Uzi Rubin

# The Global Reach of Iran's Ballistic Missiles

Institute for National Security Studies

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Memorandum 86 November 2006

המכון למחקרי ביטחון לאומי
THE INSTITUTE FOR NATIONAL SECURITY STUDIES

עוזי רובין

# הטילים הבליסטים באיראן: מחזון למציאות

Editor**:** **Judith Rosen**
Graphic Design**:** **Kedem Ltd.**
Printing House**:** **Kedem Printing**
Cover photo: Iran's Revolutionary Guards fire the Shahab 3 long range ballistic missile. Courtesy: AFP/Mehr News

Institute for National Security Studies

Tel Aviv University
Ramat Aviv
Tel Aviv 69978
Israel


November 2006

Tel. 03-6409926
Fax. 03-6422404

E-mail: jcss2@post.tau.ac.il
http://www.tau.ac.il/jcss/

ISBN: 965-459-071-9

## *Table of Contents*

## *Executive Summary*

While the international community is focused on Iran's potential nuclearization, it ought likewise to take stock of the developments in Iran's missile technology. Iran's missiles are an indispensable complement to its nuclear ambitions and merit as much scrutiny as its nuclear program.

This study describes and interprets the Iranian missile program within the context of Iran's threat perception, armament policies, and overall ambitions. Charting the origins of Iran's missile program and its development, the study presents a clear picture of where Iran's missile capability stands today and where it is likely headed. Iran's space program is a symbiotic adjunct to the missile program, and is reviewed here as well.

Among the main conclusions of this study:

- Iran's missile and space programs are progressing with singular urgency: no other country in the world, including established industrialized powers, comes close to Iran in the number and variety of ballistic missiles in development or already deployed.
- The Iranians are covering almost all technological bases: ordinary liquid propulsion, storable liquid propulsion, and solid propulsion. Along with ballistic missiles and space launch vehicles, Iran seems poised to add a cruise missile component to its strategic forces.
- Iran's development of a space launch vehicle may well be a harbinger of an ICBM.
- The range of Iran's missiles has grown steadily decade by decade, from a purely local range to an extended range that is likely to dominate the entire European continent by the end of the decade.

- Heralding the missile program with a great deal of transparency, Iran has exploited it as a psychological tool, adding it to its force of "deterrence enhancers."
- There is some doubt as to the quality and precision of the more advanced missiles, with Iran's claims likely exceeding the missiles' actual capabilities.
- Nonetheless, Iran's aspirations should be taken seriously, and given the various components of its missile program, it should be assumed that the missiles are approaching a global range.

# Introduction

Iran's aspirations for regional hegemony and global power were not born with the Islamic Revolution of 1979. Rather, they were already nurtured during the preceding secular regimes of the two modernizing Pahlavi shahs. The second and last of them, Mohammad Reza, formulated a clear policy of converting Iran's windfall from the first oil embargo and price hikes of 1973 into the mightiest military-industrial complex in the Middle East, and of exploiting this newfound power to become the guardian of the Middle East oil deposits, arbiter of Middle East affairs, and a force to be reckoned with among the industrialized nations. Not only did Mohammad Reza buy the best and the latest of Western armaments: his ambitions embraced nuclear power and long range missilery. With Iran's Bushehr nuclear reactor nowadays occupying center stage in the confrontation between the Islamic Republic of Iran and the West, few remember that it was none other than Mohammad Reza Pahlavi himself who first launched this project.

Mohammad Reza's dream was relegated to a low priority when the ayatollahs seized power in 1979 and proclaimed the Islamic Republic of Iran, based on their complete rejection of the West and its values. Ayatollah Khomeini, founder of the Islamic Republic, issued a fatwa against nuclear weapons, calling them the work of Satan and thereby commanding Iran to forego – or so it seemed at the time – one of the cornerstones of future power and stature as envisaged by the shah.

Events, however, quickly forced the Islamic Republic to embrace anew the second cornerstone of the late shah's grand design and to revive the ballistic missile program. The Iraqi missiles that devastated Iran's border district cities in the beginning of the Iran-Iraq War found Iran bereft of any means to respond in kind. From this sense of

helplessness and frustration was born the Iranian missile industry of today, an industry whose achievements are regarded with pride by most Iranians as a hallowed legacy of fortitude and perseverance in the face of a mortal enemy.

Once the fury of the Iran-Iraq War dissipated, and particularly after the US display of the awesome power of modern weaponry in the 1991 Gulf War, Iran restored the first pillar of the shah's master plan and revived the Bushehr nuclear reactor project, albeit for peaceful purposes only. Today Iran stands accused of using its "peaceful" nuclear program as a cover for a covert military nuclear program, a charge that it hotly denies. Nevertheless, the national goals of the Islamic Republic are now hardly distinguishable from those of the preceding imperial regime, namely regional hegemony and world stature. The difference is in the venue, not in the end result. While the shah planned to co-opt the West to advance his national aspirations, the present regime works to harness the power of global Islam for pushing forward its hegemonic ambitions. Many of the statements of Iran's present leaders make good material for Islamic preaching, but many other statements – for example, those extolling Iran's millennia of greatness – are hardly distinguishable from the bombastic speeches delivered at the 1967 coronation of Mohammad Reza and his wife Farah as the emperor and empress of the 3000-year old Persian Empire. Iran is very much back in the global power game, and it suits its ambitions to own nuclear-tipped long range ballistic missiles to give a punch to its ambitions, irrespective of what its leaders mouth today to placate world opinion.

The international community's attention is currently riveted on Iran's nuclear program, and rightly so. Iran's nuclearization, if achieved, will cause a tectonic shift in the global power balance and propel the course of history along an ominous route. At the same time, Iran's missiles are an indispensable complement to its nuclear ambitions and merit as much scrutiny as its nuclear program. So far, however, Iran's missiles have drawn far less attention than they should.

There may be three reasons for this curious lack of interest from Western researchers. First, Iran's missiles cannot yet reach Europe, not to speak of the US. Therefore, there is no sense of alarm such

that would prompt a closer scrutiny of Iran's missilery, as did Sputnik vis-à-vis Soviet missilery in 1957. Second, the debacle of the elusive Iraqi weapons of mass destruction created a feeling of distrust in dire predictions about Iran's missiles, and hence the lukewarm drive to write and publish about them. Third, the Iranians promote their missiles with an outstanding degree of transparency, perhaps unparalleled even in Western democracies. There are so many Iranian disclosures – verbal and visual – of their missiles that there seem to be few elements that are worthy of research and debate.

Yet the situation is in fact far from clear cut. Iran's missiles are steadily increasing their ranges, year by year. Unlike Saddam's weapons of mass destruction, Iran's missiles are not a figment of intelligence agencies' imagination: they are there for all to see, displayed, paraded, advertised, and extolled by Iran's leaders, press, and television. At the same time, this transparency – or perhaps over-transparency – has an air of carefully contrived posturing, designed to draw the observer's attention away from the magician's wrist motion.

