed to fully comply with the efforts of the UN and International Atomic Energy Agency (IAEA) to determine the true nature of its nuclear programs.

It has never been possible to prove that Iran has an active nuclear weapons program using material available in open sources, although a US National Intelligence Estimate issued in 2007 declared that there was classified evidence that Iran had had an organized program, and had suspended that program in 2003. Year after year, however, the IAEA has found new indicators of Iranian activities that Iran had not declared, and has created a steadily longer list of incidents and weapons-related activities that Iran has failed to fully explain.

In terms of its missile capability, Iran is the only country not in possession of nuclear weapons to have produced or flight-tested missiles with ranges exceeding 1,000 kilometers.[1] Iran's continued expansion of the range of its ballistic missile programs further supports international concerns about Iran's nuclear ambitions and intentions.

## Iran's Progress Towards Nuclear-Armed Missile Capability

At the same time, Iran has moved steadily closer to the ability to produce fissile material –the only thing it lacks to make nuclear weapons. While Iran has always managed to find some explanation for most of the activities the IAEA has challenged, the cumulative weight of evidence has grown so large that it is difficult not to believe that Iran is seeking to develop, manufacture, and deploy nuclear weapons and nuclear armed missiles.

Iran has admitted it has chemical weapons, but has never properly declared its holdings of chemical weapons, and the status of its biological weapons programs is unknown. Iran has, however, managed to conceal enough of its military activities, and create enough ambiguity, so that there is no reliable way to characterize its ability to acquire weapons of mass destruction and improved means to deliver them; or to estimate the current and future war fighting capabilities of Iran's chemical, biological, radiological, and nuclear weapons.

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[1] Alex Bollfrass, Arms Control and Proliferation: Iran, Arms Control Association, January 2008, available at: http://armscontrol.org/factsheets/iranprofile.

The situation is somewhat clearer in terms of delivery systems. Iran has long had long-range strike aircraft that can be used to deliver weapons of mass destruction, and its force development efforts since the end of the Iran-Iraq War have put a heavy and public emphasis on missiles. Iran already has ballistic missile forces capable of reaching targets throughout Gulf region, its Shahab missiles have ranges in excess of 1,000 kilometers and is developing a range of new ballistic and cruise missile systems that can reach targets in Israel, Egypt, and Turkey, and deep into Europe. Iran has not, however, provided a public picture of whether it will arm its missiles with chemical, biological, radiological, and/or nuclear (CBRN) warheads.

In balance, Iran seems to be developing all of the capabilities necessary to deploy a significant number of nuclear weapons no later than 2020, and to mount them on missile systems capable of striking at targets throughout the region and beyond. It has reached a level of progress where it is conceivable that Iran could build its own nuclear device as early as 2009, although a time frame of 2011-2015 seems more likely for the deployment of actual weapons and nuclear armed missile forces. Similarly, while Iran may not have a biological weapons program, it is already acquiring all of the equipment and core technology necessary to develop and manufacture them.

## Iran's Impact on the Regional Military Balance

Iran's actions have already made major changes in the military balance in the Gulf and the Middle East. Iran may still be several years to half a decade way from becoming a meaningful nuclear power, but even a potential Iranian nuclear weapons has led Iran's neighbors, the US, and Israel to focus on an Iranian nuclear threat.

For the US and Israel, this focus has led to the serious consideration of preventive war. The US, however, is also examining options for defense and extended deterrence. So is Israel, with the fundamental difference that it sees Iran as a potential existential threat to Israel's very existence.

For the Gulf States, and nations like Turkey, the prospect of a nuclear Iran has led to consideration of the acquisition of nuclear weapons and missile defenses. All have sought to find diplomatic solutions to halting Iran's program, and creating inspection regimes that can ensure that Iran does not covertly develop nuclear weapons or a breakout capability.

At the same time, however, none of the states involved can count on diplomacy succeeding and the odds of success have slowly declined as Iran's nuclear and missile capabilities have moved forward. Neither "carrots", like security and economic incentives, nor "sticks", like UN sanctions and economic constraints, have so far had much success. The end result is that military options like preventive war, deterrence, defense, and the ability to actually fight a nuclear exchange in ways that would cripple or destroy Iran, receive steadily greater attention.

## Irregular Wars and "Wars of Intimidation"

Iran's progress towards a nuclear weapons capability has had additional major effects. Every state dealing with Iran must decide whether some form of accommodation is possible, and consider its relations with Iran in the context of dealing with a future

nuclear power. While a state like Israel may focus on warfighting, other states – particularly Iran's neighbors -- must increasingly deal with an Iran which can use nuclear weapons as a tacit or overt threat to bring pressure upon them. Even the future prospect of an Iranian weapon, gives Iran added leverage in the "wars of intimidation" that shape much of the real-world behavior of nations in the region.

Iran's progress towards nuclear weapons capability also interacts with its growing capability for irregular or asymmetric warfare. It is one thing to deal with Iran's use of its Islamic Revolutionary Guards Corps (IRGC) when Iran is a relatively weak conventional power. It is another thing to risk taking decisive action, or retaliating in force against Iran's use of irregular warfare, when this risks creating lasting tension with a future nuclear power – or the risk of escalation if Iran actually deploys a nuclear capability. Furthermore, Iran's ties to Syria, influence in Iraq, links to the Hezbollah, and relations with Hamas raise the specter that Iran not only can use proxies to help it fight irregular wars, but also to help it in some future covert delivery of nuclear weapons.

Unlike the Cold War, the shifts in the regional balance caused by Iran's potential nuclear weapons capabilities cannot be simplified into some form of "zero sum game." There is a wide range of different players with different interests both inside and outside the region. There are no clear rules to the game, or even knowledge of when and whether the game will exist. The playing field also includes critical additional areas such as the Afghan and Iraqi Wars, the security of energy exports that are critical to the global economy, and the emerging role of China and Russia. Wild cards like North Korea and Pakistan, the internal politics of the United Nations, and the weakening of the US structure of global influence and alliance add still further complications.

## The Problem of Time and Complexity

Finally, any realistic examination of Iran's nuclear options must look beyond the issue of whether or not Iran crosses the nuclear threshold. It is dangerous to focus on arms control, diplomatic prevention, and preventive war, Iran in 2008 is not Iraq in 1981. Iran has had decades to build up a technology base. Iran has demonstrated that it has at least three different centrifuge designs, and that it can now build every element of the production cycle needed to develop weapons-grade U-235 and the components of fission weapons from a highly dispersed industrial base scattered throughout the country.

There is no way to be certain of Iran's progress or the ability of various intelligence agencies to analyze it. While there has been a flood of unclassified analysis, much of it contradictory and with extremely dubious sources, if any, and there have been no meaningful government reports on Iran's efforts. The closest thing to unclassified intelligence has been a few summary statements by senior US intelligence officials and a few pages of declassified summary judgments from the NIE issue in 2007 – judgments so ambiguous and badly written that there meaning has been a subject of continuing debate.

As a result, it is impossible to know how well the intelligence community can analyze and predict Iran's capabilities and how well it can target Iran's forces and facilities. It is equally impossible to determine how lethal any preventive or preemptive strikes can be, how large an attack force might be required, what level of battle damage assessment is really possible, how many restrikes might be required, and what level of persistent

surveillance and restrike activity might be need to achieve a given level of destruction or suppression of Iran's capabilities.

These uncertainties do not mean that there are not workable military options. It may well be possible to seriously delay Iran's efforts, and make them more costly and inefficient. At the same time, it is far from clear that prevention is really possible through either diplomatic or military means.

Even successful diplomatic negotiations might lead Iran to dismantle its known facilities while creating, or strengthening, a covert program that any negotiable IAEA inspection regime might fail to detect or verify convincing enough to lead to decisive international action. Even relatively successful Israeli or U.S. preventive strikes might also end in failure. Iran may have advanced to the point where a determined Iranian government can carry out an indigenous nuclear program in three to five years that supplies at least a few nuclear weapons.

Iran has already shown it has mobile long-range ballistic missiles and is working on cruise missiles. Iran is already deploying an active missile force that could be rapidly turned into a nuclear-armed force, which could then be used in the launch-on-warning (LOW) or launch-under attack (LUA)-mode – greatly increasing the risks of any preventive or preemptive strike on Iran. The same would be true of arming aircraft and putting them into the same kind of quick reaction mode – one NATO used through most of its existence.

It is also possible that if Iran is prevented from creating an effective nuclear force, it might be willing to take the risk of planning for covert nuclear strikes, or turning nuclear weapons over to proxies like the Hezbollah. Furthermore, Iran will increasingly have the option of creating an even more covert and unpredictable biological weapons program at a time when technology and equipment for far more advanced and lethal weapons is now becoming available. Nuclear weapons may be the most lethal technology of the 20th century, but it is far from clear that they will be the most lethal option in the first decades of the 21st.

None of these possibilities are reasons to reject diplomatic options or assume that preventive military action will fail. They are convincing reasons to assume that such options will not necessarily succeed, and to show great reservation about simplistic media reports or war plans or speculation by analysts who have no access to intelligence or expertise in real world war planning.

They also are reasons to consider a future in which Iran at a minimum develops a serious degree of nuclear ambiguity, where no one can be certain whether it has a rapid nuclear breakout capability or a few hidden nuclear devices or "bombs in the basement." Even apparent success in negotiating with Iran, or in executing preventive military options, could also lead to a future where Iran slowly moves towards an actual test, deployment of weapons, and a steadily improving and less vulnerable nuclear weapons delivery capability.

The situation has already evolved beyond the point where the key question for policy making is whether Iran's neighbors, the US and Israel, and the world can live with a nuclear-armed Iran. It is far from clear that Iran's neighbors, the US and Israel, and the

world have a choice. Iran has already created the equivalent of a game of three-dimensional chess in which there are far more than two players, where no player can see the full situation on the board, and each player has the latitude to make up at least some of the rules without bothering to communicate them to the other players. The fact that no one likes complexity or nuclear threats does not make war avoidable, and the same is true of games that have no predictable rules or end.

# II. Iran's Missile Arsenal and Other Delivery Systems

Iran's actions and capabilities cannot be understood simply by looking at the data available on its nuclear programs. They are being shaped by at least four other major factors. One is the priority Iran is giving to medium and long-range missiles. Another is the priority Iran is giving to irregular or asymmetric warfighting capabilities. A third is the slow pace of Iran's conventional military modernization and the decline in its conventional military strength relative to its neighbors and the US. The fourth is its perception of its overall strategic posture relative to those neighbors and the US.

Iran is clearly giving the development and deployment of ballistic and cruise missiles high priority, and creating warfighting capabilities based on systems that are sufficiently limited in payload and accuracy that they can only be effective if armed with weapons of mass destruction. While such missiles can always be used a "terror weapons" with conventional warheads, they cannot be reliable ways of hitting key point targets or doing serious damage to an area target.

Iran's ballistic missiles can only achieve significant lethality -- even against large area targets -- if armed with weapons of mass destruction. It is also doubtful that Iran could hope to achieve such lethality with its current and near-term chemical, biological, or radiological weapons capabilities – although this will become progressively more uncertain in the case of biological weapons. Nuclear weapons are the only way of arming such missiles that provides a convincing way to do massive damage to an area target, given the limits to the accuracy, reliability, and warhead capability of Iran's current deployments and more advanced development efforts.

The analysis of Iran's nuclear programs is, therefore, directly tied to the fact Iran is deploying new medium-range surface-to-surface missiles like the Shabab-3, and has much longer-range systems in development. It is equally important to note that the Iranian government has placed these systems under the command of hard-line elements in the Iranian military: the Islamic Revolutionary Guards Corps (IRGC). [2]

The IRGC is believed to play a critical role in Iran's efforts to acquire nuclear weapons technology, and to control all of Iran's longer range ballistic missiles. The key leaders of the IRGC also report directly to the Supreme Leader, Ali Hoseini-Khamenei, although Iran's President, Mahmud Ahmadinejad, plays a role in the Iranian National Security Council. Arms control experts may have the luxury of focusing on Iran's nuclear efforts but this is only part of the story. There are reasons why key US officials like U.S. Secretary of Defense Robert M. Gates have seen Iran's missile programs as a key element in Iran's overall program.[3]

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[2] Iran's military services include a wide range of different elements. The CIA reports that they include theIslamic Republic of Iran Regular Forces (Artesh): Ground Forces, Navy, Air Force of the Military of the Islamic Republic of Iran (Niru-ye Hava'i-ye Artesh-e Jomhuri-ye Eslami-ye Iran; includes air defense); Islamic Revolutionary Guard Corps (Sepah-e Pasdaran-e Enqelab-e Eslami, IRGC): Ground Forces, Navy, Air Force, Qods Force (special operations), and Basij Force (Popular Mobilization Army); Law Enforcement Forces (2008). Source: CIA, World Factbook, 2008, "Iran,"

[3] Stephen Kaufman, "Bush says Iranian group certainly providing weapons in Iraq, February 14, 2007, available at http://usinfo.state.gov/xarchives/display.html?p=washfile-english&y=2007&m=February&x=20070214171942esnamfuak0.7028467.

At the same time, there are many uncertainties as to how far Iran has gotten in developing effective ballistic and cruise missiles, and as to the nature of its current development programs. Much of the unclassified reporting is highly contradictory or makes assumptions that are not based on any clear source. Not only are Iran's actions and intentions unclear, but it is often unclear as to whether Iran has effective test and evaluation programs and has made clear decisions as to what path it is going to pursuer in missile development, shaping its future force deployment, and mixing missile, aircraft, and covert delivery capabilities. As is the case with most other aspects of Iran's efforts, it is pursuing so many options that its future path may be more a matter of opportunism than some fixed master plan,

# The Range of Iranian Programs

As **Figure 2.1** shows, Iran has a variety of short-, medium-, and long-range missiles; while many are based on other missiles such as the SCUD and the CSS, Iran has either developed them further or renamed them. Figure 2.2 shows the range of Iranian missiles that are deployed or under development, and Figure 2.3 shows an estimate of their nominal range. The reader should be aware that very different estimates exist of the nature and configuration of Iran's Shabab-3 and development missile programs, and that the range data shown are highly nominal. Missiles, like aircraft, make trade-offs between range and payload.

The figures shown generally assume a nominal 1,000 kilogram payload and often make rough estimates of the capabilities of a given missile booster and stage. Iran can increase range significantly by using a smaller warhead' although this can create risks in terms of reliability and overall design, and forces reductions in lethality that increase the need to use a nuclear weapon or highly lethal biological weapon. At the same time, it is possible to deliver much larger payloads by reducing range.

As is discussed later, there are no meaningful unclassified data that make it possible to predict what design choices Iran will make in the future. Moreover, Iran might make trade-offs in range payload for other reasons. Real world reliability and accuracy can vary with range. Altering the apogee to increase reentry speed is one way to counter missile defenses. Increasing warhead weight could provide a limited decoy or countermeasure capability, or the inclusion of some form of terminal guidance. Alternatively, an improved booster, or change in the number and nature of other stages in a missile, is a way to rapidly increase the range-payload of a mature and well-proven system. System can evolve over a decade or more.

Iran has made no secret of the fact that it includes Israel and the US as key reasons for these programs, and looks beyond its neighbors in developing them. One senior IRGC officer has described the strategic and tactical rationale behind such weapons program as follows:

> Our enemy's strategy is based on air and sea operations. That is, we believe that any future threat to us will come from the countries beyond our region. In our military analyses, we particularly consider the Americans and the Zionist regime as the two threats from beyond our region. Their strategy will be aerial operations, be it by long-range missiles or fighter planes. In the face of their

> air raids or missile attack, we have adopted the strategy of utilizing long-range or surface-to-surface missiles.[4]

The Iranian government stated as early as 1999 that it was developing a large missile body or launch vehicle for satellite launch purposes and repeatedly denied that it was upgrading the Shahab series (especially the Shahab-3) for military purposes. Iran also continued to claim that the "Shahab-4" program is aimed at developing a booster rocket for launching satellites into space. In January 2004, Iran's Defense Minister claimed that Iran would launch a domestically built satellite within 18 months. This had still not taken place as of September 2008.[5]

In December 2005, the U.S. government announced its belief that Iran had built underground missile factories that were capable of producing Shahab-1s, Shahab-2s, and Shahab-3s, as well as testing new missile designs. It was also believed that Karimi Industries was housed at one of the secret bases, which is where work is taking place on perfecting Iran's nuclear warheads.[6] Most of Iran's missile development industry reportedly is located in Karaj near Tehran. Apparently, there are two large, underground tunnels between Bandar Abbas and Bushehr.[7]

One source notes that with improvements in its Shahab missile program, Iran has attained the capability to strike any place in the Middle East from hardened, fixed sites. Apparently, launch silos for its long range missiles exist near Isfahan.[8]

U.S. officials insisted that information on the underground facilities did not come from Iranian opposition sources like the Mujahadeen-e-Khalq (MEK) and that it was reliable. They feel Iran has made significant strides in recent years using North Korean, Chinese, and Russian technology. If Iran begins work on the Shahab-5 and the Shahab-6 series, it may acquire delivery systems with the range to make it a global nuclear power, instead of merely a regional one. One observer has concluded that Iran is becoming self-sufficient in the production of ballistic missiles.[9] Another source claims that Iran is covering almost all the technological bases necessary to administer an advanced missile program;[10] reports of a possible space launch program support such assertions.