This study describes and interprets the Iranian missile program within the context of Iran's threat perception, armament policies, and overall ambitions. Iran's space program, as that of other regional powers, is a symbiotic adjunct to the missile program, and is thus included herein. This review relies exclusively on open source material, most of which has been made available – remarkably enough – by the Iranians themselves in copious media articles, interviews, still images, and video footage. Complementing the factual statements below, which are based on published material, is the author's analysis. Some additional speculations on Iran's future satellite launchers are the product of calculations generously provided by Mr. Israel Briman, Dr. Arieh Malta, Dr Ephraim Bashan, and Dr. Gad Mayer. The author wishes to thank the many people who provided source material in preparation of this work, especially Mr. Richard Speier (US) and Mr. Tal Inbar (Israel). Dr. Ephraim Kam's book on Iran[1] was a source of inspiration for many of the facts and speculations in this study.

[1] Ephraim Kam, *From Terror to Nuclear Bombs: The Significance of the Iranian Threat* (Tel Aviv: Ministry of Defense Publishing House and Jaffee Center for Strategic Studies, 2004) [Hebrew].

# 1

# *The Rationale of Iran's Armament Policy*

From its inception, the Islamic Republic of Iran adapted a policy of confrontation against the Western world, first and foremost against the US, but also against the Soviet Union, albeit in a more subdued form. However, barely two years into the revolution, an existential threat to the regime arose when Saddam Hussein launched a full-scale assault against Iran. During the ensuing eight-year war and beyond, until the 1991 Gulf War, Iraq was deemed the prime security threat to Iran. This threat perception changed with the US buildup during Operation Desert Shield, and even more so after the crushing defeat of Saddam's military machine in Operation Desert Storm, whereupon the US replaced Saddam as the chief threat to Iran's security. Following Saddam's ouster in the 2003 Iraq War, the considerable US military presence along the southern border made Iran even more apprehensive of US intentions.

Iran thus perceives its major threat as emanating from the US, with the primary threat scenario a massive military attack by US forces based in Iraq and the Gulf states, possibly supported by some US allies in the region. Iran's leadership is acutely aware of its country's military inferiority relative to the US, and nurtures no illusions of victory in a set piece battle. Rather, Iran plans to defeat the US by attrition, relying on what it believes is the American vulnerability to casualties and lack of perseverance in the face of mounting losses. This is neither original nor new: Saddam had the same low opinion of American resolve, and made a similar "body bag calculation" both in 1991 and 2003. The Iranians, though, believe they can do it better. Moreover, they are sensible enough to play the deterrence game to the hilt in the hope of discouraging the US, or at least its local allies, from actually launching an attack. Hence

unlike Saddam's secretiveness about new weapon developments, the Iranians are almost frantic in volunteering information about their weapons and capabilities, sometimes to the point of incredulity.

As a consequence of its deterrence strategy, Iran channels resources sparingly towards renewal, modernization, or enlargement of its stockpiles of field weaponry. Instead, it invests in "deterrence enhancers" – namely, weapons, systems, and tactics that could deter the US, astonish local allies, and buttress the morale and fighting spirit of Iran's own troops. In other words, Iran's military acquisitions reveal a rather defensive mindset with an intention to deter against an attack rather than to win a war by overwhelming force. No huge fleets of modern tanks supported by numerous squadrons of attack aircraft, such as would be needed to overrun neighboring countries, have been built or purchased. This policy may eventually be reversed by Mahmoud Ahmadinejad and his confrontational faction, encouraged by the tripling of Iran's oil income. To date, however, this has not occurred, although according to some sources, the Ahmadinejad regime has already earmarked multibillion-dollar budgets against vast armament acquisition programs from abroad, mostly from Russia and China.

Complementing this policy are the frequent military parades so beloved by Iran's leaders. In the Army Week parade of 2004, and again in that of 2005, an overwhelming proportion of the ground and air equipment that rolled past and flew over the grandstands hailed back to Reza Pahlavi's shopping spree of the 1970s: M113 APCs, M60 tanks, Cobra gunships, and F-14 Tomcat and F-4 Phantom fighters, to name some of what was displayed. Even a product of Israel, the most hated enemy, was displayed in the form of an Israel Aircraft Industries air refueler, a conversion from a Boeing 707 airliner.

Hence for the present Iran's armament policies seem to prefer weapons that are meant to impress before they are meant to be used in anger: to impress the US and its allies that a war with Iran would not be easy, as well as to impress Iran's own population that Iran's armed forces can put up a viable defense against the world's sole superpower. Observers too should not be misled: Iran's weapons are not mere

window dressing. They are designed to have a substantial effect, and particularly so in the case of the ballistic missile programs. Thus instead of buying fleets of new tanks and fighter aircraft, Iran has been investing its resources for developing and fielding a range of missiles designed to achieve control of the sea, land, and air spaces adjacent to its borders, mainly in the Persian Gulf. It also attempts to impress its Middle Eastern neighbors by hinting of even greater potent power projection – all against the backdrop of an ostensibly "civilian" nuclear program that would lend Iran the aura of a military nuclear power, regardless of whether its leaders actually decide to build bombs or find it more expedient to leave this option as an implicit threat.

Most of those missiles show their Chinese and Russian pedigree. Raad is a shore based anti-ship missile with the range of 350 km – enough to block the Persian Gulf at its widest point. It is apparently an advanced version of the Chinese Silkworm (in itself a copy of the Soviet Styx) with the original rocket motor replaced by a small jet engine, probably a Chinese version of the French Microturbo TR60. The Fatah 110 is evidently a guided, improved precision version of the Zelzal unguided bombardment rocket, hailing originally from China. With a declared range of 200 km and a warhead of several hundred kilograms, those missiles are intended to assault hostile troops concentrated in advance of an invasion of Iran as well as their logistic support centers – a veritable (cheap) tactical air force. Other programs encompass smaller Katyusha-type bombardment rockets dubbed Fadjr, man-portable anti-air missiles externally similar to the old Soviet Strela, and anti-tank missiles. All those weapons are meant to be effective in the battle for public opinion no less than on the battlefield. They are displayed and lauded, sometimes to the point of ludicrousness.

During the naval exercises of April 2006, crafted to impress Iran's own population with the military might of the Pasadaran (Revolutionary Guard) Navy, the Iranians uncovered with great fanfare two allegedly indigenous advanced weapons: a rocket propelled, 400 km per hour underwater projectile, and a flying boat of purportedly breakthrough design. Iranian officers speaking to the TV cameras heaped praises

on Iran's scientific community for creating those marvels of modern technology, unavailable in any other country "except Russia." A cursory examination of the video images revealed them to be 1960s vintage Soviet technologies of the more marginal kind: the Shkval short range unguided underwater rocket, and an Ekranoplan ground effect vehicle. Both technologies have not seen wide use in Soviet arsenals and are being marketed today by Russian companies, apparently with no great success – or at least that was the case until their recent promotion on Iranian TV. Obviously, the Iranians felt compelled to make a propaganda ploy to the home audiences even at the cost of harming their credibility with outside experts.

2

# *The Shahab Family of Ballistic Missiles*

Shahab ("Comet") is a generic name given by the Iranians to a line of ballistic missiles of various ranges and payloads, all sharing the heritage propulsion technology and general layout of the venerable Soviet R11 – the famous Scud ballistic missile of the 1950s. When Iran found itself unable to respond in kind to Saddam's missile attacks soon after the outbreak of the Iran-Iraq War, a small arsenal of Scud missiles with a small number of launchers was acquired from Libya, at that time one of Iran's few strategic allies. The missiles were used effectively by Iran, especially during the War of the Cities when Baghdad was subjected to a counter-offensive by Iranian ballistic missiles, causing considerable damage and loss of life. After the war, Iran turned to North Korea for the acquisition of both the 300 km Scud B replicas made in that country, and the newer 580 km Scud C allegedly developed by its nascent missile industry. Quantities of both types of missiles and their launchers were purchased, as well as their production lines. The Scud B and C were dubbed Shahab 1 and 2, respectively, and manufactured in considerable quantities. Between the Gulf War of 1991 and the Iraq War of 2003, a large number of Shahab 1s were fired operationally against encampments of the Mujaheedin el-Khalq opposition group inside Iraq – a fact that hardly drew any attention in the West.

## *Shahab 3*

The first inklings that Iran intended to obtain even longer range missiles reached the media in the 1990s. As early as 1993, an Israeli newspaper report indicated that Iran's next missile would have a range of 1300

km – sufficient to hit Tel Aviv and Riyadh, from well within Iranian territory. While the deployment of the Shahab 1 and 2 could be seen in terms of the threat from Saddam's Iraq, the range of the forthcoming missile reflected the shift in Iran's threat perception against the West. It was now the US forces in the region and their allies who were seen as the main threat. The new missile was clearly aimed to dissuade Saudi Arabia from hosting US forces, and to punish Israel if and when a US-led attack was launched against Iran. Later in the decade, the new missile, which surfaced in a July 1998 flight test trumpeted by Iran's state-owned television, was named the Shahab 3.

**Figure 1.** North Korean exports; left: Iran's Shahab 3; right: Pakistan's Ghauri

There is little doubt today that the Shahab 3 is a very close relative, if not a full fledged clone of the North Korean mysterious No Dong, a missile purportedly developed in North Korea and tested there perhaps only once; its existence has never been conceded by the North Koreans nor did any image of it reach the media. However, the Shahab 3's remarkable similarity to the Pakistani Ghauri missile lends credence to the theory that both are close relatives, perhaps customized export versions of the North Korean design (figure 1). The No Dong (to use its Western appellation – what the North Koreans call it remains a mystery) is basically an enhanced Scud airframe powered by an enhanced Scud rocket motor that uses the same room temperature liquid propellants

of the old Soviet design. Reports of Russian involvement in design improvements of the Iranian version of the No Dong surfaced almost in parallel with those about the missile itself. Russian academic institutes, research facilities, and defense industries were named as contributing to improvements in propulsion, guidance systems, and thermal shielding. Consistent reports appeared about an attempt to graft a Russian rocket motor onto the North Korean-designed airframe, which apparently encountered some difficulty. This caused delays in the development program and compelled the Iranians to buy a stock of North Korean-made rocket motors to put the program back on track. Following several more tests, Iran announced the Shahab 3 operational and inducted it into the service of the Pasadaran rocket forces in a televised ceremony presided by the supreme leader, Ali Khamenei.

Reports about even longer range Iranian missiles appeared in the Western media from the first unveiling of the Shahab 3. Speculations abounded about more advanced versions of the Shahab 3, dubbed Shahab 4 and Shahab 5, and there were reports of a solid rocket ballistic missile dubbed Cossar, with quoted ranges from 2000 to 5000 km. All such reports were emphatically denied by Iranian officials. In an interview with the London based *al-Hayat*, the deputy head of Iran's aerospace industry admitted that a certain range increase in the Shahab 3 would materialize to make it more effective against Israel, but hinted that the desired range was around 1500 km – apparently to distance the launch sites from the reach of Israeli long range F-15I strike aircraft. Other Iranian officials insisted that the Shahab 3 is the final member of the Shahab missile family – there would be no Shahab 4, 5, and so on.

In August 2004 Iran tested a new version of the Shahab 3, described as "more accurate." The missile is somewhat longer than the earlier version, its internal design seems to be significantly modified, and it carries a much revised reentry vehicle[2] with a distinct baby bottle-like

[2] To increase range, the front end of the ballistic missile is often detached from its fuselage after the burnout of the rocket motor. The front end then continues to travel towards the target, reenter the atmosphere and impact on the ground. It is therefore called a reentry vehicle. The missile's payload, whether conventional or non-conventional, is the warhead that is packaged within the reentry missile vehicle and is activated at the end of the flight.


**Figure 2.** Shahab 3-ER being prepared for a flight test, August 2004

shape (figure 2). Shortly after this test, Iranian sources disclosed that their missiles could now achieve the range of 2000 km. No specific name was given to this new version, which for the purpose of this paper will be called Shahab 3-ER. Initially some slight embarrassment could be discerned in Iranian statements over the extended range, which seemed to violate an unwritten understanding that Europe should not be targeted (the 2000 km range covers most of Eastern Europe). Recently, however, Iranian officials were citing this range openly when extolling Iran's power of resistance against prospective US military action.

The Shahab 3-ER, while dimensionally longer than the previous version, travels on the same towed launcher, powered by a Mercedes-made commercial truck. Its modified design carries the telltale signs of Soviet-style missile engineering, with significant family resemblance to the work of the famous Makayev design bureau. How exactly this is related to contemporary Russian missile engineering resources remains a mystery. Nevertheless, it seems that the Iranians are still capable of drawing on Russian expertise for the Shahab program, either directly or through intermediaries like North Korea.

With the Shahab family of ballistic missiles, Iran has already projected its power over the entire Middle East. Every major city and military installation between the western shores of Turkey and the eastern border of Pakistan and between the Black Sea in the north and

the southern narrows of the Red Sea are within range of the Shahab family of missiles. Even more significant, Iranian ballistic missiles can now cover the entire area of the Middle East from *fixed* sites deep within Iran's borders. The importance of this capability cannot be overemphasized. All the Shahab variants are designed to be transported by and fired from land mobile launchers. The survivability of land mobile missiles is based on their mobility, which permits them to travel from their launch sites into hiding places shortly after firing off their missiles. This is how Saddam's missileers evaded the US air assets sent to destroy their launchers during the 1991 Gulf War. Yet land mobility carries its own risks to survivability: if provided with timely intelligence, the attacker can theoretically intercept and destroy land mobile launchers when they are on the move for operational or logistics purposes. Hence, suitably hardened fixed sites were preferred by both superpowers as the chief (and in the case of the US, the exclusive) basing mode of the core of their ground based ICBMs. There are indications that the Iranians are now following suit.