Iran claimed to have test-launched a suborbital rocket in early 2007, and that it is planning to launch four more satellites by 2010.[11] According to experts a satellite launch capability would presage Iran's ability to produce intercontinental ballistic missiles.[12]

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[4] BBC Monitoring Middle East, Iran's Guard commander comments on Tehran's missile power, November 13, 2006.
[5] "Iran Enhances Existing Weaponry by Optimizing Shahab-3 Ballistic Missile," Jane's Missiles and Rockets, January 20, 2004.
[6] Iran has Built Underground Missile Factories," Jane's Missiles and Rockets, December 8, 2005.
[7] Federation of American Scientists, *Iran*, available at http://www.fas.org/nuke/guide/iran/missile/overview.html, March 5, 2007.
[8] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 21-22.
[9] Kenneth Katzman, Congressional Research Service.
[10] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 7.
[11] Alon Ben-David, "Iran pushes space launch limits with research rocket test." Jane's Defence Weekly. March 7, 2007.
[12] Ibid. "Iran appears to be well on the way to developing orbital launch capabilities, although they have not yet achieved them," Uzi Rubin, former director of Israel's Missile Defence Organisation, told *Jane's*. "Once they achieve satellite launch capabilities, it would signal their ability to produce an intercontinental ballistic missile, which could reach Europe and beyond."

Also, it is not unlikely that Iran is going to master cruise-missile technology in the near future. As one Israeli analyst concludes, "Iran's missile program is not a paper tiger."[13]

[13] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006.

## Figure 2.1: Estimated Iranian Missile Profiles, 2008

| Designation | Stages | Progenitor Missiles | Propellant | Range (Kilometers) | Payload (Kilograms) | IOC (Year) | Inventory |
|---|---|---|---|---|---|---|---|
| **Fateh A-110 (NP-110)** | 1 | Zelzal-2 variant, DF-11, CSS-8 | solid | 210 | 500 | 2003 | ? |
| **Tondar 69** | 1 | CSS-8 | solid | 150 | 150-200 | ? | 200 |
| **M-9 variant** | 1 | CSS-6, DF-15 | solid | 800 | 320 | ? | ? |
| **M-11 variant** | 1 | CSS-7, DF-11 | solid | 400 | ? | ? | 80 |
| **Mushak-120** | 1 | CSS-8, SA-2 | solid | 130 | 500 | 2001 | 200 |
| **Mushak-160 (Fateh 110)** | 1 | CSS-8, SA-2 | solid, liquid | 160 | 500 | 2002 | ? |
| **Mushak-200 (Zelzal-2)** | 1 | SA-2 | solid, liquid | 200 | 500 | NA | ? |
| **Saegheh** | 1? | ? | solid | 75-225 | ? | ? | ? |
| **Shahab-1** | 1 | Soviet SSN-4, N Korean SCUD B | liquid | 285-330 | 987–1,000 | 1995 | 250–300 |
| **Shahab-2** | 1 | Soviet SSN-4, N Korean SCUD C | liquid | 500-700 | 750–989 | ? | 50–450 |
| **Shahab-3** | 1 | N Korea Nodong-1 | liquid | 1,280-1600 | 760–1,158 | 2002 | 25–100 |
| **Shahab-4** | 2 | N Korea Taep'o-dong-1 | liquid | 2,000-3,000 | 1,040–1,500 | N/A | 0 |
| **Ghadr 101** | multi | Pakistan Shaheen-1 | solid | 2,500 | N/A | N/A | 0 |
| **Ghadr 110** | multi | Pakistan Shaheen-2 | solid | 3,000 | N/A | N/A | 0 |
| **IRIS** | 1 | China M-18 | solid | 3,000 | 760–1,158 | 2005 | N/A |
| **Kh-55** | 1 | Soviet AS-15 Kent, Ukraine | jet engine | 2,900–3,000 | 200 kgt nuclear | 2001 | 12 |
| **Shahab-5** | 3 | N Korea Taep'o-dong-2 | liquid | 4,000-5,500 | 390–1,000 | N/A | 0 |
| **Shahab-6** | 3 | N Korea Taep'o-dong-2 | liquid | 6,000-10,000 | 270–1,220 | N/A | 0 |

Source: Adapted from GlobalSecurity.org, available at http://www.globalsecurity.org/wmd/world/iran/missile.htm; the Federation of American Scientists, available at http://www.fas.org/nuke/guide/iran/missile; The Claremont Institute: Ballistic Missiles of the World, http://www.missilethreat.com/missiles/index.html. N/A = not available.

## Figure 2.2: Iranian and North Korean Missiles

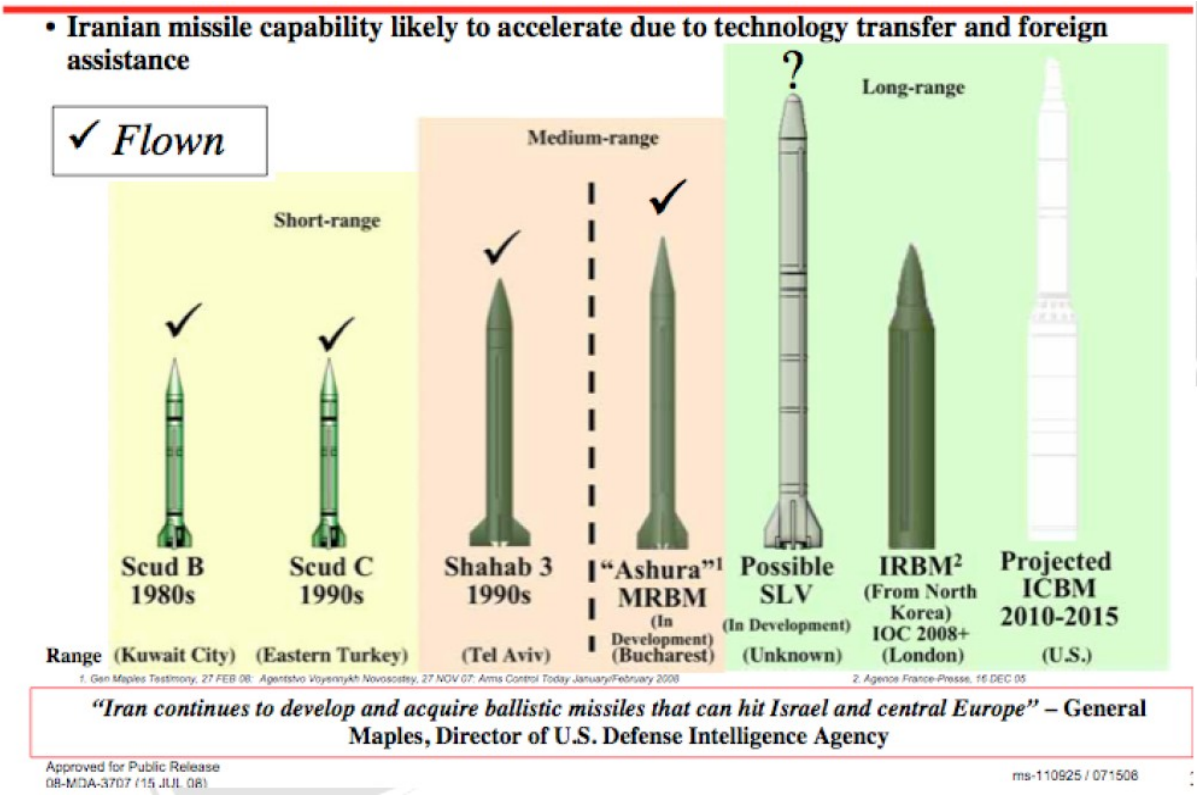
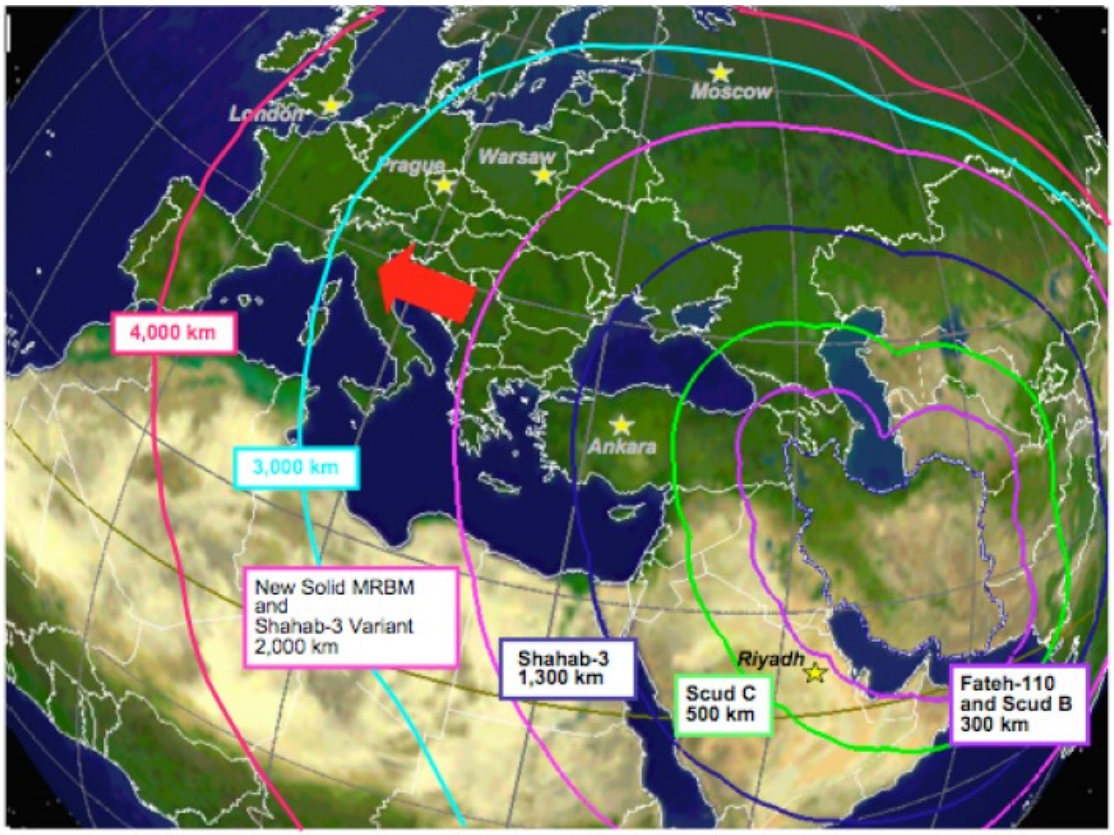


**Figure 2.3: Estimated Iranian Missile Ranges**




*Source: NASIC, B&CM Threat 2006, Jacoby Testimony March 2005*

# Iranian Shahab Missile Programs

## Shahab-1/SCUD-B

The Soviet-designed SCUD-B (17E) guided missile currently forms the core of Iran's ballistic missile forces. The missile was used heavily in the latter years of the Iran-Iraq War. In 2006, it was estimated that Iran had between 300 and 750 Shahab-1 and Shahab-2 variants of the SCUD-B and SCUD-C missiles in its inventory, although some earlier estimates for the SCUD-B ranged as low as 50.[14] These seem to be deployed in three to four battalions in a Shahab brigade.

Iran acquired its first SCUD missiles in response to Iraq's invasion. It obtained a limited number from Libya and subsequently a larger number from North Korea. Some 20 such missiles and two MAZ-543P transporter-erector-launchers (TELs) were delivered in early 1985.[15]

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[14] "Iran: Missiles" GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile.htm; Federation of American Scientists, *Iran*, available at http://www.fas.org/nuke/guide/iran/missile/overview.html, March 5, 2007.

[15] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.

The Iranians deployed these units with a special Khatam ol-Anbya force attached to the air element of the Pasdaran. Iran fired its first SCUD missiles in March 1985. While experts differ over the exact numbers involved, Iran seems to have fired as many as 14 SCUDs in 1985, 8 in 1986, 18 in 1987, and 77 in 1988. Iran fired 77 SCUD missiles during a 52-day period in 1988, during what came to be known as the "war of the cities." Sixty-one were fired at Baghdad, 9 at Mosul, 5 at Kirkuk, 1 at Tikrit, and 1 at Kuwait. Iran fired as many as five missiles on a single day, and once fired three missiles within 30 minutes. This still, however, worked out to an average of only about one missile a day, and some experts believe that Iran was down to only 10–20 SCUDs when the "War of the Cities" ended.

Iran's missile attacks were initially more effective than Iraq's attacks. This was largely a matter of geography. Many of Iraq's major cities were comparatively close to its border with Iran, but Tehran and most of Iran's major cities that had not already been targets in the war were outside the range of Iraqi SCUD attacks. Iran's missiles, in contrast, could hit key Iraqi cities like Baghdad. This advantage ended when Iraq deployed extended-range SCUD missiles.

The Iranian Shabab-1 version of the SCUD-B is a relatively old Soviet design that first became operational in 1967, designated as the R-17E or R-300E. Its thrust is 13,160 kgf (kilogram-force), its burn time is between 62 and 64 seconds, and it has an *I*sp (specific impulse) of 62-Sl due to vanes steering drag loss of 4–5 seconds. The SCUD-B possesses one thrust chamber and is a one-stage rocket (it does not break into smaller pieces). Its fuel is TM-185, and its oxidizer is the AK-27I.[16]

The Shahab-1 is reported to have a nominal range of 285-330 kilometers with its normal conventional payload. The export version of the missile is about 11 meters long, 85–90 centimeters in diameter, and weighs 6,300 kilograms. It has a nominal circular error probable (CEP) of 1,000 meters. Various reports claim that the Russian versions can be equipped with conventional high explosives, fuel air explosives, runway penetrating submunitions, and chemical and nuclear warheads. Its basic design comes from the old German V-2 rocket design of World War II. It has moveable fins and is guided only during powered flight.

The original SCUD-B was introduced on the JS-3 tracked chassis in 1961 and appeared on the MAZ-543 wheeled chassis in 1965. The SCUD-B missile later appeared on the TEL based on the MAZ-543 (8x8) truck. The introduction of this new cross-country wheeled vehicle gave this missile system greater road mobility and reduced the number of support vehicles required.

The export version of the SCUD-B comes with a conventional high-explosive warhead weighing about 1,000 kilograms, of which 800 kilograms are the high-explosive payload and 200 are the warhead structure and fusing system. It has a single-stage storable liquid rocket engine and is usually deployed on the MAZ-543, an eight-wheel TEL. It has a strap-down inertial guidance, using three gyros to correct its ballistic trajectory, and it uses internal graphite jet vane steering. The warhead hits at a velocity above Mach 1.5.

[16] "SCUD-B/Shahab-1," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-1.htm

The following timeline tracks the history of the Shahab-1 (SCUD-B) after it was first introduced in Iran in 1985:

- **1985:** Iran began acquiring SCUD-B (Shahab-1) missiles from Libya for use in the Iran-Iraq War.[17] About 20 SCUD-Bs were delivered along with two MAZ-543P TELs.[18]
- **1986:** Iran turned to Libya as a supplier of SCUD-Bs.[19] Syria is believed to have supplied Iran with a small number of SCUD-B missiles.[20]
- **1987:** A watershed year. Iran attempted to produce its own SCUD-B missiles, but failed. Over the next five years, it purchased 200–300 SCUD-B missiles plus 6-12 TELs from North Korea.[21]
- **1988:** Iran began producing its own Shahab-1s, though not in large quantities.[22]
- **1988:** The Iranian government is reported to have made its first test launch of a ballistic missile, which was believed to be a 'SCUD-B' variant with a range of 320 km (199 miles) and a payload of 985 kg, developed with the assistance of either North Korea or the People's Republic of China (PRC).[23]
- **1991:** It is estimated that at approximately the time of the Gulf War, Iran stopped producing its own Shahab-1s and began purchasing the more advanced SCUD-Cs (Shahab-2). This is said to be a system with an 800-kilogram warhead and a 500-kilometer range versus comparable profiles of 1,000 kilograms with 300 kilometers range for the Shahab-1.[24]
- **1993:** Iran sent 21 missile specialists, led by Brigadier General Manteghi, to North Korea for training.[25]
- **1998:** The Iranian government publicly test fired a Shabab-1 in the Caspian Sea. This test is very important to the study of Iran's ballistic missile program. The Shahab-1 that was tested in the Caspian, was tested from its' TEL, on board a commercial vessel. This constitutes a different kind of missile threat to the United States and coastal range countries.[26]
- **2001:** Reports dictate nearly 70 missiles of varying class and designation were fired into Iraq from Iran. Iran is reported to have purchased a number of Syrian and 120 North Korean 'SCUD-B' missiles. United States Air Force reports from 1996 indicate that number could be in the 200s. The

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[17] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm

[18] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[19] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm

[20] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[21] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm; Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[22] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm

[23] Missilethreat.com, The Claremont Institute, October 1, 2008, available at http://www.missilethreat.com/missilesoftheworld/id.180/missile_detail.asp

[24] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm

[25] Paul Beaver, "Iran's Shahab-3 IRBM 'Ready for Production'," Jane's Missiles and Rockets, June 1, 1998.

[26] Kenneth R. Timmerman, "Countdown to Crisis," *Crown Publishing Group,* 2005, 315-318.

same report implicates North Korea in the sale of approximately 170 SCUD-Cs to Iran. The precise number of these missiles, however, is quite uncertain.[27]

- **October 2007:** *Jane's* indicates development of the Shahab-3 program has obviated the need for Iran to acquire additional Shabab-1 and 2s.

Some sources estimate Iran bought 200–300 SCUD-Bs (Shahab-1s) and SCUD-Cs (Shahab-2s), or the suitable components for Iranian reverse-engineered systems, from North Korea between 1987 and 1992 and may have continued to buy such missiles after that time.[28]

Israeli sources have estimated that Iran had at least 250–300 Shahab-1 missiles and at least 8–15 launchers on hand in 1997. Some current estimates indicate that Iran now has 6–12 launchers and up to 200 SCUD-B (R-17E)/Shabab-1 missiles with a 230–310-kilometer range. Some estimates give higher figures. The International Institute for Strategic Studies (IISS) estimates in 2008 that Tehran had up to 18 launchers and 300 Shabab-1 and Shahab missiles.[29] It is, however, uncertain how many of those are Shabab-1s and how many are Shahab-2s.

The IISS estimates that Iran's IRGC has at least one brigade of Shabab-1 missiles with 12-18 missile launchers, ands that the Iranian army has a matching capability with the same number of launchers. Other estimates put the total as high as three brigades with higher numbers of launchers and missiles.

U.S. experts also believe that Iran can now manufacture virtually all of the Shabab-1, with the possible exception of the most sophisticated components of its guidance system and rocket motors. Some estimates have put production rates as high as 10-12 missiles per month, although experts feel the actual numbers may be an order of magnitude lower., and considerable confusion exists in unclassified estimates as to whether the production estimates being reported apply to the SCUD-B, SCUD-C, or a mixture of both. This makes it difficult to estimate how many missiles Iran has in its inventory and how many it can acquire over time, as well as to estimate the precise performance characteristics of Iran's missiles, since it can alter the weight of the warhead and adjust the burn time and improve the efficiency of the rocket motors.

Several factors contribute to the uncertainty of Iran's arsenal. Iran tends to be extremely secretive and often redesignates systems without warning or notification. Also, Iran has several production facilities which build their own variants of the original systems purchased from North Korea or China. Therefore, the exact numbers of domestically produced, and foreign bought missile systems is unclear.

It seems likely that Iran made at least one experimental ship-based launch of the Shabab-1/SCUD-B. There are reports that the Shahab weapon system was publicly tested in 1998 in the Caspian Sea. This test is very important to the study of Iran's ballistic missile program. The Shahab-1 that was tested in the Caspian was tested from its TEL, on board a commercial vessel. This constitutes a different kind of missile threat to the United States and coastal range countries. The SCUD then has the possibility of being covertly

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[27] Bill Gertz, "Iran's Regional Powerhouse," *Air Force Magazine Online,* June 1996, available at http://www.afa.org/magazine/June1996/0696iran.asp

[28] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.

[29] (2008) 'Country comparisons – commitments, force levels and economics', The Military Balance, 108:1, 419-450.

brought adjacent to a coastline and launched without notice. Then, as quickly as the weapon fired, it could return to covert status. This method of delivery brings the weapon in closer range, which improves its accuracy, and decreases its chance of being spotted by radar. Due to the flight time of the missile, it could be delivered without major radar signal.[30] This seems to have been to examine options for extending the attack range of the missile into Iraq, but it does at least raise the possibility of covert ship-based missile launches against Israel or even the US.

## Shahab-2/SCUD-C

Iran served as a transshipment point for North Korean missile deliveries during 1992 and 1993. Part of this transshipment took place using the same Iranian B-747s that brought missile parts to Iran. Others moved by sea. For example, a North Korean vessel called the *Des Hung Ho,* bringing missile parts for Syria, docked at Bandar Abbas in May 1992. Iran then flew these parts to Syria. An Iranian ship coming from North Korea and a second North Korean ship followed, carrying missiles and machine tools for both Syria and Iran. At least 20 of the North Korean missiles have gone to Syria from Iran, and production equipment seems to have been transferred to Iran and to Syrian plants near Hama and Aleppo.

The SCUD-C is the NATO terminology for improved versions of the SCUD-B, but is often used to describe systems variants developed in North Korea and modified in countries like Iraq and Iran. All are reported to have significantly better range and payload than the SCUD-B.

North Korea seems to have completed development of the Iranian version of the missile in 1987, after obtaining technical support from China. While it is often called a "SCUD-C," it seems to differ substantially in detail from the original Soviet SCUD-B. It seems to be based more on the Chinese-made DF-61 than on a direct copy of the Soviet weapon,.

Experts estimate that the North Korean version of the missile have a range of around 310 miles (500 kilometers), a conventional warhead with a high-explosive payload of 700 kilograms, and relatively good accuracy and reliability. While some experts feel the payload of its conventional warhead may be limited for the effective delivery of chemical agents, Iran might modify the warhead to increase payload at the expense of range and restrict the using of chemical munitions to the most lethal agents such as persistent nerve gas. It is also possible that North Korea may have armed its SCUD-C forces with biological agents and have done development work on a nuclear warhead.

Iran seems to have acquired its first versions of the missile by 1990, Iran formally denied the fact it had such systems long after the transfer of these missiles became a fact. Hassan Taherian, an Iranian foreign ministry official, stated in February 1995 "There is no missile cooperation between Iran and North Korea whatsoever. We deny this."[31]

There were, however, many reports during the 1990s about North Korean missile technology transfers to Tehran. For example, a senior North Korean delegation traveled to Tehran to close the deal on November 29, 1990, and met with Mohsen Rezaei, the former Commander of the IRGC. Iran either bought the missile then or placed its order

[30] Kenneth R. Timmerman, "Countdown to Crisis," *Crown Publishing Group,* 2005, 315-318.
[31] "Flashpoints: Iran," Jane's Defense Weekly, March 4, 1995, p. 18.

shortly thereafter. North Korea then exported the missile through its Lyongaksan Import Corporation. Iran imported some of these North Korean missile assemblies using its B-747s and seems to have used ships to import others.

There are reports it fired them in the early 1990s from mobile launchers at a test site near Qom to a target area about 310 miles (500 kilometers) away south of Shahroud. There are also reports that units equipped with such missiles deployed as part of Iranian exercises like the Saeqer-3 (Thunderbolt 3) exercise in late October 1993.[32]

Iran probably had more than 60 of the longer-range North Korean missiles by 1998, although other sources report 100, and one source reports 170. Iran may have five to ten SCUD-C launchers, each with several missiles. This total seems likely to include four North Korean TELs received in 1994[33]

A number of reports indicate that Iran may have modified some aspects of the system, or provide contradictory specifications. As a result, many of the details of performance what is now normally referred to as the Shabab-2 are unclear. Various reports indicate, however, that it has a diameter of 0.885 meters, a height of 11–12 meters, a launch weight of 6,370–6,500 kilograms, an unknown stage mass, an unknown dry mass, and an unknown propellant mass. In terms of propelling ability, its thrust is unknown, its burn time is unknown, and it has an effective *I*sp of 231. It is reported to have one thrust chamber and is a one-stage rocket (it does not break into smaller pieces). Its fuel is Tonka-250, and its oxidizer is the AK 20P.[34]

These reports indicate that it has an approximate range between 500 and 700 miles, or 804 to 1127 kilometers, a CEP of 50 meters, and it carries a 750-989 kilogram warhead. Even the most conservative estimates of the missile's range indicate that it has enough range-payload to give Iran the ability to strike all targets on the southern coast of the Gulf and all of the populated areas in Iraq, although not the West. Iran could also reach targets in part of eastern Syria, the eastern third of Turkey, and cover targets in the border area of the former Soviet Union, western Afghanistan, and western Pakistan.

Accuracy and reliability still present important operational uncertainties, as does the missile's operational CEP. Much would depend on the precise level of technology Iran deployed in the warhead. Neither Russia nor the People's Republic of China seems to have transferred the warhead technology for biological and chemical weapons to Iran or Iraq when they sold them the SCUD-B missile and CSS-8. However, North Korea may have sold Iran such technology as part of the SCUD-C sale. If it did so, such a technology transfer would save Iran years of development and testing in obtaining highly lethal biological and chemical warheads. In fact, Iran would probably be able to deploy far more effective biological and chemical warheads than Iraq had at the time of the Gulf War.

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[32] Anthony H. Cordesman, *Iran and Nuclear Weapons* (Washington, DC: Center for Strategic and International Studies, 7 February 2000), p. 36.

[33] CIA reports that North Korea has transferred at least four SCUD TELs to Iran. The TELs were transferred in late-1994 and can launch SCUD-B and -C missiles.Tony Capaccio, *Defense Week*, 1 May 1995, pp.1, 14.

[34] "Shahab-2," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-2.htm

It is currently estimated that Iran has 50–150 Shabab-2s/SCUD-Cs in its inventory.[35] While early development of the SCUD-C tracks closely with that of the SCUD-B, the following timeline tracks the development of Iranian Shabab-2s/SCUD-C missiles since the Gulf War:

- **1991**: Iran apparently received its first shipment of about 100-170 North Korean SCUD-C missiles.
- **1994:** By this year, Iran had purchased 150–200 SCUD-Cs from North Korea.[36]
- **1997:** Iran began production of its own SCUD-C missiles. This is generally considered a technological leap for Iran, and it is believed that a large portion of its production capability and technology came from North Korea.[37]
- **2004-2006:** According to Iranian sources, Iran fired Shabab-2 missiles in most of its major military exercises. In 2004, the Shabab-2 became an active participant in all military drills and exercises, being consistently tested and with successful results. An additional public test was in April 2006 beginning a regional war game.[38]
- **November 2006**: Iran was reported to have successfully fired Shahab-2 and Shahab-3 missiles in military exercises.[39]
- **Undated and unconfirmed**: According to one report, Iran set up a production line for Shahab-2 missiles in Syria.[40]
- **October 2007:** *Jane's* indicates development of the Shahab-3 program has obviated the need for Iran to acquire additional Shabab-1 and 2s.

Most experts do agree that Iran can now assemble Shabab-2s missiles using foreign-made components. There is less agreement as to whether it can now make every component of the entire Shabab-2 missile system and warhead package in Iran, but this seems increasingly likely. Iran also is continuing to modify and improve some components of the missile. It may be working with Syria in such development efforts, as well as North Korea, although some experts note that Middle Eastern nations have problems in cooperating in such sensitive areas.[41]

Iran has now deployed enough Shabab-2 missiles and launchers to make its missile force highly dispersed and difficult to attack. According to some reports, Iran has also created shelters and tunnels in its coastal areas that it could use to store these and other missiles in hardened sites to reduce their vulnerability to air attack. These reports give Iran potential mix of launch on warning and launch under attack capabilities and the ability to

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[35] "Iran: Missiles" GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile.htm

[36] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm.

[37] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm.

[38] Missilethreat.com, The Claremont Institute, October 1, 2008, available at http://www.missilethreat.com/missilesoftheworld/id.180/missile_detail.asp

[39] BBC Monitoring Middle East, Iran's Guard commander comments on Tehran's missile power, November 13, 2006; Ed Blanche, "Iran stages display of missile firepower", Jane's Missiles and Rockets, January 1, 2007.

[40] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 37.

41 Allegations of such cooperation echoes in recent reports emerging out of Israel claiming that Syria was planning to supply Iran with spent nuclear fuel for reprocessing into weapons-grade plutonium. Ian Black, "Syria planned to supply Iran with nuclear fuel, Israel says." Guardian. June 25, 2008. http://www.guardian.co.uk/world/2008/jun/25/syria.iran

ride out preventive or preemptive attacks. There is no hard reporting, however, to confirm that Iran has put such plans into action.

## Shahab-3

Iran appears to have begun to shift from a reliance on missile imports to a technological partnership with North Korea in creating new missiles and missile production capabilities in the early 1990s.. The visit to North Korea in 1993 by General Manteghi and his 21 specialists seems a possible date when Iran shifted from procurement to development.

One key reason for this shift was to ensure that Iran could not be sanctioned or interdicted by US and other international action or military embargos. Iran may also, however, have seen acquiring longer-range and more capable missiles as a key to being able to use relatively heavy nuclear weapons, and to threatening targets outside the region in Israel and Europe that could help intimidate or deter US military action. A Figure 2.2 shows, even the SCUD-C did not guarantee that Iran could attack all of Israel or key regional allies of the US like Egypt and Turkey with large payloads.

.As a result, the Iranians seem to have begun using some of the designs for the North Korean No Dong medium-range ballistic missile in an attempt to manufacture their own version of the missile, the Shahab-3. Between 1997 and 1998, Iran began testing the Shahab-3. While Iran claimed Shahab-3's purpose was to carry payloads of submunitions, it is more likely that Iran would use the Shahab-3's superior range to carry a chemical, nuclear, or biological weapon.

### *Missile Development*

Iran's new Shahab-3 series is a larger missile that seems to be based on the design of the North Korean No Dong 1/A and No Dong B missiles -- which some analysts claim were developed with Iranian financial support. The initial versions of the Shabab-3 also had strong similarities to Pakistan's Ghauri I missile, which may also have benefited from transfers of North Korean technology and possibly Chinese technology as well. It has become extremely difficult to track the level of official, quasi-official, and private transfers of technology and components, and well as to distinguish rumor from fact.

While the Shabab-3 is based on North Korean designs and technology, it is being developed and produced in Iran and has steadily evolved over time. This development effort is controlled and operated by the IRGC. Iranian officials, however, claimed that the production of the Shahab-3 missiles was entirely domestic. Former Iranian Defense Minister Ali Shamkhani argued in May 2005 that the production was comprised of locally made parts and that the production was continuing.[42]

As the following timeline shows, the Shahab-3 is a constantly evolving system, and has been tested in a number of variants:

- **October 1997:** Russia began training Iranian engineers on missile production for the Shahab-3.[43]

[42] "Iran Says Shahab-3 Missile Entirely Iranian, Production Ongoing," Agence France Presse, May 5, 2005.
[43] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm

- **1998:** Iran began testing its own Shahab-3s. Problems with finding or making an advanced guidance system hindered many of Iran's tests, however. Meanwhile, Iran begins experimenting with the Shahab-4.[44]

- **July 23, 1998:** Iran launched its first test flight of the Shahab-3. The missile flew for approximately 100 seconds, after which time it was detonated. It is not known whether the missile malfunctioned or if this was an apogee test because the Iranians did not want to risk discovery.[45]

- **July 15, 2000**: Iran had its first successful test of a Shahab-3, using a new North Korean engine.[46]

- **Summer 2001:** Iran claimed to have begun production of the Shahab-3.[47]

- **July 7, 2003:** Iran completed the final test of the Shahab-3. Allegations emerged that Chinese companies like Tai'an Foreign Trade General Corporation and China North Industries Corporation had been aiding the Iranians in overcoming the missile's final technical glitches.[48] The missile was seen in Iranian military parades and displayed openly. Iran announced at the same time an increase in the production rate of the Shahab-3 to several a month and introduction into service.[49]

- **September 22, 2003:** The Shahab-3 was displayed on mobile launchers at a military parade. Reportedly, the parade announcer said that the shown missile had a range of 1,000 miles.[50]

- **October 2003:** Iran claimed it was abandoning its Shahab-4 program, citing that the expected increase in range (2,200 to 3,000 kilometers) would cause too much global tension.

- **Late 2003:** Some sources indicated that Iran had begun only limited production of the Shahab-3.

- **August 11, 2004:** Iran decreased the size of the Shahab-3 warhead with a significantly modified reentry vehicle and propulsion system, making a move toward being able to mount a nuclear warhead to a Shahab-3. At this point, the modified Shahab-3 is often referred to as the Shahab-3M.[51] The missile had a new, smaller, and "bottleneck" warhead. This kind of warhead has a slower reentry than a cone-shaped warhead and has advantages using warheads containing chemical and biological agents. Some estimated that it had a range of 2,000 kilometers for a 700-kilogram warhead, but this may be confusion with another solid-fueled system. A second variant may exist with a larger fin, a meter less length, and less than a 1,500-kilometer range.[52]

- **September 19, 2004**: Another test took place, and the missile was paraded on September 21 covered in banners saying "we will crush America under our feet" and "wipe Israel off the map."[53]

- **May 31, 2005:** Iranian Defense Minister Ali Shamkhani claimed that Iran successfully tested a new missile motor using solid-fuel technology with a range of 1,500-2,000 kilometers, and a 700-kilogram warhead. Shamkhani was quoted as saying, "Using solid fuel would be more durable and increase the range of the missile."[54] It remains uncertain if this referred to the Shahab-3 or the modified Shahab-3, the IRIS missile.