**Figure 3.** Iran's Shahab missile power projection from hardened fixed sites (site locations are notional)

Without the need to move the launchers from one spot to another over open roads to cover far-removed targets to the east, south, and west, Iran's missiles are significantly less vulnerable to preemption. In fact, Iran can afford to deploy them from fixed silos – indeed the first indications that Iran is doing so have been recently hinted at in the open media. Figure 3 illustrates the power projection and survivability potential of Iran's missile. The 580 km Shahab 2 can hit both Baghdad and Doha without moving from a launch point in the Shat El Arab area. A Shahab 3 missile can hit Tel Aviv or Riyadh from a fixed launch point near Tabriz. Ankara (Turkey), Alexandria (Egypt), and Sana'a (Yemen) are all within range of a Shahab 3-ER launcher positioned in a fixed site near Esfahan.

With this kind of power projection capability, namely, with missiles that are both capable of reaching every corner of the Middle East and survivable against preemption, Iran is already the major missile power of the region, at least in theory. The effectiveness of its missiles, however, seems to qualify this capability to some extent.

**Figure 4.** Shahab 3 in Tehran with the banner "Israel should be wiped off the map," September 1999. Similar banners have since been displayed on Shahab 3 launchers in every annual Martyr's Week parade.

The Shahab missiles are frequently used by Iran to impress and dazzle. Since 1999, the Shahab 3 and its ER variant have been paraded before Iran's leaders (and the world's TV cameras) each September

during the annual Martyr's Week (the Iran-Iraq War commemoration) ceremony. The number of paraded missiles varies from year to year, the highest to date being six missiles. From 2004 and on, the annual parade has included the new ER version. Invariably two of the Shahab 3 launchers carry giant banners with anti-Israel and anti-US slogans, such as "Israel should be wiped off the map" and "We shall crush the US," or equivalent sentiments (figure 4). The slogans are written in English and/or Persian. Clearly, the Shahab 3 is not just a strategic weapon: it is meant to have a psychological impact no less than it is meant to work as a military weapon system.

And in fact, it is the technical viability of the missile that is somewhat questionable, at least in Western eyes. Since it is impossible to hide the flight testing of ballistic missiles the size of the Shahab 3 from the prying eyes of the US early warning satellites, the number and frequency of the Shahab 3 tests of all variants is fairly well known. Observations from space can reveal some information about the degree of success in such tests. The Iranian policy on disclosing the Shahab 3 test has not been consistent. In some cases the tests were advertised with great fanfare by Iran's media; in other cases the Iranians remained silent, but the Western media nevertheless reported on the tests. Hence, the record of the Shahab 3 flight test and some idea about the rate of success is available from open sources. It seems that in the eight years between the first Shahab 3 flight test in July 1998 and the most recent flight test of May 2006, only ten flight tests were conducted. This is a remarkably low number for what is surely a strategic weapon for Iran. Moreover, according to Western sources, about half of those tests ended in total or partial failure. With this kind of record, no Western armed force would have declared any of the Shahab 3 versions as fully operational and ready for deployment. Yet the Iranians have done so, and with considerable relish since three years ago, at a time when the missile was tested barely six times with very mixed results. Not only did Iran "induct" the Shahab 3 into its strategic rocket forces in July 2003 with an impressive martial ceremony; it has also declared an increase in production rate to several units per month. Evidently, the less than

stellar record of the Shahab flight test program has not discouraged Iran's military authorities.

In Western practice, any weapon system that is not proven by a high rate of success in the test range is not considered operational and will not be mass produced for operational use until fully qualified. The Iranians' approach seems to be very different: if the design works once or twice in the test range, they are apparently ready to take the chance that it will also work in the battlefield and move it to series production and deployment. Rigorous qualification can come later. This telescoped approach permits them to reap the full propaganda benefit from the Shahab family of missiles, highlighted by the enthusiastic promotion in the annual military parades, years before the weapon is destined to achieve maturity in Western terms.

It is dangerous, however, to dismiss the Shahab 3 line of missiles as mere window dressing. While their flight test record is mixed, there is a general agreement by foreign observers that some of their tests were indeed successful, proving the design as viable, if as yet not entirely reliable. Iran's claim of a 2000 km range should also not be dismissed. While there is no information so far about any test to the full 2000 km range, this does not mean that the missile will not be able to reach it if so programmed. Since the Iranian rocket forces have deployed the Shahab 3 for several years already, they must have accumulated considerable experience in operating it. There should be no doubt that in case of conflict, Iran will launch Shahab 3 missiles regardless of their flight test record, and that some of them will reach their destinations. Once the Iranians claim their Shahab missiles are operational, Iran's neighbors and the rest of the world should take this claim at face value and factor it into their defense plans.

# 3
# *Solid Propellant Ballistic Missiles*

It May 2005, Iran's then-minister of defense, Ali Shamkhani, made a statement that Iran had succeeded in testing solid propellant rocket motors for a "twin engine" (two-stage?) missile. Later Iranian disclosures hinted that this rocket motor was designed for the Shahab missile. Shamkhani himself went on the record with lengthy explications why solid rockets were superior to liquid rockets in achieving better accuracy.

Iran manufactured small diameter solid propellant rocket motors for its unguided Zelzal heavy rockets for quite some time prior to Shamkhani's statement. Hence, his revelations must reflect some significant progress in Iran's missile capabilities. From his elaborate extolling of solid propellant rocketry, his allusion to a twin engine missile, and the linking of the new rocket motor to the Shahab missile, it can be inferred that Iran is engaged in a solid propellant, multi-stage strategic range ballistic missile program. Replacement of the current liquid propulsion of the Shahab 3 by solid propulsion makes no sense; this would practically result in a completely new missile and would require redevelopment and retesting. Hence, the linkage of the new rocket capability with the Shahab could be interpreted as a success in the development of solid rocket motors with the Shahab class diameter – about 1.25 to 1.35 meters, according to various sources. If so, this would indeed signify a quantum leap in Iran's engineering prowess: large diameter solid rocketry is far more sophisticated than that of the small diameter motors used for unguided rockets of the Katyusha class, and opens the way to reliable, survivable, multi-stage ballistic missiles and military space launch vehicles. There is no reason to discredit this

information, which would mean that Iran has two parallel lines of strategic rocket development: the liquid propellant line, and the solid propellant line, much like Pakistan, with its (liquid) Ghauri and (solid) Shaheen parallel missile lineages.

Large diameter solid propellant motors can be stacked up to make multi-stage missiles. The Shaheen 2 is a good example: its second stage is a shortened version of its first stage. Thus, Iran's mastery of large diameter solid propulsion is a harbinger of long range solid propellant missiles, and significantly, of multi-stage, efficient satellite launch vehicles for low earth orbit packages.

4

# *Cruise Missiles*

For some time Iran has been manufacturing long range anti-ship, jet propelled winged missiles, obviously derived from Chinese designs. These are often called cruise missiles, but this is a misnomer. The appellation “cruise missile” belongs to long range jet propelled and winged land attack missiles (or more precisely pilotless aircraft, the German V1 being the earliest precursor of such weapons). Recent revelations hint that Iran may at some time in the future add such weapons to its strategic arsenal.