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[44] Kenneth Katzman, Commission to Assess the Ballistic Missile Threat to the United States, 1998, available at: http://www.globalsecurity.org/wmd/library/report/1998/rumsfeld/pt2_katz.htm
[45] "Iran Tests Shahab-3 Ballistic Missile," Jane's Missiles and Rockets, August 1, 1998.
[46] "Shabab-3/Zelzal 3," Global Security.org, available at: www.globalsecurity.org/wmd/world/iran/shahab-3.htm
[47] David Isby, "Shahab-3 Enters Production," Jane's Missiles and Rockets, November 26, 2001.
[48] Ed Blanche, "Shahab-3 Ready for Service, Says Iran," Jane's Missiles and Rockets, July 23, 2003.
[49] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 24.
[50] Federation of American Scientists, *Iran*, available at http://www.fas.org/nuke/guide/iran/missile/overview.html, March 5, 2007.
[51] "Shahab-3/Zelzal 3," GlobalSecurity.org, available at: www.globalsecurity.org/wmd/world/iran/shahab-3.htm
[52] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.
[53] Farhad Pouladi, "Iran Vows to Continue Nuclear Drive At all Costs," Agence France Presse, September 22, 2004.
[54] "Iran 'Tests new Missile Engine,'" BBC News, May 31, 2005, available at: http://news.bbc.co.uk/2/hi/middle_east/4596295.stm

- **September 2005:** Two new missiles were tested, again with a triconic or baby-bottle warhead some 3 meters long. Some experts speculate that it can disperse chemical and biological weapons or is better suited to a nuclear warhead. Others feel it is an airburst warhead, capable of better dispersing chemical and/or biological weapons Two Shahab-3 missiles with triconic warheads were displayed at a parade. These missiles were believed to be new variants of the Shahab-3.
- **February 16, 2006:** Iran is believed to have successfully completed four successful missile test launches this year, including one of a Shahab-3 and a Shahab-4 missile with ranges of 1,300 kilometers and 2,200 kilometers, respectively.
- **April 7, 2006:** The *London Telegraph* reports that Iran has succeeded in adapting the nosecone of the Shahab-3 missile to deliver a nuclear weapon. Allegedly, a modified Shahab-3 could carry the Pakistani version of a nuclear warhead, and it is rumored that Iran possesses this design.
- **November 23, 2006:** It was reported that Iran for the first time fired Shahab-3 missiles in an exercise in early November. Allegedly, a Shahab-3 version with a range of 1,900 kilometers (with cluster bombs) was fired.
- **September 2006**: Iran was reported to have more than 30 Shahab-3s and 10 TELs, but this is not confirmed.[55]
- **November 2006**: Iran was reported to have successfully fired Shahab-2 and Shahab-3 missiles in military exercises. The Shahab-3 version, according to Iranian sources, carried cluster warheads, had a strike range of about 1,900 kilometers, and landed "a few meters away" from its intended target.[56]
- **August 2007:** Reports that Iran has developed a remote controlled launch system that can be used to operate dozens of unmanned Shahab-3 ballistic missile launchers in underground bunkers.[57]
- **October 2007:** *Jane's* indicates development of the Shahab-3 program has obviated the need for Iran to acquire additional Shabab-1 and 2s.
- **July 8-10, 2008**: Iran reports a series of missile tests at the Holy Prophet III exercises, including a Shahab-3 with a conventional warhead weighing one ton and a 2,000-kilometer range. Iranian media depicted what appeared to be two Shahabs lifting off within seconds of one another.[58] Iranian Revolutionary Guards Commander Hossein Salami tells an Iranian reporter that the Shahab-3 had undergone further improvements, including to its navigation and ignition systems, and featured enhanced maneuverability and reaction time. Iranian media claims that the Shahab-3 can now be launched "at night and in adverse weather conditions."[59]

The Iranian test and development program has so far been uncertain, although many of the problems may have been driven by changes in performance requirements and specifications rather than problems in technology, systems integration, and manufacturing. Iran has also had the option of relying on the Shahab-2/SCUD C to threaten or intimidate its neighbors, deploy the Shabab-3 in initial test beds, and defer full-scale deployment until it comes closer to having nuclear or other advanced warheads.

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[55] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.
[56] BBC Monitoring Middle East, Iran's Guard commander comments on Tehran's missile power, November 13, 2006; Ed Blanche, "Iran stages display of missile firepower", Jane's Missiles and Rockets, January 1, 2007.
[57] "Iran develops remote-controlled launch system for Shahab-3 missiles," *Jerusalem Post*, August 22, 2007, available at http://www.nti.org/e_research/profiles/Iran/Missile/1788_6350.html
[58] Cowell, Alan, "Iran reports missile test, drawing rebuke," International Herald Tribune, July 9, 2008.
[59] "Report: Iran Sends Missile Test Warning," BBC News, 10 July 2008; Alex Vatanka, "Iran Launches Dual-Purpose Missiles," Jane's Intelligence Review, 18 July 2008; Lauren Gelfand, "Tensions Rise in the Wake of Iranian Missile Tests," Jane's Defense Weekly, 11 July 2008.

As of early 2006, Iran had conducted some ten launches at a rate of only one to two per year. Roughly 30 percent had fully malfunctioned, and six launches had had some malfunction. Many were also high apogee tests where the missile was destroyed in mid flight to keep the missile within Iranian territory.

This has led some analyst to speculate that Iran might be developing a capability to use the Shabab-3 as a launch vehicle for a nuclear EMP weapon, and that it might develop a covert ship-based launch capability to attack the US. In reports to the House and the Senate, analysts have voiced their concern over the possibility of these types of attacks by Iran:

> Testifying before the US Senate Committee on the Judiciary's Subcommittee on Terrorism, Technology and Homeland Security on 8 March 2005, Peter Pry, a senior staff member of the Congressional EMP Commission, said that these flights were reported to have been terminated by a self-destruct mechanism on the missile. "The Western press has described these flight tests as failures because the missiles did not complete their ballistic trajectories," he told the subcommittee. "Iran has officially described all of these same tests as successful. The flight tests would be successful if Iran were practicing the execution of an EMP attack."
>
> As evidence of Iranian interest in EMP weapons, he quoted an article from an unidentified Iranian political military journal as saying: "Once you confuse the enemy communication network you can also disrupt the work of the enemy command and decision-making centre... when you disable a country's military high command through disruption of communications, you will, in effect, disrupt all the affairs of that country. If the world's industrial countries fail to devise effective ways to defend themselves against dangerous electronic assaults then they will disintegrate within a few years."[60]
>
> In testimony before the House Armed Services Committee and in remarks to a private conference on missile defense, Dr. William Graham warned that the U.S. intelligence community “doesn’t have a story” to explain the recent Iranian tests. One group of tests that troubled Graham, the former White House science adviser under President Ronald Reagan, were successful efforts to launch a SCUD missile from a platform in the Caspian Sea. “They’ve got [test] ranges in Iran which are more than long enough to handle SCUD launches and even Shahab-3 launches,” Dr. Graham said. “Why would they be launching from the surface of the Caspian Sea? They obviously have not explained that to us.”
>
> Another troubling group of tests involved Shahab-3 launches where the Iranians "detonated the warhead near apogee, not over the target area where the thing would eventually land, but at altitude,” Graham said. “Why would they do that?” Graham chairs the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, a blue-ribbon panel established by Congress in 2001.
>
> “The only plausible explanation we can find is that the Iranians are figuring out how to launch a missile from a ship and get it up to altitude and then detonate it,” he said. “And that’s exactly what you would do if you had a nuclear weapon on a SCUD or a Shahab-3 or other missile, and you wanted to explode it over the United States.”[61]

Still, other observers caution that these and similar actions might simply be a scare tactic used by Iran, but without much substance.[62] Although an asymmetric EMP attack is a

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[60] "Shahab Break-ups Suggest Possible EMP Trial," *Jane's Missiles and Rockets*, 1 May 2005

[61] Dr. William R. Graham Chairman Commission to Assess the Threat to the United States From Electromagnetic Pulse (EMP) Attack, Statement Before the House Armed Services Committee, July 10, 2008 available at: www.empcommission.org/docs/GRAHAMtestimony10JULY2008.pdf

[62] Officials in Iran have also reported that in March 2006, they successfully tested their “Fajr-3” long-range missile, which they claim has a range of 2000 miles, and which is invisible to radar. However, other intelligence sources

technically feasible launch option, high apogee tests have many other explanations and reporting on the projected lethality of EMP weapons often does not consider the difference between the comparatively low yield of any initial Iranian fission weapon and the impact of US and Soviet tests in space with thermonuclear weapons. Such a threat cannot be ignored, but it also should not be exaggerated. Iran continues to use deception and misinformation as asymmetrical weapons in its war with the western world, and this could very well be an example of that.

Iran is known to have tested at least two major payload configurations.[63] One report states that the latest TELs used for launching a Shabab-3 need one hour to arrive at the launch site, set up the TEL, and fire the missile.[64] In November 2006, Iran conducted another military exercise, termed "Great Prophet II". During the ten-day war games, the IRGC deployed ten infantry divisions, including several mechanized and armored brigades, and launched 15 missiles including Shabab-2 and Shabab-3 ballistic missiles. Reports allege that some of the Shahab-3 missiles were equipped with cluster warheads.[65]

The IRGC conducted another military exercise, the "Great Prophet III", on July 9, 2008. During the exercise, nine medium and short-range missiles were fired from the Iranian desert, including an upgraded Shahab-3, the 150km range Fateh, and the 400km Zelzal.[66] A still picture showing four missiles taking off in the desert was used by the international media. However, closer examination revealed that the image had been doctored. The original image from the Iranian news website Jamejam clearly showed that one missile had not taken off, but another image altered by the PR arm of the IRGC and widely circulated, showed otherwise.[67] While the latest tests do not reveal any new capability beyond what has already been seen, they do signal Iran's continuing determination to advance and demonstrate its missile capability.

While it is impossible to draw a precise inference on the number of missiles in stock, it can be assumed that Iran is capable of producing Shahab-3s in large quantities.[68]

## *Uncertain Performance*[69]

Discussions of the Shahab-3's range-payload, accuracy, and reliability are uncertain and will remain speculative until the system is far more mature. A long-range ballistic missile

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reportedly argue that the "Fajr-3" is merely an upgraded artillery shell with a very short range. *"Iran Claims Test of Fajr-3 Missile 'Invisible' to Radar, Interceptors"*, April 3, 2006, MissileThreat.com, [http://www.missilethreat.com/news/200604030826.html].

[63] Dr, Robert H. Schmucker, "Iran and Its Regional Environment," Schmucker Technologies, Pease Research Institute Frankfurt, March 27, 2006, www.hsfk.de and http://www.hsfk.de/static.php?id=3929&language=de.

[64] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[65] "Iran's 'Great Prophet' military drill," *Jane's Intelligence Digest*, November 17, 2006.

[66] Joshua Mitnick and Bill Gertz, "Tehran's missile tests fail to impress U.S., Israel, Revolutionary Guard Corps flexes muscles," *The Washington Times*, July 10, 2008.

[67] Cris Smyth, "Times - Picture: Iran 'fakes' missile launch after misfire," *International Institute for Strategic Studies*, 10 July 2008.

[68] Ed Blanche and Doug Richardson: "Iran gives details of latest Shabab-3 missile", Jane's Missiles and Rockets, February 1, 2007.

[69] For further details on the history and nature of the Shahab and Iran's programs, see Andrew Feickert, Missile Survey,: Ballistic and Cruise Missiles of Selected Foreign Countries, Congressional Research Service, RL30427, (regularly updated); the work of Kenneth Katzman, also of the Congressional Research Service; the "Missile Overview" section of the Iran Profile of the NTI (http://www.nti.org/e_research/profiles/Iran/Missiles/; and the work of Global Security, including http://www.globalsecurity.org/wmd/world/iran/shahab-3.htm.

requires at least 10–30 tests in its final configuration to establish its true payload and warhead type, actual range-payload, and accuracy – and some experts put the number much higher for a nation that does not have a long history of advanced missile production and development.

While there are many highly detailed unclassified estimates of the Shahab-3's performance available, they at best are rough engineering estimates and are sometimes speculative to the point of being sheer guesswork using rounded numbers. Its real-world range will depend on both the final configuration of the missile and the weight of its warhead.

Various sources now guess that the Shahab-3 has range between 1,280 and 2,000 kilometers, but the longer-range estimate seems to be based on Iranian claims and assumptions about an improved version, not full-scale operational tests.[70] U.S. experts believe that the original Shahab-3 missile had a nominal range of 1,100 to 1,300 kilometers, with a 1,200 kilogram payload. The basic system is said to have been 16.5 meters long, have a diameter of 1.58 meters, with a launch weight of 17,410 pounds. Iran has claimed that the Shahab-3 has a range of 2,000 kilometers. This may reflect different estimates of different versions of the missile.

In June 2003, Iran conducted a test fight of the Shahab-3. Details concerning the test are lacking; however, Israeli sources suggest that this launch was the most successful to date. A foreign ministry spokesman stated that, "it was a final test before delivering the missile to the armed forces. It was within the same range that we had declared before."[71] This report suggests that Iran's Shabab-3 missile program is improving to the point of being deployed to Iranian military units.

Nasser Maleki, the head of Iran's aerospace industry, stated on October 7, 2004, "Very certainly we are going to improve our Shahab-3 and all of our other missiles." Tehran claimed in September 2004 that the Shahab-3 could now reach targets up to 2,000 kilometers away, presumably allowing the missiles to be deployed a greater distance away from Israel's Air Force and Jericho-2 ballistic missiles.[72]

IRGC Political-Bureau Chief Yadollah Javani stated in September 2004 that the modified Shahab-3 -- sometimes called the Shahab-3A or Shahab-3M -- could be used to attack Israel's Dimona nuclear reactor.[73] Iran performed another test on October 20, 2004, and Iran's Defense Minister, Ali Shamkani, claimed it was part of an operational exercise. On November 9, 2004, Iran's Defense Minister also claimed that Iran was now capable of mass producing the Shahab-3 and that Iran reserved the option of preemptive strikes in defense of its nuclear sites. Shamkani claimed shortly afterward that the Shahab-3 now had a range of more than 2,000 kilometers (1,250 miles).[74]

One leading German expert has stressed the uncertainty of any current estimates and notes that range-payload trade-offs would be critical. He puts the range for the regular Shahab-3 at 820 kilometers with a 1.3-ton payload and 1,100 kilometers with a 0.7-ton

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[70] Ed Blanche, "Iran claims Shahab-3 Range Now 2,000km," Jane's Missiles and Rockets, November 1, 2004.
[71] "Iran Confirms Test of Missile That Is Able to Hit Israel," *New York Times*, 8 July 2003
[72] "Iran Boasts Shahab-3 is in Mass Production," Jane's Missiles and Rockets, November 19, 2004.
[73] "Iran threatens to Abandon the NPT," Jane's Islamic Affairs Analyst, September 29, 2004
[74] Douglas Jehl, "Iran Reportedly Hides Work on a Long-Range Missile," The New York Times, December 2, 2004.

payload. (An analysis by John Pike of GlobalSecurity.org also points out that missiles -- like combat aircraft -- can make trade-offs between range and payload. For example, the No Dong B has a range of 1,560 kilometers with a 760-kilogram warhead and 1,350 kilometers with a 1,158-kilogram warhead.[75])

The German analyst notes that an improved Shahab could use a combination of a lighter aluminum airframe, light weight guidance, reduced payload, increased propellant load, and increased burn time to increase range. He notes that little is really known about the improved Shabab-3, but estimates the maximum range of an improved Shahab-3 as still being 2,000 kilometers, that a 0.7–0.8-ton warhead would limit its range to 1,500 kilometers, and that a 0.8-1.0-ton warhead would reduce it to 1,200 kilometers. A 1.2-ton warhead would limit it to around 850 kilometers. He feels Iran may have drawn on Russian technology from the R-21 and the R-27. Photos of the system also show progressive changes in cable duct position, fins, and length in 2004 and 2005.[76]

Some aspects of the differences in range estimates may be a matter of Iranian propaganda, but a number of experts believe that Iranian claims refer to the modified Shahab-3D or the Shahab-3M and not the regular Shahab-3. There are reports that such modified versions use solid fuel and could have a range of up to 2,000 kilometers. They also indicate that the standard Shahab-3 remains in production, but the improved Shahab is now called the Shahab-3M. [77]

There has been some official reporting on the missile warhead. In 2004, then U.S. Secretary of State Colin Powell accused Iran of modifying its Shahab-3 to carry a nuclear warhead based on documents the U.S. government had received from a walk-in source. While experts argued that this information was yet to be confirmed, others claimed that Iran obtained "a new nosecone" for its Shahab-3 missile.[78] In addition, other U.S. officials claimed that the source of the information provided "tens of thousands of pages of Farsi-language computer files" on Iranian attempts to modify their Shahab-3 missile to deliver a "black box," which U.S. officials believed to "almost certainly" refer to a nuclear warhead. These documents were said to include diagrams and test results, weight, detonation height, and shape, but did not include warhead designs.[79]

Media reporting indicates that the United States was able to examine drawings on a stolen laptop from Iran and found that Iran had developed 18 different ways to adapt the size, weight, and diameter of the new nose cone on its Shahab-3 missile. It was also reported, however, that Iran's effort to expand the nose cone would not work and that Iran did not have the technological capabilities to adapt nuclear weapons into its Shahab-3 missile.

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[75] "Iran: Missiles Development," GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile-development.htm.

[76] See the work of Dr. Robert H. Schmucker, "The Shahab Missile and Iran's Delivery System Capabilities," Briefing to the James Shasha Institute conference on a nuclear Iran, May 30-June 2, 2005; and , "Iran and Its Regional Environment," Schmucker Technologies, Pease Research Institute Frankfurt, March 27, 2006, www.hsfk.de and http://www.hsfk.de/static.php?id=3929&language=de.

[77] IISS, Iran's Strategic Weapons Programs: A Net Assessment, IISS Strategic Dossier, 2005, p. 102.

[78] Sonni Efron, Tyler Marshall, and Bob Drogin, "Powell's Talk of Arms Has Fallout," The Lost Angeles Times, November 19, 2004.

[79] Carla Anne Robbins, " Briefing Iranian Missile To Nuclear Agency," The Wall Street Journal, July 27, 2005, p.3.