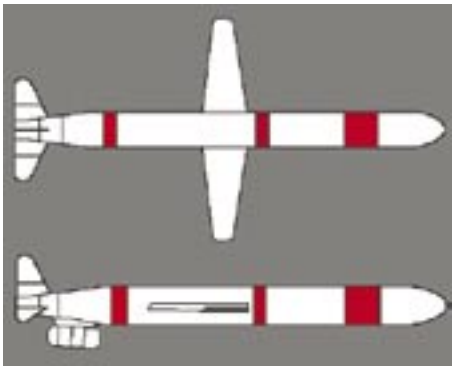

**Figure 5**. Russia's strategic nuclear capable cruise missile, the Kh55 (NATO code name Kent)

With the breakup of the Soviet Union in 1991, a portion of its nuclear strategic force was marooned in the newly independent Ukraine. This included about 500 or so KH55 (NATO code name AS15 Kent, figure

5) air launched, nuclear capable cruise missiles. Those missiles, equivalent to the US Tomahawk, have a range of 3000 km. Shortly after the secession of Ukraine, the nuclear warheads of the marooned Kh55s were disassembled from the missiles by Russian air force personnel and shipped back to Russia. The missiles themselves remained in the Ukraine until 2001 or 2002 when a political arrangement between the two countries permitted their repatriation to Russia, where they have been converted to conventionally armed weapons. According to official Ukrainian government disclosures, between twelve and twenty of the missiles never reached Russia. They were diverted by corrupt officials of the previous regime to China, Iran, and probably also to North Korea.

That Iran was interested in acquiring this type of weapon is only natural. After all, US cruise missiles featured prominently in the 1991 Gulf War and in Iraq in 2003, as well as in several inter-war strikes against Saddam's Iraq. The Kh55, however, is not readily useable by Iran: it is an air-dropped weapon that can currently be launched from only two types of aircraft, the Tupolev 95 Bear turboprop bomber, and the Tupolev 160 Blackjack supersonic bomber, which Iran does not possess. The missile can be converted to land based launching by the addition of a booster rocket, but the small number of stolen Kents would not make such a conversion profitable. Even if most of the shipment went to Iran (various sources claim that only six to eight missiles reached Tehran) such small numbers do not make an arsenal, and it is more likely that the missiles were stolen for study and emulations. The Kh55 is equipped with an efficient small fan jet engine, a key technology for long range cruise missiles that has been mastered to date only in the US, Russia, and Europe. It is also equipped with a sophisticated guidance system. Thus, it is reasonable to assume that the theft of the KH55s will serve for the development of an indigenous version of a strategic cruise missile, perhaps through a joint program of the three participants in the theft. The eventual surfacing of an Iranian strategic cruise missile can therefore be anticipated with some degree of confidence.

5

## *The Newly Acquired BM25 Ballistic Missile*

In January 2006, a German newspaper revealed the transfer of a new type of missile from North Korea to Iran, dubbed BM25 and having a range of 3500 km. The transfer of the new missiles to Iran was subsequently confirmed by Israel's chief of military intelligence, General Amos Yadlin, although the attributed range in his statement was 2500 km. The missile is reported to be a land based, extended range version of the venerable Soviet era SSN6 SLBM (figure 6). According to the reports, eighteen of those missiles with their launchers were purchased from North Korea. The Iranian government denied the

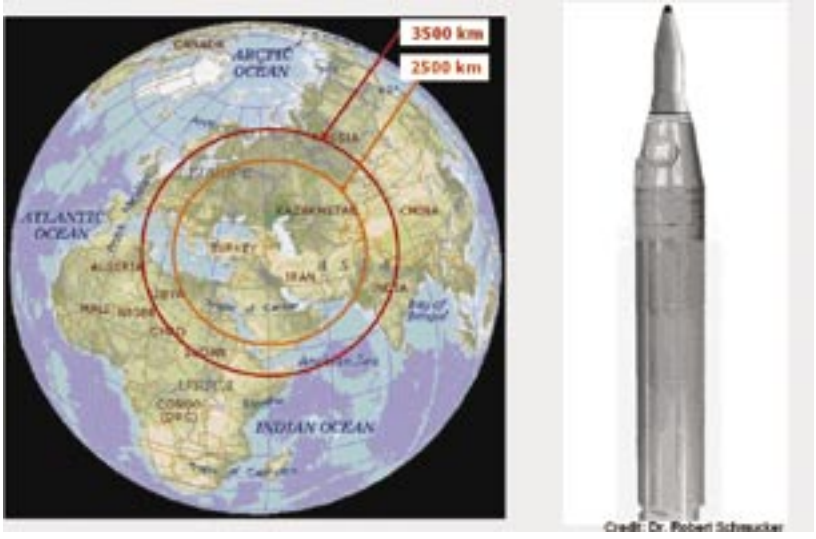


**Figure 6.** The BM25 (land mobile version of the Soviet SSN6 SLBM) and its range from eastern Iran according to Israeli and German sources (BM25 modeling courtesy of Dr. Robert Schmucker)

reports, while Russia's minister of defense Ivanov denied any Russian government involvement in this affair.

The SSN6 (R27 in Soviet designation) was the first generation Soviet SLBM of the 1960s, roughly equivalent to the US Polaris of the same vintage. Unlike the American missile with its solid propellant rocket motor, the SSN6 was powered by a storable liquid propulsion system. While this technology does not match the rugged simplicity of solid propulsion, it nevertheless permits the launching of the missile at a moment's notice without the need for a protracted fueling up process. The feature of instant readiness is mandatory for missiles based in submarines, where the process of fueling up prior to their launching is hazardous to the safety of the boat and jeopardizes its survival.

The SSN6 was operational in the Soviet navy even past the dissolution of the USSR, the last missiles of that type being decommissioned in 1993. According to one source,[3] the North Koreans managed to acquire this missile's technology sometime between 1992 and 1998 – that is, during the most chaotic period of post-Soviet Russia. In the process of its acquisition, the SSN6 design was modified significantly, the missile being stretched by 15 percent (or 30 percent) to accommodate more fuel and increase its range from the original 2500 km to 3500 km (or 4000 km). Furthermore, the missile's design was adapted for land mobility, the revised missile now being transported on and launched from a ground vehicle.

The technology of storable liquid propulsion is significantly more complex than that of the previous generation of North Korean missiles, and its mastery is not a trivial endeavor: special materials, tools, facilities, and expertise are required. That the North Koreans managed to master this technology on their own from sets of drawings or from the copying of smuggled Russian examples stretches the imagination. Moreover, the metamorphosis of a 2500 km SLBM into a 3500 km land based missile requires fundamental modifications. Lengthening the missile and adding propellant entails significant modification of the airframe

[3] www.globalsecurity.org.

and its thermal protection as well as changes to the missile's guidance, control, and trajectories. Taking a basic design that was optimized for the benign, controlled environment of submarines and ruggedizing it to withstand the extreme temperatures – from freezing mountaintops to burning deserts – expected in land based usage requires careful redesign and re-qualification of its internal structures. In a submarine, the missile is stored in and fired from an upright position. A vehicle-mounted land based missile is stored horizontally and must be swung into vertical position before launching. This adds yet another layer of required modifications.

That all this was achieved by the North Koreans without direct access to the Russian designers of the SSN6 is hardly credible, to say the least. It stands to reason, then, that the acquisition and modification of the SSN6 was accompanied by a structured technology transfer process, with direct and frequent contacts between the North Korean and Russian rocket teams. That such an intimate and protracted process did not reach the headlines in the West is testimony to the careful cloaking of this illegal operation, which contravened Russia's solemn undertaking to control its missile and missile technology exports. Some hints, however, were leaked to the public media. In one celebrated case, the Russian police stopped a group of Russian engineers from the Makayev design bureau, the designers of the SSN6, from traveling to North Korea. When queried about the purpose of their intended trip, the Makayev engineers claimed that they were working on a North Korean space launcher. The code name of the purported space launcher was, however, identical to the Soviet code name of the SSN6 before its existence was declassified.

Information about the presence in North Korea of a new baby bottle-shaped missile hailing from the SSN6 first surfaced in Western media in early 2004. Western intelligence expected the North Koreans to display a new type of long range missile in their September 2003 Independence Day parade. This did not happen, but subsequent reports claimed that the missiles that did not show up were of the new baby bottle type. In that case, it stands to reason that North Korea had inducted

the new missile into its strategic rocket forces and was deploying it operationally. Curiously enough, though, there has been no reliable report to date of any flight testing of this missile from North Korea or in fact from anywhere else. The changes made to the basic design of the SSN6 to transform it into an extended range land mobile missile must have resulted in what was practically a completely new missile. No armed force in the West – in fact, not even Russia or China – would have deployed such a missile operationally without several successful flight tests. Yet no "baby bottle" of North Korean origin is known to have been test flown.[4] Even the North Korean Rocketfest of July 4, 2006, when at least seven and perhaps as many as ten missiles of at least three types were launched within hours of each other, apparently did not include a "baby bottle" test.

Two hypotheses can be offered to explain this mystery. First, the revised SSN6 was flight tested in Russia in the course of the technology transfer cum redesign process, perhaps as a condition for the completion of the transaction. Second, as in previous cases, North Korea deployed the missile operationally with an eye to its testing from the territories of overseas customers. If the latter is the case, then North Korea must have had export in mind as one of its objectives in investing resources to acquire and modify the SSN6 missile. If indeed the acquisition of the SSN6 from Russia occurred in the early 1990s as reported, then its coincidence with Iran's initial purchase of the Taeppo Dong missile, later to surface in Iran as the 1300 km Shahab 3, is significant. The income from the sale of the Taeppo Dong to Iran (and Pakistan) might have motivated North Korea to invest in another export bonanza, and perhaps to finance the new endeavor.

Still, there are some more profound mysteries involved in the transfer of the BM25 from North Korea to Iran. First, what drove Iran to buy into an entirely new line of missiles with their associated technology, while the extensive investment in the Shahab 3 system seemed to bear

[4] The Global Security online publication claims that a BM25 was flight tested by Iran on January 17, 2006, and that the range achieved in this test was 3000 km. All other sources report the January 17 event as a Shahab 3 test.

fruit? Second, what compelled Iran to buy a missile that had never been tested in flight? Third, was Russia's present administration involved in the transaction? Fourth, how were the missiles transported to Iran?

Iran was already running two parallel long range ballistic missile programs at the time of the BM25 acquisition: the Shahab 3 program, which was already in series production; and the yet unnamed two stage solid propellant ballistic missile program, still in development. Again, this resembles the Pakistani practice of maintaining two parallel ballistic missile programs, the liquid propellant Ghauri (the sibling of the Shahab 3) and the solid propellant Shaheen. There is no satisfactory explanation to date as to what compelled Iran's defense establishment to invest in yet a third line of ballistic missiles with its unique, storable liquid propellant technology. If this was an expression of dissatisfaction from the mixed results of the Shahab 3 flight test record, then why buy a missile that had never been test flown before? If it was to benefit from the enhanced survivability endowed by its lack of need to be fueled before launching, why not wait for the indigenous solid propellant ballistic missile with its even greater survivability? If it was to benefit from the greater reported range of the BM25, why was it so urgent for the Iranians to achieve a range increase by purchasing a new untested missile rather than by waiting for their own two-stage solid propellant ballistic missile to mature? The precise range capability of the BM25 remains unknown, but its maximum attributed figure is 4000 km. This would not give Iran any added clout in the Middle East theater beyond what it already had from the newer version of the Shahab 3, but it would alarm the Europeans, whose entire homeland territories all the way to the Irish Sea would now lie within the range of the new missile. Why alienate the Europeans, when Iran's policy of engagement with them to drive a wedge between Europe and the US seemed to work?

Assuming that Iran did have an urgent need to bridge some undisclosed gap in its missile capability, why did it invest resources in an untested design? According to the reports, the deal included eighteen BM25 missiles and their launchers – a significant stockpile rather than a trade sample. The Iranians are not known for spending money lightly; it

stands to reason that in their own eyes they have received value for their money. Perhaps, as speculated above, the BM25 was already tested in Russia in the course of its development. Another possibility is that the deal included flight tests in Iran, yet to be performed, with a North Korean warranty against failures. At this stage, theories abound, but they remain just that – theories.

The sale of eighteen BM25 missiles by North Korea proves the existence of a production line, whether in that country or elsewhere. Even if the missiles were not produced specially but taken out from North Korea's operational stockpile, they had to be manufactured at some time. Assuming that a production line has indeed been established in North Korea, it is hardly conceivable that it is completely independent of Russian support in some materials or components. Now, if the missiles arrived recently in Iran as reported, the deal to buy them and the activity to manufacture or refurbish them occurred during the tenure of the present Russian administration. No support of the production or refurbishment of the Iranian destined missile could take place without the knowledge of the Russian government. This raises the troubling question of Russia's degree of involvement in the transaction. The Russian government's denial of involvement in the transfer of the BM25 from North Korea to Iran is most problematic, in light of the almost unavoidable need for Russian industrial support for the transaction.

Finally, there remains the question of how North Korea transported the missiles to Iran. As a rule, large cargo aircraft belong to licensed and regulated air freight companies. For example, the largest fleet of Antonov 124 heavyweight cargo aircraft – the biggest airlifter in the world – is owned by the Russian registered company Volga-Dnepr. It is reasonable to assume that airlifting such sensitive items as ballistic missiles could not have been accomplished without at least some degree of governmental permission. If, on the other hand, the missiles were moved to Iran aboard North Korean ships (as reported by at least one source), then the question remains why the shipments were not blocked by the naval forces of the PSI signatories, as was done in 2003

in the case of the Scud shipment to Yemen.