U.S. nuclear experts claimed that one reason for this failure was that the project "wasn't done by the A-team of Iran's program."[80]

Some experts believe that the new bottleneck warhead tested in 2004 was for the Shahab-3M and makes it more accurate and capable of air-burst detonations, which could be used to more effectively spread chemical weapons. Others believe a smaller warhead has increased its range. According to one source, the baby-bottle shaped missiles, which surfaced in 2004, represent an entirely new missile development if they carry a triconic warhead. Reportedly, the latter warhead does not fit on a Shabab-3 missile. Further, some analysts believe that this warhead would be the prime vehicle for a nuclear weapon.[81] The same source states that the SHIG (a unit known as Department 2500 or Shahid Karimi) started a project (project 111) between 2001 and 2003 to fit a nuclear warhead on a Shabab-3.[82]

Several tests of the Shahab-3 have been launched, only with limited success. Successful tests of the Shabab-3 are confirmed for February 2006. Reports indicate four successful tests at ranges of up to 1300 km. Additional tests of this weapon system are confirmed in November 2006 and are capable of operational testing in military exercises from that point on.[83] It is believed that around 20 missiles were operational in May 2004. By February 2006 it is believed that 30 to 50 were operational.[84]

As for other aspects of performance, it is again easy to find many highly precise estimates, but impossible to know if any are correct – even for the versions of the Shabab-3 that Iran has tested to date. One source, for example, reports that the Shahab-3 has a CEP of 190 meters and carries a 750–989–1,158-kilogram warhead. The problem with all such reporting, however, lies in the definition of CEP: It is a theoretical engineering term that states that 50 percent of all the missiles launched will hit within a circle of the radius of the CEP. It also assumes that all missiles are perfectly targeted and function perfectly throughout their entire flight. It makes no attempt to predict where the 50 percent of the missiles that hit outside the circle will go, or missile reliability. Engineering estimates basing CEP on the theoretical accuracy of the guidance platform have also often proved to be absurdly wrong until they are based on the actual performance of large numbers of firings of mature deployed systems (the derived aim point method). [85]

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[80] Dafna Linzer, "Strong Leads And Dead Ends In Nuclear Case Against Iran," The Washington Post, February 8, 2006, p. A01.

[81] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[82] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[83] Duncan Lennox, ed., *Jane's Strategic Weapons Systems 46* (Surrey: Jane's Information Group, January 2007), 71-73.

[84] Lennox *Jane's Strategic Weapons Systems 42* (Surrey: Jane's Information Group, January 2005), 102-103.

[85] There is a radical difference in the performance of proven systems, where actual field performance can be measured, and estimates based on engineering theory. With proven system, the distribution of the impact of warheads relative to the target tends to be "bivariate normally distributed" relative to the aim point. Most are most reasonably close, and progressively fewer and fewer hit further away, with only a few missing by long distances.

As an entry in Wikepedia notes, "One component of the bivariate normal will represent range errors and the other azimuth errors. Unless the munition is arriving exactly vertically downwards the standard deviation of range errors is usually larger than the standard deviation of azimuth errors, and the resulting confidence region is elliptical. Generally, the munition will not be exactly on target, i.e. the mean vector will not be (0,0). This is referred to as bias. The mean error squared (MSE) will be the sum of the variance of the range error plus the variance of the azimuth error plus the

The same source reports that the Shahab-3 has a height of 16 meters, a stage mass of 15,092 kilograms, a dry mass of 1,780–2,180 kilograms, and a propellant mass of 12,912 kilograms. In terms of propelling ability, its thrust is between 26,760–26,600 kgf, its burn time is 110 seconds, and it has an effective *I*sp of 226 and a drag loss of 45 seconds. According to this source, the Shahab-3 possesses one thrust chamber. Its fuel is TM-185, and its oxidizer is the AK 27I. [86]

Iran may have advanced to the point where relatively high levels of accuracy are possible for this missile, but this remains to be seen. If the system uses older guidance technology and warhead separation methods, its CEP could be anywhere from 1,000 to 4,000 meters (approximately 0.0015 to 0.001 CEP). If it uses newer technology, such as some of the most advanced Chinese technology, it could have a CEP as low as 190–800 meters.

In any case, such CEP data are engineering estimates based on the ratios from a perfectly located target. This means real-world missile accuracy and reliability cannot be measured using technical terms like CEP even if they apply to a fully mature and deployed missile. The definition of the term is based on the assumption that the missile can be perfectly targeted at launch and it performs perfectly through its final guidance phase; CEP can somewhat arbitrarily be defined as the accuracy of 50 percent of the systems launched in terms of distance from a central point on the target. True performance can be derived only from observing reliability under operational conditions and by correlating actual point of impact to a known aim point.[87]

A German expert notes, for example, that the operational CEP of the improved Shahab-3 is likely to be around 3 kilometers, but the maximum deviation could be 11 kilometers.[88] In short, unclassified estimates of the Shahab-3's accuracy and reliability available from public sources are matters of speculation, and no unclassified source has credibility in describing its performance in real-world, warfighting terms. In 2007, Yahya Safavi, the commander of the IRGC, announced on Iranian state television that Iran test-fired its latest version of the Shahab-3. According to the general, the missile used had a CEP of "several meters."[89] The CEP varies with the distance the missile flies, but most experts believe that a CEP of only several meters on a SCUD-based missile is unrealistic.

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covariance of the range error with the azimuth error plus the square of the bias. Thus the MSE results from pooling all these sources of error. The square root of the MSE is the circular error probable, commonly abbreviated to CEP. Geometrically, it corresponds to radius of a circle within which 50 % of rounds will land."
None of this has proven true, however, of estimates made in the design stage or with very limited tests. The actual hit distribution can be much further away from the aim point and most or all missiles can fall outside the theoretical CEP.
It should also be noted that the concept of CEP is only strictly meaningful if misses are roughly normally distributed. This is generally not true for precision-guided munitions. As the Wikepedia entry also states, "Generally, if CEP is n meters, 50 % of rounds land within n meters of the target, 43% between n and 2n, and 7 % between 2n and 3n meters. If misses were exactly normally distributed as in this theory, then the proportion of rounds that land farther than three times the CEP from the target is less than 0.2%. With precision-guided munitions, the number of 'close misses' is higher."

[86] "Shahab-3," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-3.htm

[87] See endnote 315.

[88] See the work of Dr. Robert H. Schmucker, "The Shahab Missile and Iran's Delivery System Capabilities," Briefing to the James Shasha Institute conference on a nuclear Iran, May 30-June 2, 2005, and "Iran and Its Regional Environment," Schmucker Technologies, Pease Research Institute Frankfurt, March 27, 2006, www.hsfk.de and http://www.hsfk.de/static.php?id=3929&language=de.

[89] Ed Blanche and Doug Richardson: "Iran gives details of latest Shabab-3 missile", Jane's Missiles and Rockets, February 1, 2007.

This is not a casual problem, since actual weaponization of a warhead requires extraordinarily sophisticated systems to detonate a warhead at the desired height of burst and to reliably disseminate the munitions or agent. Even the most sophisticated conventional submunitions are little more than area weapons if the missile accuracy to target location has errors in excess of 250–500 meters, and a unitary conventional explosive warhead without terminal guidance is little more than a psychological or terror weapon almost regardless of its accuracy.

The effective delivery of chemical agents by either spreading the agent or the use of submunitions generally requires accuracies less than 1,000 meters to achieve lethality against even large point targets. Systems with biological weapons are inherently area weapons, but a 1,000-kilogram nominal warhead can carry so little agent that accuracies less than 1,000 meters again become undesirable. Nuclear weapons require far less accuracy, particularly if a "dirty" ground burst can be targeted within a reliable fallout area. There are, however, limits. For example, a regular fission weapon of some 20 kilotons requires accuracies under 2,500–3,000 meters for some kinds of targets like sheltered airfields or large energy facilities.

What is clear is that the Shahab could carry a well-designed nuclear weapon well over 1,000 kilometers, and Iran may have access to such designs. As noted earlier, the Shahab-3 missile was tested in its final stages in 2003 and in ways that indicate it has a range of 2,000 kilometers, which is enough to reach the Gulf and Israel. A. Q. Khan sold a Chinese nuclear warhead design to Libya with a mass of as little as 500 kilograms and a one-meter diameter. As later chapters show, IAEA and US background briefings in 2008 make it highly probable that entire designs, or key elements of such designs, were sold to Iran as well.

## *Mobility and Deployment*

The Shahab-3 is mobile, but requires numerous launching support vehicles for propellant transport and loading and power besides its TELs.[90] The original version was slow in setting up, taking five hours to prepare for launch.[91] Some five different TELs have been seen, however, and some experts believe the current reaction time is roughly an hour.[92]

The Shahab-3's deployment status is highly uncertain. Some reports have claimed that the Shahab-3 was operational as early as 1999. Reports surfaced that development of the Shahab-3 was completed in June 2003 and that it underwent "final" tests on July 7, 2003. However, the Shahab-3 underwent a total of only nine tests from inception through late 2003, and only four of them could be considered successful in terms of basic system performance. The missile's design characteristics also continued to evolve during these tests. A CIA report to Congress, dated November 10, 2003, indicated that upgrading of the Shahab-3 was still under way, and some sources indicated that Iran was now seeking a range of 1,600 kilometers.

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[90] "Shahab-3D," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-3d.htm.

[91] Doug Richardson, "Iran is Developing an IRBM, Claims Resistance Group," Jane's Rockets and Missiles, December 14, 2004

[92] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.

Speculations about the possibility of replacing the liquid propulsion fuel with solid fuel for the Shahab-3 have been dismissed due to technical reasons. Apparently, reengineering the current design with solid fuel propulsion would lead to a completely modified missile. Rather, the development of a solid fuel propulsion system in a missile the size of the Shahab-3 would point to an entirely new line of missiles that are much more sophisticated than the Shahab-3. It has been reported that Iran operates Pakistani-designed Shaheen missiles, which use solid fuel propulsion. In addition, Iran is known to have received assistance in solid fuel propulsion technology by China. It is, however, unclear to what extent Iran has mastered or is using solid fuel missiles. [93]

There is an argument among experts as to whether the system has been tested often enough to be truly operational. The CIA reported in 2004 that Iran had "some" operational Shahab-3s with a range of 1,300 kilometers. Some experts feel the missile has since become fully operational and Iran already possesses 25–100 Shahab-3's in its inventory.[94] Iranian opposition sources have claimed that Iran has 300 such missiles.

According to other sources, the IRGC operated six batteries in the spring of 2006 and was redeploying them within a 35-kilometer radius of their main command and control center every 24 hours because of the risk of a U.S. or Israeli attack. The main operating forces were deployed in the west in the Kermanshah and Hamadan provinces with reserve batteries farther east in the Fars and Isfahan provinces.[95]

A substantial number of other experts believe the Shahab-3 may be in deployment, but only in "showpiece" or "test-bed" units using conventional warheads and with performance Iran cannot accurately predict. The IISS reports that the IRGC has one battalion of Shabab-3 missiles with six launchers, each of which has 4 missiles (Total operational force of 24).[96]

## Shahab-3A/3B/3M/3D/IRIS

There are many speculative reports on the state of Iran's evolving Shabab-3 program. In October 2004, the Mujahedin-e Khalq (MEK) claimed that Iran was developing an improved version of the Shahab with a 2,400-kilometer range (1,500 miles). The MEK has an uncertain record of accuracy in making such claims, and such claims could not be confirmed. Mortezar Ramandi, an official in the Iranian delegation to the UN, denied that Iran was developing a missile with a range of more than 1,250 miles (2,000 kilometers).[97]

In 2004, a Shahab-3B was reportedly developed that had an increased maximum range of 2,500 km. It may have a solid propellant serving as first or second stage propulsion. However, the supposed payload was only 800kg, 500 kg less than the standard Shahab-3.[98] Other experts believe that a new solid fueled missile, using part of the Shabab-3 is under development, rather than a modification of the Shabab-3. In any case, a change to a solid fueled booster would mark a significant move in Iranian technological capability, as

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[93] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 25.
[94] "Iran: Missiles" GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile.htm
[95] "Iran Moves Its Shabab-3 Units," Jane's Missiles and Rockets, April 1, 2006.
[96] IISS, *Military Balance, 2008*, "Iran,"
[97] Douglas Jehl, "Iran is Said to Work on New Missile," International Herald Tribune, December 2, 2004, p. 7.
[98] "Shabab-3/4," Jane's Strategic Weapon Systems, July 18, 2007.

some experts believe Iran switched the fuel source from liquid fuel to solid. The possible existence of a Shahab-3 with a solid fuel source created yet another variant of the Shahab-3 series, the Shahab-3D, or the IRIS missile.

Such a development of a solid fuel source might also help Iran to enter into space and serve as a potential satellite launch vehicle. Perfecting solid fuel technology would also move Iran's missile systems a long way toward the successful creation of a limited range intercontinental ballistic missile (LRICBM), which is what the Shahab-5 and Shahab-6 are intended to accomplish.[99] On January 26, 2007, Iranian sources reportedly claimed that Iran has successfully converted one of its missiles into a satellite delivery vehicle.[100] This information remains unconfirmed.

If there is an IRIS launch vehicle, reporting suggests that it consists of the No Dong/Shahab-3 first stage with a bulbous front section ultimately designed to carry the IRIS second-stage solid motor, as well as a communications satellite or scientific payload.[101] The IRIS solid fuel missile itself may be the third-stage portion of the North Korean Taep'o-dong-1.[102]

The Shahab-3D alone is not capable of launching a large satellite probe into space, and it is possible that it is a test for the second- and third-stage portions of the IRBM Ghadr designs and the LRICBM Shahab-5 and Shahab-6.[103]

No test flights of the Shahab-3D have been recorded on video, but it is believed that they have taken place at a space launch facility.[104] The following timeline shows the reported tests of the Shahab-3 variants and IRIS:

- **July 22, 1998:** First test flight (exploded 100 seconds after takeoff).
- **July 15, 2000:** First successful test flight (range of 850 kilometers).
- **September 21, 2000:** Unsuccessful test flight (exploded shortly after takeoff). After the test, an Iranian source claimed that the missile was a two-stage/solid fuel propulsion system.
- **May 23, 2002:** Successful test flight.
- **July 2002:** Unsuccessful test flight (missile did not function properly).
- **June 2003:** Successful test flight. Iran declared this was the final test flight before deployment.
- **August 11, 2004:** Successful test flight of Shahab-3M. The missile now had a "baby bottle" warhead.
- **October 20, 2004:** Another successful test flight of Shahab-3M. Iran now claimed the modified missile had a range of 2,000 kilometers.[105]

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[99] "Iran: Missiles Development," GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile-development.htm.

[100] Stratfor, Iran: The potential for a satellite launch, January 29, 2007.

[101] "Shahab-3D," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-3d.htm

[102] "Iran: Missiles Development," GlobalSecurity.org, available at: http://www.globalsecurity.org/wmd/world/iran/missile-development.htm.

[103] "Shahab-3D," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-3d.htm

[104] "Shahab-3D," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-3d.htm.

[105] IISS, Iran's Strategic Weapons Programs: A Net Assessment, IISS Strategic Dossier, 2005, p. 102.

- **February 25, 2007:** Shahab-3A, sub orbital sounding flight test. The details of this launching are not clear, yet this firing appears in conjunction with Iranian efforts to launch commercial satellites into orbit.[106]
- **September 22, 2007:** In an Iranian military exercise, a missile with the range of 500 kilometers more than Shahab-3 is displayed. The missile known as "Qadr-1" and its launcher are displayed in today's parade of the armed forces. Qadr-1 is a ballistic missile with a warhead and an explosive-impact and surface fuse system which is launched vertically.[107]
- **February 4, 2008:** Iran conducts a successful test launch of the Kavoshgar-1 (Explorer-1) research rocket to inaugurate its first domestically built space center 60 km southeast of Semnan City. The Kavoshgar-1 is a variant of the single stage Shahab-3 intermediate-range ballistic missile, specifically the Shahab-3B variant with the "baby bottle" nose.[108]

## Shahab-4

Iran may also be developing larger designs with greater range-payload using a variety of local, North Korean, Chinese, and Russian technical inputs. These missiles have been called the Shahab-4, the Shahab-5, and the Shahab-6. As of September 2006, none of these missiles were being produced, and the exact nature of such programs remained speculative.[109]

Some experts believe the "Shahab-4" has an approximate range between 2,200 and 2,800 kilometers. Various experts have claimed that the Shahab-4 is based on the North Korean No Dong-2, the three-stage Taep'o-dong-1 missile, the Russian SS-N-6 SERB, or even some aspects of the Russian SS-4 and SS-5,[110] but has a modern digital guidance package rather than the 2,000–3,000 meter CEP of early missiles like the Soviet SS-4, whose technology is believed to have been transferred to both North Korea and Iran.

Russian firms are believed to have sold Iran special steel for missile development, test equipment, shielding for guidance packages, and other technology. Iran's Shahid Hemmet Industrial Group is reported to have contracts with the Russian Central Aerohydrodynamic Institute, Rosvoorouzhenie, the Bauman Institute, and Polyus. It is also possible that Iran has obtained some technology from Pakistan.

One source has provided a precise estimate of some performance characteristics. This estimate of "Shahab-4 gives it an estimated height of 25 meters, a diameter of 1.3 meters, and a launch weight of 22,000 kilograms. In terms of propelling ability, its thrust is estimated to be around 26,000 kgf and its burn time is around 293 seconds. It is said to be a 2 and/or 3-stage rocket that possesses three thrust chambers, one for each stage. Its fuel for the first stage is heptyl, and its oxidizer is inhibited red fuming nitric acid.[111]

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[106] Iran announces rocket launch," *International Herald Tribune*, 25 February 2007.
[107] "Iran displays Qadr-1 missile at military exercise," Fars News Agency, 22 September 2007; "Iran Presents Ghadr - A 'New' Ballistic Missile," Jane's Defence Weekly, 3 October 2007.
[108] Iran Launches Rocket to Commemorate New Space Center," The New York Times, 5 February 2008; Joseph Bermudez, "Iran Inaugurates Space Terminal and Launches Research Rocket," Jane's Defense Weekly, 13 February 2008; "Smoke and Mirrors- Analyzing the Iranian Missile Test," Jane's Intelligence Review, 14 March 2008.
[109] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.
[110] Federation of American Scientists, *Iran*, available at http://www.fas.org/nuke/guide/iran/missile/overview.html, March 5, 2007.
[111] "Shahab-4," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-4.htm.

Iran has sent mixed signals about the missile development status. In October 2003, Iran claimed it was abandoning its Shahab-4 program, citing that the expected increase in range (2,200 to 3,000 kilometers) would cause too much global tension.[112] Some speculate that Iran may have scrapped its Shahab-4 program because it either was not innovative and large enough and/or to avoid controversy. The reason announced by some Iranians for creating a missile like the Shahab-4 was for satellite launches.

The IRIS/Shahab-3D, with its solid fuel source, however, has shown potential for space launches. The improved range and bottleneck warhead design offered by the Shahab-3M (which began testing in August 2004) may make the Shahab-4 simply not worth the effort or controversy.[113] According to unconfirmed reports by the National Council of Resistance of Iran (NCRI), a resistance group, Iran for the first time launched a Shahab-4 missile on August 17, 2004.[114]

In May 2005, Ali Shamkhani, Iran's Minister of Defense announced the successful development of a "twin engine," which subsequently was interpreted as a two-stage missile with a solid propellant. Initial assumptions over an improved version of the Shabab-3 were refuted, as observers claimed that introducing a solid propellant, two-stage motor into a Shabab-3 made little sense.[115] Yet Iranian sources have not clarified their statements about the alleged new motor, therefore leaving open speculations whether the new engine was in use at all, perhaps in use with the Shabab-4 and 5 missiles, or whether it existed at all. The Pakistani Shaheen, on the other hand, is solid fueled. The IISS *Military Balance 2007* reports that Iran holds an unspecified number of Shaheen missiles. Perhaps Iran has modified the motor of that engine for its own program.

Iranian Defense Minister Mostafa Mohammad-Najjar indicated in a public press conference in 2006 that the nation was in the process of "researching and building" the Shahab-4.[116]

According to German press reports, however, Iran is moving ahead in its development of the Shahab-4. In February 2006, the German news agency cited "Western intelligence services" as saying that Iran successfully tested the Shahab-4 missile with a range of 2,200 kilometers on January 17, 2006, and the test was announced on Iranian television several days later by the Commander of the IRGC.[117] Additionally, reports indicate that the test was terminated after the separation of the nose reentry vehicle (RV).[118]

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[112] Doug Richardson, "Iran is Developing an IRBM, Claims Resistance Group," Jane's Rockets and Missiles, December 14, 2004.

[113] "Shahab-4," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-4.htm

[114] Doug Richardson, "Iran is developing an IRBM, claims resistance group", Jane's Missiles and Rockets, January 1, 2005.

[115] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 7.

[116] Associated Press, "Iran: Russia Says New Rocket Raises Nuclear 'Suspicions,'" *The New York Times*, http://www.nytimes.com/2008/02/07/world/worldspecial/07briefs-ROCKET.html?ref=world, 7 February 2008.

[117] "Western Intelligence Confirms Iranian Missile Developments – German Report," BCC Monitoring International Report, February 6, 2006, available through Lexus Nexus.

[118] Duncan Lennox, ed., *Jane's Strategic Weapons Systems 46* (Surrey: Jane's Information Group, January 2007), 71-73.

In the first week of February 2008, reports indicate that Iran tested a missile. Russian reports claim that it was possibly a more advanced Shahab-3, indicating either the 4 series or 5 series. Russian officials expressed concern over the test citing a missile test is an integral part of nuclear weapons programs.[119] These reports remain unverifiable.

## Shahab-5 and Shahab-6

Israeli intelligence has reported that Iran is attempting to create a Shahab-5 and a Shahab-6, with a 3,000-5,000-kilometer range. These missiles would be based on the North Korean Taep'o-dong-2 and would be three-stage rockets. If completed, the Shahab-5 and the Shahab-6 would take Iran into the realm of intercontinental ballistic missiles (ICBMs) and enable Iran to target the U.S. eastern seaboard. The Shahab-5 and the Shahab-6 would possess a solid fuel third stage for space entry and liquid fuel for the first stage take units.

It is alleged that Russian aerospace engineers are aiding the Iranians in their efforts. It is believed that the engineers will employ a version of Russia's storable liquid propellant RD-216 in the missile's first stage. The RD-216 is an Energomash engine originally used on the Skean/SS-5/R-14, IRBM, Saddler/SS-7/R-16, ICBM, and Sasin/R-26 ICBM missiles used in the Cold War. The effort to develop an ICBM with the Russian RD-216 engine in some sources has been named Project Koussar.[120] These reports remain uncertain, and Israeli media and official sources have repeatedly exaggerated the nature and speed of Iranian efforts.[121]

Due to the deception and denial strategy of the Iranian government regarding its missile programs, it is unknown whether or not the Shahab-5 or the Shahab-6 has been tested or constructed. Because little is known about the Shahab-5 project and even less is known about Shahab-6, much of the data is speculative at best.

Extrapolations for the Shahab-5 have been made based on the North Korean Taep'o-dong-2. The Shahab-5 has an approximate range between 4,000 and 4,300 kilometers. The Shahab-5 has an unknown CEP, and its warhead capacity is between 700 and 1,000 kilograms. It has a height of 32 meters, a diameter of 2.2 meters, and a launch weight of 80,000–85,000 kilograms. In terms of propelling ability, some experts estimate its thrust to be 31,260 kgf and its burn time to be 330 seconds. The Shahab-5 is a three-stage rocket that possesses six thrust chambers, four for stage one, and one for the two remaining stages. The Shahab-5 and the Shahab-6 would be considered long-range ICBMs.[122]

As stated previously, in the first week of February 2008 reports indicate that Iran tested a missile. Russian reports claim that it was possibly a more advanced Shahab-3, indicating either the 4 series or 5 series. Russian officials expressed concern over the test citing a

[119] GlobalSecurity.org, "Shahab-4," available at http://www.globalsecurity.org/wmd/world/iran/shahab-4.htm
[120] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.
[121] "Shahab-5," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-5.htm
[122] "Shahab-4," Federation of American Scientists, December 1, 2005, available at: http://www.fas.org/nuke/guide/iran/missile/shahab-4.htm.

missile test is an integral part of nuclear weapons programs.[123] Again, these reports remain unverifiable.

Analysts have suggested that the Shahab-6 is a two or three-stage liquid/solid fuel rocket. The missile uses most of the same systems as the Shahab-5, but economies in weight and payload increase the range to approximately 6,000 km (3,728 miles). The missile is intended to carry one single warhead with a substantial yield, most likely in the area of 500-1,000 kg. As a result of its inaccuracy, the missile's utility it probably restricted to attacking population centers and spreading radiation rather than hitting military targets. Thus, the Shahab-6 is more likely a blackmail/terrorist weapon than a military asset. Significant reports indicate that the Shahab-5 and Shahab-6 have the possibility of being developed into satellite launch vehicles (SLV). Little is known about the Shahab-5 project and even less is known about Shahab-6. Sources indicate that the project has been classified as Kosar.[124]

The integration of technology from the Taep'o-dong 2 missile into the Shahab-5 represents a substantial security risk for the U.S. If its 6,000 km reported range is accurate, the Shahab-6 will be able to target most of Europe, Russia, and Asia. Reports indicate its engine's possible burn time would be up to 330 seconds, which would classify the system as an ICBM.[125] At this time there has been no credible reporting of a Shahab-6 launch. This information is dependent on the uncertain intelligence available on these systems.

## Satellite Launch Vehicle (SLV) Programs

As early as 1998 Iran announced its objective to establish a space program. One source reports that when Iran's Supreme Leader Ali Khamenei visited a defense fair the same year, images of a satellite launch vehicle (SLV) surfaced that apparently showed a SLV resembling the Shahab-3 with the letters IRIS painted on it.[126] Iran has never openly declared its space program assets, but on February 25, 2007, proclaimed that it had fired a test rocket into a suborbital altitude. This apparently was based on a vehicle identified as Shahab-4.[127]

There are a number of speculations about the satellite launch, but claims of the Shahab-4 with a two-stage, solid propellant motor seem to be the most prevalent. This may, however, simply be attributed to the fact that Iranian official sources distributed such information and other sources lacked any convincing evidence. Parts of the missile that was fired on February 25, 2007 apparently fell back to earth by parachute. This test caused considerable concern among Western observers. It may or may not be the case that Iran signaled its intentions to speed up its ballistic missile program; there is simply

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[123] Associated Press, "Iran: Russia Says New Rocket Raises Nuclear 'Suspicions,'" *The New York Times*, http://www.nytimes.com/2008/02/07/world/worldspecial/07briefs-ROCKET.html?ref=world, 7 February 2008

[124] Missilethreat.com, The Claremont Institute, October 1, 2008, available at http://www.missilethreat.com/missilesoftheworld/id.180/missile_detail.asp

[125] Anthony Cordesman, Martin Keliber, "Iran's Military Forces and Warfighting capabilities: The Threat in the Northern Gulf," 2007, *Praeger Security International*, http://0-psi.praeger.com/.

[126] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 39.

[127] Federation of American Scientists, *Iran*, March 5, 2007, available at http://www.fas.org/nuke/guide/iran/missile/overview.html.

not enough reliable data available that can give credible evidence to whether the launch is a step toward the acquisition of an ICBM or not.

According to one source, Iran is working on the following satellite projects:

- Zoreh: Allegedly, Iran was the contractor for this communication satellite, but did not engineer any of the parts for it. The satellite was supposed to be launched by a Russian vehicle.
- Safir 313: This is a 20-kilogram heavy, Iranian-made satellite that was supposed to be launched in early 2005, but the first reported launches didn't take place until 2008.
- Mesbah: Reportedly, this is a 70-kilogram satellite produced by an Italian-Iranian joint venture. It was supposed to be launched by a Russian vehicle.
- Sina 1: This is a Russian communication and observation satellite. Apparently, the Iranian role consisted of a tracking and data retrieval station and possibly to expand cooperation with a successor satellite named Sina 2.[128] Reportedly, the Sina 1 was Iran's first satellite that it launched into space. The launch occurred in October 2005.[129]

One analyst speculates about the difficulties in discerning Iranian space vehicle launch capabilities as follows:

> Though an indigenously built Iranian satellite launch vehicle could exist, the launch of a North Korean-manufactured Taepodong-2 with an Iranian flag painted on it is far more likely (although any Iranian-built missile would likely be nearly identical to the Taepodong-2 and in grainy imagery of such a launch it could be impossible to tell one from the other). Either way, any Iranian satellite launch vehicle will look strikingly similar to the Taepodong family, and there would almost certainly be North Korean scientists on the ground at the launch site.[130]

In late January 2007, it was reported that Iran had converted a ballistic missile into a satellite launch vehicle. Reports assume that the missile is either a version of the Shahab-3 or the Ghadar-110, based on the reported weight of 30 tons.[131] According to the latest DIA estimates, Iran may develop a 3,000-mile ICBM by the year 2015. The advances in missile technologies have substantiated evidence that there is close cooperation between North Korean and Iranian space missile programs, but no reliable information about this is available.[132]

On February 4, 2008, Iran inaugurated its first domestically built space center with the launch of the Kavoshgar-1 (Explorer-1) research rocket, according to Russian news sources. This platform is apparently capable of carrying a satellite into low orbit. Iran also unveiled its first domestically built satellite, Omid, or Hope, during this inauguration. The Iranian spokesman said, "The launch of the Explorer rocket into space was conducted strictly for scientific purposes. Our achievements in space research, as well as our progress in nuclear research, serve peace and justice."[133]

Iran reportedly test-fired a new rocket, named Safir-e Omid, capable of carrying a satellite into orbit on August 17, 2008, as part of its rapidly developing space program. The White House said Iran's rocket announcement was "troubling," calling it part of a

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[128] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 7.
[129] Nazila Fathi, "Iran says it launched suborbital rocket into space, with eye toward lifting satellites", New York Times, February 26, 2007.
[130] STRATFOR, Iran: The Potential for a Satellite Launch, January 26, 2007.
[131] Aerospace Daily & Defense Report, Iran converts missile into sat launch vehicle, January 29, 2007.
[132] Aerospace Daily & Defense Report, Iran converts missile into sat launch vehicle, January 29, 2007.
[133] "Iran says Space Program Poses No Threat to Peace," Ria Novosti, February 2, 2008.

pattern of Iranian activity to build a nuclear program and the means to potentially launch a weapon. "The Iranian development and testing of rockets is troubling and raises further questions about their intentions," said White House spokesman, Gordon D. Johndroe. Rocket scientists agree that the same technology that puts satellites into orbit can deliver warheads.[134] The launch was assessed as a failure by US and Israeli intelligence reporting, which claimed that the Safir failed to separate in its second stage launch.[135]

On September 25, 2008 President Mahmoud Ahmadinejad announced that Iran planned to launch a satellite into space soon using its own satellite carrier rocket, Ahmadinejad said the Persian nation will soon "launch a rocket, which has 16 engines and will take a satellite some 430 miles" into space.[136]

## Ghadr 101 and Ghadr 110

Iran's rapidly developing space program has generated growing unease among world leaders that are already concerned about its nuclear and ballistic missile programs. Iran's lack of transparency, coupled with its lack of cooperation with IAEA inspectors, makes any developments in its space program suspect. It has also led to growing speculation that Iran will develop the capability to deploy a small force of ICBMs, and some analysts have again raised the possibility that Iran will seek to acquire EMP weapons.

As has been noted earlier, the uncertainties surrounding Iran's solid fuel program are compounded by reports of a separate missile development program. The Iranian exile group NCRI claimed in December 2004 that the Ghadr 101 and the Ghadr 110 were new missile types that used solid fuel and were, in fact, IRBMs. Their existence has never been confirmed, and conflicting reports make an exact description difficult. One analyst claims that the Russian Kh-55 cruise missile (see below) is being reengineered by Iran under the name Ghadr.[137]

At the time, U.S. experts indicated that the Ghadr is actually the same as the Shahab-3A/Shahab-3M/Shabab-4, which seemed to track with some Israeli experts who felt that Iran was extending the range/payload of Shahab-3 and that reports of both the Gadr and the Shahab-4 were actually describing the Shahab-3A/3M.[138] Another source claims that Ghadr missiles can be compared to SCUD-E missiles.[139] The SCUD-E designation has been used to describe Tapeo Dong-1 and Nodong-2 missiles.

In May 2005, Iran tested a solid fuel motor for what some experts call the Shahab-3D, possibly increasing the range to 2,500 kilometers, making space entry possible, and setting the stage for the Shahab-5 and the Shahab-6 to be three-stage rockets resembling ICBMs.[140] This test showed that Iran had developed some aspects of a successful long-

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[134] William J. Broad, "Iran Reports Test of Craft Able to Carry a Satellite," The New York Times, August 17, 2008, http://www.nytimes.com/2008/08/18/world/middleeast/18iran.html

[135] Charles P. Vick, "Booster Orbital Launch Attempt," GlobalSecurity.org, August 19-28, 2008 available at: http://www.globalsecurity.org/space/world/iran/orbital-attempt02_finally.htm.

[136] "Iran to launch satellite carrier rocket to space," Associated Press, September 25, 2008, available at http://washingtontimes.com/news/2008/sep/25/iran-to-launch-satellite-carrier-rocket-to-spac-1/

[137] Richard Fisher Jr.: China's Alliance With Iran Grows Contrary to U.S. Hopes, available at http://www.strategycenter.net/research/pubID.109/pub_detail.asp, March 5, 2007.

[138] Andrew Koch, "Tehran Altering Ballistic Missile," Jane's Defense Weekly, December 8, 2004.

[139] Doug Richardson, "Iran is developing an IRBM, claims resistance group", Jane's Missiles and Rockets, January 1, 2005.

[140] "Iran Tests Shahab-3 Motor," Jane's Missiles and Rockets, June 9, 2005.

range, sold fuel missile design, but did not show how Iran intended to use such capabilities.