No immediate answer to those questions comes to mind. The sale and delivery of the BM25 missiles to Iran is even more enigmatic and more troubling in its potential implications than that of the No Dong / Shahab 3. The BM25 affair seems to be just the tip of a vast proliferation iceberg. It hints at the rich and varied resources that radical proliferators like Iran can draw upon to satisfy their ambitious armament programs. It hints equally at the complicity of otherwise respectable governments and at the apparent helplessness of the West in curbing proliferations of missiles that could threaten its own security.

6

# *Iran's Missile Exports*

Although young in conventional terms, Iran's missile industry is already displaying the symptoms of a military industrial complex. Less than a decade after its establishment, the fledgling missile industry of Iran was already engaged in exporting its products. It is unclear whether this reflects a deliberate government policy of military assistance to like minded states or some local initiatives to generate extra revenues. Most probably, both motivations played a role in prompting the Iranian missile industry to sell its products abroad.

According to one report, the Iranians offered to sell a quantity of Shahab 1 (Scud B) to the Democratic Republic of Congo (formerly Zaire). How this huge and strife ridden country could use those missiles is unclear. More substantially, and probably reflecting the strategic alliance between the two states, Iran has reportedly been supplying Syria with missile-related material and expertise in support of the latter's own vigorous missile program. According to several reports, Iranian experts participated in the establishment of a Scud C (Shahab 2) production line in Syria. Mention was also made of Iranian assistance in solid propellant rocketry, though this seems to involve heavy unguided artillery rockets rather than ballistic missiles proper.

By far the largest and most audacious missile export venture by Iran was its deal with Qaddafi's Libya to supply it with a comprehensive missile facility and industry. That deal, valued at $12 billion, fell through when Qaddafi reversed his country's policy in 2004 and gave up his nuclear and missile ambition. The recriminations in Tehran over the volte face seemed to revolve around the financial loss to Iran no less than over the "betrayal" of the radical Islamic camp by Qaddafi. The

transfer of heavy bombardment rockets to Hizbollah by Iran is a case by itself. It is unclear whether this can be regarded as export proper, since it is unknown whether the Lebanese terror organization is required to pay for the rockets. It may well be that the Iranians are transferring them free of charge, as part of an overall policy of deterrence against Israel.

Finally, a recent news item from a website publication reports a brewing deal to sell Iranian Shahab missiles to Venezuela and Cuba. Since the report comes from what is an apparent Venezuelan opposition website, its reliability is questionable. The notion that Fidel Castro might provoke a second Cuban missile crisis is almost ludicrous. At the same time, given the warming relationship and mutual admiration between Venezuela's president Hugo Chavez and Iran's president Mahmoud Ahmadinejad and their shared distaste of the US, the idea of some kind of missile transfer from Iran to Venezuela may not be too imaginary in the future. Perhaps the very appearance of the above news item, far fetched as it seems, might act as a germ of a future deal of this kind.

7

# *Iran's Space Program*

Iran announced its intention of becoming a spacefaring nation almost as soon as it unveiled the Shahab 3 missile. In a televised visit of Iran's supreme leader Ali Khamenei to an Iranian arms exposition in 1998, the cameras recorded a scale model of an SLV (Space Launch Vehicle) with a bulbous nose fairing. Nearby stood a model of a satellite of uncertain provenance (figure 7). The multi-stage SLV had the initials IRIS painted on its sides and was clearly related to the Shahab missile. Analyzing the images, Israeli experts concluded that the IRIS was most probably a "theme SLV" and not a practical design, since its lifting capabilities were calculated to be miniscule.

**Figure 7**. Models of an Iranian indigenous space launch vehicle and a reconnaissance satellite, March 1998

For many years, the SLV program did not feature prominently in Iranian statements and disclosures, although it did surface occasionally. In 2000, when a Shahab 3 test was reported as a failure by US sources, the Iranian minister of defense declared that the tested article had been a prototype SLV with a solid propellant second stage. Later on, an Iranian source claimed that the much speculated upon Shahab 4 missile was in reality an SLV.

In contrast to the dearth of disclosures on the program's progress, Iran used its very existence as leverage, in an attempt to alleviate the impact of the Missile Technology Control Regime on its acquisitions. Iran participated enthusiastically in Russian sponsored conferences on commercial space in the early 2000s, and was very active in convening the UN missile expert committees of 2002–2003. On each occasion, Iranian representatives claimed the right of access to space for peaceful purposes, hence the right to buy SLV technologies. Since SLVs are essentially very long range ballistic missiles, the Iranian demand was tantamount to the revocation of the MTCR.

It was only recently that Iranian publications and statements started to focus once more on the space program, stressing in numerous released statements its satellite aspect, designed purportedly for peaceful purposes, more than the satellite launcher aspect. The number of those programs and even their names shifted frequently, making it difficult to make a definite list of them. It seems that the Iranians are conducting at least four satellite programs (although one Iranian source listed five programs):

1. Zoreh: a heavy communication satellite contracted in Russia, to be lofted to geostationary earth orbit by an unspecified Russian SLV. This program was contracted by Iran, but seems to have no Iranian content in the satellite.
2. Safrir 313 (name uncertain): a light Iranian-made satellite of about 20 kg, to be lofted to low earth orbit by an Iranian SLV, probably from an Iranian spaceport. This would be Iran's "entry ticket" into space and a confirmation of Iran's spacefaring status. Iranian statements in late 2004 spoke about launching it in March–April 2005. This did not happen, and no new date has been mentioned since then. This may indicate that the program is suffering from some significant problems.
3. Mesbah: a light satellite weighing 70 kg, to be lofted to low earth orbit by an unspecified Russian SLV. The satellite was contracted with the Italian company of Carlo Gavazzi, a reputable satellite maker. This satellite is touted as a joint Italian–Iranian project, but

there is no information about the Iranian content in it, and its purpose and on board instruments remain undisclosed beyond the ambiguous objective of "research."

4. Sina 1: a communication and earth observations satellite, made in Russia and lofted to low earth orbit on October 10, 2005 by the Russian Kosmos 3 SLV. While the satellite seems to have no Iranian contents, it can be surmised from various statements that Iran purchased or built a tracking and data retrieval station for it. If so, the Sina 1 serves as Iran's first step in establishing the ground segment for a future spy satellite system. The CEO of Iran's electronics industry declared that the Sina 1 could take pictures of Israel, although this was not its prime purpose. Lately the Iranians disclosed that a successor satellite, the Sina 2, has been contracted from Russia. No date, however, was cited for the launch of this satellite.

A truly national space program consists of three essential components: first, the ability to design, manufacture, and operate one's own satellites; second, the ability to design and manufacture one's own satellite launchers; third, and no less crucial – the ability to orbit one's own satellites from one's own national territory. Without the possession of a national spaceport, the capability to launch satellites at will is at risk. Here geography plays a major role. The location of a spaceport must be such as to minimize the risk to surrounding populations, at the same time providing a safe and politically unencumbered flight path to the space launcher. The flight path should minimize collateral damage to populations and property in case of malfunction, and should not infringe upon airspaces of adjacent countries. This set of requirements is rather stringent, and not many countries in the world have suitable spaceport locations. Europe, for example, is barred by geography from lifting heavy satellite launchers from its own territory, and does so in an overseas spaceport located in South America, albeit on French-owned territory (French Guiana).

Iran is fortunate that its territory provides an abundance of splendid locations for prospective spaceports. The present author and his

colleagues checked just one such potential site, near the city of Qom, and found it very suitable. A southeasterly launch direction from this site would achieve most of the benefit of the Earth's eastbound rotation, while putting the satellite in a 54° inclination orbit – a very good


inclination for spy satellites observing the Middle East (figure 8).

**Figure 8**. Notional spaceport location and safe launch corridor for Iran's indigenous space launch

It is reasonable to expect that Iran will build or buy two basic types of space launchers: a light SLV for near term orbiting of small "entrance ticket" satellites, and a heavier design for orbiting military satellites, mainly spy satellites weighing several hundred kilograms (figure 9). The light SLV could well be something very much like North Korea's Paektusan 1 (referred to as Taeppo Dong 1 by the Western press) as launched in 1998: a first stage derived from the Shahab 3, a second stage derived from the smaller Shahab 2, and a small solid propellant third stage, made locally or purchased from China. There is no reason why an SLV like that could not be perfected in short order. In fact, it is surprising that such an SLV has not made an appearance to date.


**Figure 9**. Notional modeling of Iran's prospective SLV families (credit for light SLV modeling: Mark Wade, Encyclopedia Astronautica)

The heavier, workhorse-type of SLV is more demanding. Iran could buy the alleged North Korean Paektusan (Taeppo Dong) 2 heavier SLV, if it really exists. Alternatively, Iran could emulate Saddam Hussein's rocket engineers by clustering several Shahab 3 rockets into a heavy first stage, use a single Shahab 3 as a second stage, and top it with a small solid propellant motor as a third stage.[5] It is, however, more likely that the workhorse SLV will be based on Iran's emerging solid propellant capability. The hint in this direction came from Shamkhani's 2000 information on an SLV with a solid propellant second stage. An all-solid propellant, three-stage SLV with the diameter of the Shahab 3 would yield a very effective launch vehicle. It would have no problem in orbiting several hundred kg spy satellites from Qom or an equivalent spaceport within Iran, with none of its spent stages endangering inhabited areas. A two-stage version of this SLV could make a very capable long range ballistic missile that could reach all the way from Iran to the Atlantic Ocean. A three-stage ballistic missile based on this SLV could put a warhead on any point in the US.

[5] In December 1989, the Iraqis launched the El Abid SLV, consisting of a cluster of five Scud Bs as a first stage, topped by a single Scud B as a second stage. No information is available about its third stage. The mission did not achieve earth orbit, either by design or because of some failure.

In summary, Iran is already developing satellites, has announced its intention to orbit at least some of them by its own national space launcher, and its geographic situation permits the orbiting of its own satellites from its own territory. All these are the ingredients of a truly independent Iranian space program.

Iran's space program was announced eight years ago. The achievements to date are relatively meager compared to what could be done in this period of time, and thus it seems than that the program did not enjoy high priority. Yet the rate of Iranian statements and disclosures pertaining to the space program is picking up speed. It may well be that the increased oil revenues now provide sufficient funds to nourish both the missile and the space programs. If so, the world is bound to see an Iranian space launch in the not too distant future.

What are the implications of this program? First and foremost, Iranian spy satellites would enhance its military posture against prospective US attacks, by providing "over the horizon" visual information on concentrations of troops and armaments. No less important, it would buttress Iran's national pride and raise its prestige in the world. Most significant, however, is the prospective impact on the global power balance. Iran's SLVs would justifiably be seen as implicit harbingers of prospective ICBMs. Any suitably modified SLV can serve as an ICBM, and Iran would not actually need to develop an ICBM. It would be enough for its satellites to pass above US territory to remind Washington that Iran has come of age, and now has a truly global reach.

# Conclusion

Iran's missile and space programs are progressing with singular urgency. No other country in the world, including established industrialized powers, comes close to Iran in the number and variety of ballistic missiles in development or already deployed. The Iranians are covering almost all technological bases, from ordinary liquid propulsion to storable liquid propulsion to solid propulsion. Side by side with investing in ballistic missiles and space launch vehicles, they seem poised to add a cruise missile component to their strategic forces. The range of their missiles is growing steadily decade by decade: from the 600 km or so of the late 1980s to 1300 km in the early 1990s, to 2000 km in the early 2000s all the way to 2500-3500 km today. From purely local reach, their missiles' range grew to dominate the entire Middle East as well as some portions of Europe. At this rate, Iranian missiles will dominate the entire continent of Europe by the end of this decade. Once they perfect their workhorse SLV, their reach will become truly global.

While the missile forces are built up, Iran is using whatever is already available to good psychological purpose. Not only are its missiles paraded in public on a yearly basis; they are frequently alluded to by Iranian officials in heralding the military prowess of the regime. The transparency of the Shahab 3 missile program was most impressive. Contrary to the other three radical regimes in the region who have or have had their own missile programs – Libya, Syria, and Saddam's Iraq – the Iranians announced their missile tests, at least the successful ones, and released impressive photographic material to the media. Only recently have the Iranians retreated somewhat from the policy of transparency. Until then, the amount of material released and

the number and variety of statements was abundant, though the at times conflicting reports lent the program an air of secrecy cloaked behind a veil of transparency.

Furthermore, the record is not unmixed. The deluge of images and statements and the large number of programs have yielded an inconsistent picture. To date the Iranians have paraded at least three variants of the Shahab 3 missiles, transported by at least four different variants of the basic transporter-launcher. This does not indicate a truly focused effort. An average flight test rate of about one per year for all three variants is not especially rigorous, and many of those tests apparently ended in some kind of failure. The acquisition from abroad of a new missile that has never been tested before may be indicative of some urgency to correct a perceived deficiency, perhaps some skepticism about the Shahab 3 design. The eight-year old space program resulted to date in one single launch of a foreign-made satellite by a foreign SLV. All the indications are that the missile and space programs have suffered from deficiencies in leadership and resources. Significantly, there is no Iranian Von Braun and no Iranian Sergey Korolev behind the overall effort. The disparate programs are making headway, but in a somewhat chaotic manner.

Yet Iran's missile and space programs are no paper tigers. They are obviously the keystones of an overarching defense policy, the objective of which is first and foremost to deter the US and its allies from blocking Iran's path towards regional hegemony. However, today's weapons of deterrence are apt to become tomorrow's weapons of dominance. If and when Iran perfects its own nuclear weapons, by then it will have several reliable ballistic and cruise missiles available as means of delivery. Nuclear Iran's missiles will project the power of its radical, uncompromisingly fundamentalist mastery over Israel and other US allies in the Middle East, over the entire continent of Europe, and over the US homeland itself. It is incumbent for the intended targets to stand up in defense of liberal democracy against this looming threat.

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