The NCRI again claimed in March 2006 that Iran was moving forward with the Ghadr solid fuel IRBM. It also claimed that Iran had scrapped the Shahab-4 because of test failures and performance limitations. It reported that Iran had substantial North Korean technical support for the Ghadr, that it was 70 percent complete, and had a range of 3,000 kilometers. One Israeli expert felt that NCRI was confusing a solid-state, second-stage rocket for the liquid-fueled Shahab-4 with a separate missile.[141]

*Jane's* has reported that unnamed intelligence sources have stated that a parallel, indigenously-built IRBM is being built by the Shaid Bagheri Industrial group with range of 2,000 km and a payload of about 900 kg. The Iranian government announced in November 2007 that it was developing this new missile, Ashoura (or Ashura). An Israeli report in April 2008 reported that Ashoura is a two-stage solid propellant missile with a triconic nose shape similar to the Shahab-3A. A Russian report in November 2007 said that the Ashoura had had a failed flight test, and an Israeli report said that the sold propellant motors were tested but not launched.[142]

Work by Dr. Robert Schmucker indicates that Iran is working on solid-fueled systems, building on its experience with solid fuel artillery rockets like its Fateh A-110 and with Chinese support in developing solid fuel propulsion and guidance. The Fateh, however, is a relatively primitive system with strap-down gyro guidance that is not suited for long-range ballistic missiles, although it is reported to be highly accurate.[143]

On September 21, 2008 Iran quietly paraded a version of the Ghaadr-110 tactical solid propellant ballistic missile. Two images of the ballistic missile were shown by the FARS News Agency, and the only noticeable difference between the Iranian Ghadr-110 and the Chinese M-9 – which is the missile the Ghadr is reportedly based on – is a shortened conical nosecone. The appearance of the Ashura/Ghadr seems to be further evidence of two things; Chinese missile proliferation to Iran, and that the claims made by the MEK regarding this particular program were true.[144]

As is the case with longer-range variants of the Shahab, it is probably wise to assume that Iran is seeking to develop options for both solid- and liquid-fueled IRBMs and will seek high-range payloads to ensure it can deliver effective CBRN payloads even if it cannot produce efficient nuclear weapons. It is equally wise to wait for systems to reach maturity before reacting to vague possibilities, rather than real-world Iranian capabilities.

## Uncertain Reports of Future ICBMs

It is a long way from launching small satellites, or a successful IRBM program, to a fully functional ICBM force. One Russian general was almost certainly correct in stating

[141] Robin Hughes, "Iranian resistance group alleges Tehran is developing new medium range missile," Jane's Defense Weekly, March 22, 2006.
[142] "Ashura," Jane's Strategic Weapon Systems, July 21,2008.
[143] Dr. Robert H. Schmucker, "Iran and Its Regional Environment," Schmucker Technologies, Peace Research Institute Frankfurt, March 27, 2006, www.hsfk.de and http://www.hsfk.de/static.php?id=3929&language=de; Robin Hughes, Iran's ballistic missile developments – long-range ambitions, Jane's Defence Weekly, September 13, 2006.
[144] Iranian military parade photographs of the FARS News Agency of September 21, 2008. Reported I by Charles P. Vick, The Latest in North Korean & Iran Ballistic Missile & Space Booster Developments, GlobalSecurity.org, October 10, 2008, available at: http://www.globalsecurity.org/space/world/iran/missile-developments.htm.

during an Iranian military exercise in November 2006 that Iran did not possess the capability to produce intercontinental ballistic missile.[145] The problem is, however, that the future is much harder to predict. There also are a number of additional reports discussing Iran's capability to use missiles and deliver weapons of mass destruction that have less credibility than the previous reports, but some of which indicate that Iran's technology base may be more advanced than most reports indicate.

Iran's recent Safir flight failures show that Iran is quickly trying to establish and advance its space program. These recent launches, along with the recent photos of what appears to be the Ghadr-110, make development in expanding the range its ballistic programs all the more likely.

# Iran's Other SSM Programs

## Iranian Fateh A-110 (PRC CSS-8)

Among the missiles that have been under development by Iran has been a range of SSM known as Zelzal. One Zelzal program of interest is the Fetah A-110, Zelzal-2 variant that is reportedly based on China's CSS-8. *Jane's* reports that Iran may have some 200 Chinese CSS-8, or M-7/Project 8610 short-range missiles. These are Chinese modifications of the SA-2 surface-to-air missile for use as a surface-to-surface system. It has a 190-kilogram warhead and a 150-kilometer range. Up to 90 may have been delivered to Iran in 1992, and another 110 may have been delivered later. The system is reported to have poor accuracy.[146] Iran has since used this PRC system as a base model for its Fateh system developments.

The Fateh A-110 is designed to replace many of the aging SCUD systems currently used in the Middle East. While the program is based in Iran, the missile is believed to incorporate components from Chinese contractors. In 2006 The US Department of the Treasury accused Great Wall Industry, a Chinese Corporation and its partners for playing a lead role in the development of the Fateh missile system.[147]

The Fateh A-110 is part of Iran's indigenous Zelzal missile program. The Fateh missile program was started in 1997 by the Iranian government owned Aerospace Industries. The Fateh A-110 is a single-staged, solid-propelled, guided variant of the Zelzal-2 SRBM.[148] Reporting indicates that the Fateh A -110 has a range of anywhere between 160 and 210 km, but it is possible that Iran will add, if it has not already added, an extra booster to increase the range of the missile to 400 km (249 mi).[149]

The Fateh A-110 was released for distribution by the Iranian Aerospace Industries Organization (IAIO) in 2003 after three successful launches – May 2001, September

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[145] AFX International Focus, *Russian military says Iran 'not capable' of creating intercontinental missiles*, November 2, 2006.

[146] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27.

[147] Michael Herald, "US Shows Muscle by Punitive Action," *New Zealand Herald,* 30 August 2006, on http://www.nzherald.co.nz/.

[148] Andrew Koch, Robin Hughes, and Alon Ben-David, "Tehran Altering Ballistic Missile," *Jane's Defence Weekly*, 8 December 2004.

[149] MissilteThreat.com, Fateh A-110, a project of the Claremont Institute, October 10, 2008, available at: http://www.missilethreat.com/missilesoftheworld/id.39/missile_detail.asp; and GlobalSecurity.org, Fateh-110 / NP-110 / Mushak, April 28, 2004, http://www.globalsecurity.org/wmd/world/iran/mushak.htm.

2002, and February 2003 – with a reported range "in excess of 200 km" by Iranian media agencies.[150] The missile entered low-rate production in October 2002 and initial operational achievement is believed to have occurred in 2004.[151] The Fateh A-110 has since been tested three times – at the "Holy Prophet II" exercises of 2006, as well as tests in January and September 2007.

The Fetah A-110 is similar in shape to the Zelzal-2, but it has two delta-shaped control fins at the nose and four delta control fins just in front of the rear wings. This aerodynamic control arrangement is new for a ballistic missile, and has been developed by Iran to provide improved accuracy.[152] From the available information, analysts have assessed the missile as having an accuracy of 100m CEP and using a combination of inertial guidance and a Global Positioning Satellite (GPS) system to locate its target.[153]

Iranian sources claim that the weapon has a high degree of accuracy which would require it to have a more sophisticated guidance system. It can carry a payload of some 500 kg and is most likely intended to deliver only high explosive, chemical, or submunitions warheads. The possibility remains, however, that Iran could deploy the Fateh A-110 with biological or nuclear warheads.[154]

It is also noteworthy that there are reports that claim that the Fateh A-110 missile may be based on the Chinese DF-11A missile, which has a range of 200 to 300 km and is capable of carrying nuclear warheads.[155] This is yet another example of the uncertainties that are still surrounding Iran's domestic missile programs, as well as its stockpile numbers and capabilities.

Iran's deceptive behavior, as well as the fact that the Fateh A-110 is domestically made, has made it impossible to know the number of Fateh A-110 and other PRC CSS-8 variants are in Iran's missile stockpile. This a problem in assessing the amount of missiles, of any type, Iran possesses.

## M-9 and M-11 missiles

For over a decade there has been occasional speculation whether or not Iran acquired Chinese M-9 and M-11 missiles, which are based on the Russian SCUD designs. It seems evident that Iran expressed interest in these missiles, but apparently China did not deliver any missiles because of U.S. pressure. One source notes that China may have delivered one or two M-11 SRBMs with a 300 km range in the early 1990s.[156]

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[150] Jane's Sentinel Security Assessment – The Gulf States, Armed Forces Iran Ballistic Missiles, Jane's, July 28, 2008, accessible from: http://search.janes.com.

[151] Lennox, ed., *Jane's Strategic Weapons Systems 46* (Surrey: Jane's Information Group, January 2007), 67-68.

[152] Jane's Sentinel Security Assessment – The Gulf States, Armed Forces Iran Ballistic Missiles, Jane's, July 28, 2008, accessible from: http://search.janes.com.

[153] MissilteThreat.com, Fateh A-110, a project of the Claremont Institute, October 10, 2008, available at: http://www.missilethreat.com/missilesoftheworld/id.39/missile_detail.asp.

[154] MissilteThreat.com, Fateh A-110, a project of the Claremont Institute, October 10, 2008, available at: http://www.missilethreat.com/missilesoftheworld/id.39/missile_detail.asp.

[155] GlobalSecurity.org, Fateh-110 / NP-110 / Mushak, April 28, 2004, http://www.globalsecurity.org/wmd/world/iran/mushak.htm.

[156] NTI, Iran's missile capabilities – long-range artillery rocket programs, available at http://www.nti.org/e_research/profiles/Iran/Missile/3367_3397.html.

Yet other sources report that Iran could have received 80 M-11 systems along with TELs, but these reports are unconfirmed, and Iran has never publicly tested the weapon. [157] Reports confirm that the M-11 is the nuclear capable Pakistani Shaheen-1.[158] Reports also confirm that transfers of M-11 technology and support have taken place between Pakistan and Iran, with Chinese aid.[159]

Some experts speculate whether deliveries have taken place illegally, despite China's pledge to not sell the missiles, although most reports do not confirm that any of the missiles are in stock with Iranian forces. Although on September 22, 2005 the BBC translated Iranian media reports of an Iranian military parade that included numerous ballistic missiles including an M-11 Variant/Tondar-68, purchased from China, with a range 400 km and possibly an M-9 missile, with a range 600 km, also purchased from China.[160]

Since Iran has shown itself to be capable of reverse engineering and altering ballistic missiles for the purpose of domestic production, it is possible that if Iran received any of these missiles or there components it may have been able to start domestic production of a variant of the PRCs M-11 and/or DF-11. Some reports have stated that Iran is doing just this, although the status of its M-11 variant project is uncertain. Also due to the lack of consistent public display of the M-9, reports from 1996 on suggest possible termination of the Iranian M-9 program,[161] although this could be due to continued Iranian secrecy and deception in regards to its missile programs.

It has also been reported that the Syrian missile program was developed in a joint project with Iran. These reports indicate that the Iranian M-11 variant would likely be similar, if not the same as, the Syrian single-stage, solid-propelled SRBM, with a range of 280 to 400 km -- within the limits of the Missile Technology Control Regime (MTCR); with a 500 or 800 kg warhead that can be equipped with high explosives, chemicals, sub-munitions, fuel air explosives (FAE), or a nuclear yield of 2, 10 or 20 kT; and an accuracy of 600 m CEP. The accuracy of the weapon could be increased with a projected separating warhead. The separating warhead is a design feature that requires the warhead to detach itself from the missile body and continue on to its objective. The warhead is then able to adjust its trajectory based on fin design and its range due to weight redistribution. This attribute would be unique to the Iranian version.[162]

As with a majority of the Iranian and Syrian missile programs and their capabilities, this information remains unconfirmed; making the status of the projects as well as the stockpile numbers rough estimates, if not unknown.

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[157] Duncan Lennox, ed., *Jane's Strategic Weapons Systems 46* (Surrey: Jane's Information Group, January 2007), 69.
[158] Bill Gertz ,"China's Broken Promises Outlined; Helms Makes List of Arms Offenses," *The Washington Times,* July 23, 2001, availble at: www.washtimes.com/.
[159] "Nukes for Sale," *The Statesman, India,* March 2, 2004 available at: www.thestatesman.net.
[160] BBC, "Iran Parades Missiles: Iranian account of parade," and AFP, "Iran flaunts ballistic missiles with anti-US, Israeli slogans," September 22, 2005, available through: http://www.missilethreat.com/archives/id.1892/detail.asp.
[161] Anthony Cordesman, Martin Keliber, "Iran's Military Forces and Warfighting capabilities: The Threat in the Northern Gulf," 2007, *Praeger Security International*, http://0-psi.praeger.com/.
[162] Duncan Lennox, *Jane's Strategic Weapons Systems* 46 (Surrey: Jane's Information Group, January 2007), 169; and MissilteThreat.com, M-11 variant, a project of the Claremont Institute, October 10, 2008, available at: http://www.missilethreat.com/missilesoftheworld/id.66/missile_detail.asp.

## BM-25/SS-N-6

Some sources have reported that Iran has concluded an agreement with North Korea to buy 18 IRBMs (initially called BM-25) that in return are reverse-engineered Russian SS-N-6 submarine launched ballistic missiles (SLBM). Apparently, Iran tested a BM-25 in January 2006; the missile is reported to have flown more than 3,000 kilometers. Several sources claim that the BM-25 has a range of up to 4,000 kilometers.[163]

Iran is believed to have received 18 missiles; an Israeli source reportedly confirmed the delivery, but claimed that the missile's range was 2,500 kilometers.[164] This report seems to be confirmed by a German intelligence that stated that Iran had taken delivery of 18 disassembled medium-to-intermediate range ballistic missiles from North Korea in 2005, which were described as BM-25 models with a range of 2,500 km.[165]

One source claims that the initial SS-N-6 used a complicated propulsion as well as guidance system, and it appears questionable that North Korea and/or Iran are capable of making the necessary adjustments to create a land-launched version and achieving a range of over 2,000 miles.[166]

## Raduga KH-55 Granat/Kh-55/AS-15 Kent

Ballistic missiles are scarcely the only platforms Iran has to deliver weapons of mass destruction. In addition to covert means or using proxies, Iran can use cruise missiles, drones or unmanned combat aerial vehicles (UCAV), or aircraft equipped with either air-to-surface missiles or free fall bombs. Little is known about the extent to which Iran has explored many of these options, but some of its actions make it clear that it is examining them.

One clear example is Iran's covert acquisition of long-range cruise missiles. The Raduga Kh-55 Granat is a Ukrainian-/Soviet-made armed nuclear cruise missile first tested in 1978 and completed in 1984.[167] The Russian missile carries a 200-kiloton nuclear warhead, and it has a range of 2,500–3,000 kilometers. It has a theoretical CEP of about 150 meters and a speed of Mach 0.48–0.77.

Its guidance system is reported to combine inertial-Doppler navigation and position correction based on in-flight comparison of terrain in the assigned regions with images stored in the memory of an on-board computer. It was designed to deliver a high-yield nuclear weapon against fixed-area targets and has little value delivering conventional warheads. While it was originally designed to be carried by a large bomber, and its weight makes it a marginal payload for either Iran's Su-24s or F-14As, it has land and ship launch capability. It can also be adapted to use a much larger nuclear or other CBRN

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[163] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[164] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 29.

[165] Jane's Sentinel Security Assessment – The Gulf States, Armed Forces Iran Ballistic Missiles, Jane's, July 28, 2008, accessible from: http://search.janes.com.

[166] Reportedly, Iran concluded an agreement with North Korea to buy 18 IRBMs (BM-25) which in return are reverse-engineered Russian SS-N-6 SLBMs. Apparently, Iran tested a BM-25 in January 2006; the missile is reported to have flown more than 3,000 km.

[167] "KH-55 Granat," Federation of American Scientists, available at: www.fas.org/nuke/guide/russia/bomber/as-15.htm.

warhead by cutting its range, and it may be a system that Iran can reverse engineer for production.[168]

Russian President Boris Yeltsin made further manufacture of the missile illegal in 1992.[169] Still, the Ukraine had 1,612 of these missiles in stock at the end of 1991, and it agreed to give 575 of them to Russia and scrap the rest.[170] The plans to give the missiles to Russia in the late 1990s proved troublesome, however, and an organization was able to forge the documents regarding 20 missiles and listed them as being sold to Russia, while in fact 12 seem to have been distributed to Iran and 6 to China (the other two are unaccounted for).[171] It was estimated that the missiles were smuggled to Iran in 2001.[172]

Ukrainian officials confirmed the illegal sale on March 18, 2005, but the Chinese and Iranian governments were silent regarding the matter. While some U.S. officials downplayed the transaction, the U.S. State Department expressed concern that the missiles could give each state a technological boost.[173] The missiles did not contain warheads at the time of their sale, and they had passed their service life in 1995 and were in need of maintenance.[174] It is, however, feared that Iran could learn from the cruise missiles technology to improve its own missile program and the missiles could be fitted to match Iran's Su-24 strike aircraft.[175] According to one source, Parchin Missile Industries and CSIG are to reverse engineer the missile, but as of March 2007 are likely still at an early stage of the process.[176]

The availability of the Kh-55 is impeded by the fact that this missile was designed to be launched only from long-range Tupolev bombers, which Iran does not possess. It is therefore not unlikely that the Kh-55 primarily serves for research purposes and/or reverse engineering of its small fan jet engine, especially since the turbo fan engine for the Kh-55 was manufactured in Ukraine. The Kh-55 therefore may serve as an important stepping-stone in the development of cruise missile capabilities.[177]

If Iran could make the Kh-55 cruise missile fully operational, rather than simply use it for reverse engineering purposes, Iran would acquire a capability to strike targets in Western Europe, an option that is widely believed to alter strategic and political considerations between the United States and its allies. Iran's capability in this regard, however, remains a theoretical one. It is highly doubtful that Iran possesses the means to employ a Kh-55

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[168] Robin Hughes, "Long-Range Ambitions," *Jane's Defense Weekly*, September 13, 2006, pp. 22-27; http://www.globalsecurity.org/wmd/world/russia/as-15specs.htm; http://www.globalsecurity.org/wmd/world/russia/kh-55.htm, and http://www.globalsecurity.org/wmd/world/iran/x-55.htm.

[169] "KH-55 Granat," Federation of American Scientists, available at: www.fas.org/nuke/guide/russia/bomber/as-15.htm.

[170] "Cruise missile row rocks Ukraine," BBC News, March 18, 2005, available at: http://news.bbc.co.uk/2/hi/europe/4361505.stm

[171] Bill Gertz, "Missiles Sold to China and Iran," The Washington Times, April 6, 2005, available at: http://washingtontimes.com/national/20050405-115803-7960r.htm

[172] Bill Gertz, "Missiles Sold to China and Iran," The Washington Times, April 6, 2005, available at: http://washingtontimes.com/national/20050405-115803-7960r.htm

[173] Paul Kerr, "Ukraine Admits Missile Transfers," Arms Control Association, May 2005, available at: http://www.armscontrol.org/act/2005_05/Ukraine.asp

[174] "Ukraine investigates supply of missiles to China and Iran," Jane's Missiles and Rockets, May 1 2005.

[175] "18 cruise missiles wee smuggled to Iran, China" Associated Press, March 18, 2005.

[176] Robin Hughes, "Iran's ballistic missile developments – long-range ambitions", Jane's Defence Weekly, September 13, 2006.

[177] Uzi Rubin: *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv, November 2006, p. 28.

according to its widely stated technical capabilities. Even though the Kh-55 may have a maximum range of 3,000 kilometers, there are numerous technical obstacles that Iran would have to overcome before launching a cruise missile.

Iran would need to adapt its aircraft or naval vessels to be operational to fire a Kh-55, or to convert it to a land-based system. There is currently no indication that Iran possesses aircraft or ships with such capability, but Iran has a number of ships with search-track radars that might be modified to launch cruise missiles The Kilo-class submarines in Iran's possession are not fitted to launch Kh-55 missiles, only short-range SS-N-27 cruise missiles, but it is possible that some kind of deck chamber could be rigged.

Guidance would be a potential problem. The full technical details of the KH-55 guidance system are not clear, but Iran would need access the equivalent of the GPS (Global Positioning System), TERCOM (Terrain Contour Matching), or GLONASS (Global Navigation Satellite System) systems. In 2000, the Iranian defense minister announced that Iran was beginning to produce its own laser gyros, which are at the core of any modern navigation system, but the CEP of a modified KH-55 missile that flew ranges approaching 3,000 kilometers could be well over 1,000 meters, and reliability could be a very serious issue.

Iran might be able to use unmanned aerial vehicles or aircraft to provide additional guidance data during the launch and course correction phase, or plant some kind of covert homing signal. One analyst also claims that Iran might develop the capability to launch a cruise missile based on the Kh-55 from its Su-24 and F-14A aircraft.[178]

## Aircraft Delivery

The uncertainty surrounding Iran's military intentions and capabilities makes it imperative to examine any and all credible means of delivery of CBRN munitions. Iran seemingly has focused much of its defense and military strategic planning on advancing its missile programs, asymmetrical tactics, denial and deception, and advancing its existing and possible CBRN programs. These factors coupled with Iran's lacking and aging conventional military make a CBRN aircraft delivery method a definite possibility when assessing Iran's potential capabilities with its available resources.

The Iranian Air Force (IAF) is still numerically strong, but most of its equipment is aging, worn, and has limited mission capability. There are over 300 combat aircraft in the inventory [the International Institute for Strategic Studies (IISS) estimates 281 combat aircraft]. Operational command is divided into three commands and their subsequent units--Eastern, Western, and Southern.

Many of Iran's aircraft are either not operational or cannot be sustained in extended air combat operations. This applies to 50–60 percent of Iran's U.S. and French-supplied aircraft and some 20–30 percent of its Russian- and Chinese-supplied aircraft. It has nine fighter-ground attack squadrons with 162–186 aircraft; seven fighter squadrons with 70–74 aircraft; a reconnaissance unit with 4–8 aircraft; and a number of transport aircraft, helicopters, and special purpose aircraft.

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[178] Richard Fisher Jr.: China's Alliance With Iran Grows Contrary to U.S. Hopes, available at http://www.strategycenter.net/research/pubID.109/pub_detail.asp, March 5, 2007.

The Iranian Air Force is headquartered in Tehran with its training, administration, and logistics branches, as well as a major central Air Defense Operations Center. The headquarters has a political directorate and a small naval coordination staff. It has three major regional headquarters: Northern Zone (Badl Sar), Central Zone (Hamaden), and Southern Zone (Bushehr). Iran has large combat air bases at Mehrabad, Tabriz, Hamadan, Dezful, Bushehr, Shiraz, Isfahan, and Bandar Abbas. It has smaller bases at least at 11 other locations.

As is the case with most aspects of Iranian military forces, estimates of Iran's exact air strength differ by source. The IISS estimates the air force has 14 main combat squadrons. These include nine fighter ground-attack squadrons, four with at least 65 U.S.–supplied F-4D/Es, four with at least 60 F-5E/F, and one with 30 Soviet-supplied Su-24MK, 13 Su-25K, and 24 French F-1E Mirage aircraft. Iran possesses some MiG-29, Su-25K, and 24MK, and Mirage F-1E Iraqi aircraft it seized during the Gulf War. Another source reports that Iran has five fighter squadrons; two with 25 U.S.–supplied F-14s each, two with 25–30 Russian/Iraqi-supplied MiG-29A/-UBs, and one with 24 Chinese supplied F-7Ms.[179] How many of these are operational is not known.

Most Iranian squadrons can perform both air-defense and attack missions, regardless of their principal mission--although this does not apply to Iran's F-14 (air-defense) and Su-24 (strike/attack) units. Iranian sources claim that the IAF's F-14s have been modified to increase its AWG-9's radar range and capability and that Iran has integrated the R-73 air-to-air missile (AAM) and various air-to-ground weapons with the aircraft.[180] Iran's F-14s were, however, designed as dual-capable aircraft, and it has not been able to use its Phoenix air-to-air missiles since the early 1980s. Iran has claimed that it is modernizing its F-14s by equipping them with Improved Hawk (I-Hawk) missiles adapted to the air-to-air role, but it is far from clear that this is the case or that such adaptations can have more than limited effectiveness. In practice, this means that Iran might well use the F-14s in nuclear strike missions. They are capable of long-range, high payload missions and would require minimal adaptation to carry and release a nuclear weapon.[181]

Iran has acquired spare parts for F-14 aircraft from U.S. overstock through intermediaries.[182] As a consequence, the U.S. Defense Logistics Agency tightened its supervision of surplus goods sales. One source states that Iran claims to be able to produce up to 70 percent of all F-14 parts indigenously. However, Iran continues to make constant efforts to acquire F-14 and other U.S. aircraft parts on the world market. It is questionable whether or not Iran can keep more than 30 F-14 aircraft serviceable.[183]

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[179] The range of aircraft numbers shown reflects the broad uncertainties affecting the number of Iran's aircraft which are operational in any realistic sense. Many aircraft counted, however, cannot engage in sustained combat sorties in an extended air campaign. The numbers are drawn largely from interviews; Jane's Intelligence Review, Special Report No. 6, May, 1995; Jane's Sentinel - The Gulf Staffs, "Iran," various editions; the IISS, Military Balance, various editions, "Iran;" Andrew Rathmell, The Changing Balance in the Gulf, London, Royal United Services Institute, Whitehall Papers 38, 1996; Dr. Andrew Rathmell, "Iran's Rearmament: How Great a Threat?," Jane's Intelligence Review, July, 1994, pp. 317-322; Jane's World Air Forces (CD-ROM).

[180] Iran Defense Reports, http://www.irandefence.net/archive/index.php/t-744.html

[181] Wall Street Journal, February 10, 1995, p. 19; Washington Times, February 10, 1995, p. A-19.

[182] Cnn.com, Iran, China exploit U.S. military surplus supermarket, January 16, 2007.

[183] Guy Anderson, "isonmainer suspends sale of F-14 parts", *Jane's Defence Weekly*, February 7, 2007.

According to the *Flight International* magazine, Iran has managed to keep operational a large number of its F-14 fleet until today. Iran - with the help of Russian experts & technology - is comprehensively upgrading its F-14 fleet involving new radar, engine and a glass cockpit. This will not only keep their F-14s operational but will give Iran also a potent F-14 force well into the future.[184]

According to one source, Iran has improved its Su-24s within-flight refueling capability, a Upaz-A buddy refueling system to extend the range of other aircraft, installed active radar jammers and electronic countermeasures, and upgraded some aspects of the weapons launch and target software. [185] These reports cannot be fully confirmed.

Some reports indicate that Iran ordered an unknown number of TU-22M-3 "Backfire C" long-range strategic bombers from either Russia or the Ukraine.[186] While discussions to buy such aircraft seem to have taken place, no purchases or deliveries have ever been confirmed.

Iran is also reportedly seeking to acquire up to 250 Russian-built Su-30 MKs to update its land-based aircraft fleet. The Su-30, an advanced fighter-bomber, has a range of 1,620 nautical miles which can be extended with in-flight refueling. Its weapons payload of 17,000 pounds and advanced avionics make it a much more capable delivery system.[187]

An unknown number of "new" Su-25s were delivered to the Iranian Revolution Guards Corps Air Force (IRGCAF) in 2003. Where these Frogfoots originated from was unclear. Since the number was said to include advanced Su-25T and Su-25UBK aircraft reports suggested that these aircraft could have come from Russia or Ukraine, two countries Iran had significant contact with during the 1990s especially regarding aircraft manufacture.

In July 2003 Chengdu Aircraft Industrial Corporation (CAIC) unveiled the new "Super-7" or Chao Qi fighter plane to the public. The new Super-7 is an all-purpose light fighter, required to have all-weather operation capabilities, be capable of performing the dual tasks of dogfight and air-to-ground attack, and have the ability to launch medium-range missiles. Mass production of the fighter will not begin until two and a half years of research are completed. The plane is being produced to be sold abroad to developing nations. China said it had received orders from Iran and some African countries. Production of the Super-7 aircraft, now called the FC-1 (with an export designation of JF-17) was supposed to begin in 2006, but this was believed to have been delayed. Iran had not received any such aircraft by 2008.[188]

On 30 July 2007 the *Jerusalem Post* reported that Iran was negotiating with Russia to buy 250 Sukhoi Su-30 "Flanker" fighter-bombers. Israeli defense officials were investigating the potential Iran-Russia deal, in which Iran would pay $1 billion for a dozen squadrons' worth of the jets. Iran would also buy 20 Ilyushin Il-78 Midas tankers that could extend the fighters' range as part of the deal. The move was seen as a response to the new

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[184] *Flight International Magazine,* September 1999, available at: http://info.flightinternational.com/?bbcam=adwds_z1&bbkid=flight+international&x=&jtid=83112&client_code=

[185] Iran Defense Reports, http://www.irandefence.net/archive/index.php/t-744.html

[186] Jane's Sentinel Security Assessment-The Gulf States, Armed Forces, Iran, October 7, 2004

[187] Philip Ewing, "Iran May Buy 250 Jets from Russia," *Navy Times*,August 1, 2007.

[188] Globalsecurity.org, July 10, 2008, available at: http://www.globalsecurity.org/military/world/iran/airforce.htm

American plans to sell billions of dollars' worth of weapons to potential Iranian adversaries in the Middle East, including Saudi Arabia, Egypt and Israel. The report came soon after other deals to sell advanced Su-27 and Su-30 combat fighters to Indonesia, Malaysia and Venezuela.[189]

On July 28, 2008 Brigadier General Ahmad Miqani was quoted as saying that Iran's Air Force has achieved self-sufficiency in the repair, maintenance and overhaul of its equipment. He added that Iranian military experts are capable of overhauling F-5 two-seaters, F-14 Tomcat fighter jets, 707 and 747 aircrafts with only forty days of work. "We have upgraded our air force fleet, state-of-the-art radar-systems, and rocket launchers over the past few years," Brig. Gen. Miqani said, adding that the country would continue its efforts to reach the peak of its military capability. The Iranian Air Force chief announced that the country is mass producing different types of drones used in reconnaissance missions, pinpointing enemy bases, and carrying explosives.[190]

It should be noted that in addition to conventional warfighting capabilities, Iran has a large number of attack and air-defense aircraft that could carry a small- to medium-sized nuclear weapon long distances, particularly since such strikes are likely to be low-altitude one-way missions. (These were the mission profiles in both NATO and Warsaw Pact theater nuclear strike plans.) Several might conceivably be modified as drones or the equivalent of “cruise missiles” using autopilots, on-board computers, and an add-on global positioning system.

# Iran’s Uncertain Path

Iran is the only country not in possession of nuclear weapons to have produced or flight-tested missiles with ranges exceeding 1,000 kilometers. The Iranian missile program is largely based on North Korean and Russian designs and has benefited from Chinese technical assistance.[191] It is very important to remember this when analyzing and assessing Iran’s motives, intentions and capabilities in regards to its ballistic missile programs; and how they relate to Iran’s existing and possible WMD programs.

Iran is putting immense effort into programs that can deliver weapons of mass destruction, and many of which make sense only if they can eventually be equipped with a nuclear or highly lethal biological weapon. It must be stressed, however, that Iran’s problems are evolutionary, opportunistic in character and execution, and reliable unclassified reports do not exist on many of their key details.

Accordingly, any analysis of Iran’s efforts to acquire weapons of mass destruction has to both look beyond its nuclear programs, but recognize that much of the same degree of uncertainty that that surrounds Iran’s nuclear, chemical and biological weapons efforts exists in analyzing its delivery systems. This does not, however, mean that the analysis of Iran’s nuclear programs can credibly be it means that all of Iran’s relevant efforts need

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[189] YAAKOV KATZ and HERB KEINON “Reports: Russia to sell long-range fighter jets to Teheran” July 30, 2007: http://pqasb.pqarchiver.com/jpost/access/1315547451.html?dids=1315547451:1315547451&FMT=ABS&FMTS=ABS:FT&type=current&date=Jul+30%2C+2007&author=YAAKOV+KATZ%3BHERB+KEINON&pub=Jerusalem+Post&edition=&startpage=01&desc=Reports%3A+Russia+to+sell+long-range+fighter+jets+to+%3B+Teheran

[190] ”Iran Overhauls F-14 Fighter Jets,” Fars News Agency, July 29, 2008 available at: http://english.farsnews.net/newstext.php?nn=8705081124

[191] Alex Bollfrass, Arms Control and Proliferation: Iran, Arms Control Association, January 2008, available at: http://armscontrol.org/factsheets/iranprofile.

more analysis in net assessment terms, and that both official and unofficial analytic efforts that only examine part of Iran's programs have limited value and credibility.

The Iranian missile program has been shrouded in secrecy, deception, and the unknown. Iran obtains weapons of various design and origin, and frequently retains a single name and reclassifies its physical missile assets, which adds to the confusion. At present the future of the Iranian missile program is uncertain, but the existence of these missiles must continue to raise questions in the international community, as to what Iran's military intentions are in conventional and unconventional terms, regionally and globally.

## Appendix A: Key Acronyms

AEOI - Atomic Energy Organization of Iran
AVLIS - Atomic Vapor Laser Isotope Separation
BNPP - Bushehr Nuclear Power Plant
CAIC - Chengdu Aircraft Industrial Corporation
CBRN - Chemical, Biological, Radiological, and Nuclear warheads
CEP - Circular Error Probable
CSL - Comprehensive Separation Laboratory
CWC -Chemical Weapons Convention
DIV - Design Information Verification
EBW - Exploding Bridgewire
EIA - U.S. Energy Information Agency
EMP - Electromagnetic Pulse
ERI - Education Research Institute
FEP - Fuel Enrichment Plant
FMP - Fuel Manufacturing Plant
GLONAS - Global Navigation Satellite System
GPS - Global Positioning System
IAEA - International Atomic Energy Agency
IAF - Iranian Air Force
IAIO - Iranian Aerospace Industries Organization
IAP - Institute of Applied Physics
IISS - International Institute for Strategic Studies
IOC - Initial Operating Capability
IR-40 - Iran Nuclear Research
IRBM - Intermediate Range Ballistic Missile
IRGC - Islamic Revolutionary Guards Corps
IRGCAF - Iranian Revolution Guards Corps Air Force
*I*sp - Specific Impulse
Kgf - Kilogram-force
KM - Kimia Maadan Company
LOW - Launch-on-warning
LRICBM - Limited Range Intercontinental Ballistic Missile
LSL - Laser Spectroscopy Laboratory
LUA - Launch-under attack
MEK - Mujahadeen-e-Khalq
MIX - Molybdenum, Iodine, Xenon Radioisotope Production Facility Reactor
MLIS - Molecular Isotope Separation
MRBM - Medium Range Ballistic Missile
MTRC - Missile Technology Control Regime
NATO - North Atlantic Treaty Organization
NCRI - National Council of Resistance of Iran
NIOC - National Iranian Oil Company
NPT - Non Proliferation Treaty
PFEP - Pilot Fuel Enrichment Plant
PHRC - Physics Research Center

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| PIT | - Physical Inventory Taking |
| PLC | - Programmable Logic Control |
| PRC | - Peoples Republic of China |
| SHIG | - Shahid Hemat Industrial Group |
| SLBM | -Submarine Launched Ballistic Missile |
| SRBM | - Short Range Ballistic Missile |
| TEL | - Transporter-Erector-Launcher |
| TERCOM | - Terrain Contour Matching |
| TRR | - Tehran Research Reactor |
| UCAV | - Unmanned combat aerial vehicles |
| UCF | - Uranium Conversion Facility |
| UO2 | - Uranium Dioxide |
| UF4 | - Uranium Tetrafluoride |
| UF6 | - Uranium Hexafluoride |