IRAN’S BALLISTIC MISSILE POTENTIAL

David Montague, Uzi Rubin, and Dean Wilkening[1]

This paper questions what we believe to be an overly pessimistic, and potentially misleading, assessment of Iran's ballistic missile potential presented in the recently released East-West Institute report entitled *Iran's Nuclear and Missile Potential: A Joint Threat Assessment by U.S. and Russian Technical Experts* (May 2009). Our critique is in no way intended to diminish the efforts of the East-West Institute in putting together a team of US and Russian participants to assess Iran's nuclear and ballistic missile potential. Such bilateral discussions are desperately needed to clarify areas of agreement, as well as potential differences, regarding the threat posed by Iran. The East-West Institute has had a distinguished history of facilitating such exchanges. Nor is this critique intended to suggest that Iran poses an imminent military threat to Europe. Rather, we limit our focus to the technical assessment of Iran's ballistic missile potential contained in the *Joint Threat Assessment* (JTA) report and two Technical Addendums. We will not comment here on Iran's nuclear potential, as discussed in the report, or on the efficacy of ballistic missile defenses for coping with emerging ballistic missile threats. Our focus here is solely on the JTA assessment of Iran’s ballistic missile potential because if this assessment is not accurate, it affects any subsequent prescriptions for how best to deal with this potential problem.

In general, the JTA report tends to downplay Iran's ballistic missile accomplishments, leading to the conclusion that it will take many years before Iran is capable of threatening Europe or Russia with Intermediate-Range Ballistic Missiles (IRBMs), or the United States with Inter-Continental Ballistic Missiles (ICBMs). We do not believe that a ballistic missile threat to Europe or the United States is necessarily imminent because it depends, among other things, on political decisions taken by Iran. However, we believe that Iran’s technical accomplishments in the area of ballistic missiles are further along than the JTA report and the Technical Addendums lead one to believe. The JTA report itself is contradictory in this regard, concluding that “Iran could develop in perhaps 6 to 8 years a ballistic missile capable of delivering a 1000 kg nuclear warhead to a range of 2000 km.”[2] when, in fact, the day after the JTA report was released, Iran successfully tested a two-stage solid-propellant ballistic missile (the “Sejjil”) capable of delivering a 1000 kg payload to a range between 2000 km and 2500 km (depending on assumptions one makes about the rocket’s efficiency and payload). The fact that the report minimizes Iran's development of solid-propellant ballistic missiles, the Sejjil in particular, is perhaps its greatest weakness. The report's assessment of Iran's liquid-propellant ballistic missile developments seems more accurate, though even here the report tends to minimize Iran's accomplishments to date, as illustrated by the successful February 2, 2009 launch of the Safir-2 space launch vehicle (SLV) which placed the 27 kg Omid satellite into low earth orbit.

---

[1] David Montague is the retired President of Lockheed-Martin Missile Systems Division, Sunnyvale, California; Uzi Rubin is the former director of the Israel Missile Defense Organization and currently the CEO of Rubincon Defense Consulting Ltd.; and Dean Wilkening is a senior research scientist at the Center for International Security and Cooperation at Stanford University.

[2] JTA, pg. 16, paragraph 5.3b.

To begin, the JTA report is misleading when comparing the Iranian missile program to the US or Soviet ballistic missile programs during the Cold War. Iran may lag "very far behind the leading missile countries," but this does not mean that it cannot produce a modest number of ballistic missiles of sufficient technical sophistication to threaten Europe, Russia, or the United States if it decides to do so. Nor is it clear that Iran "will continue to rely for a considerable time on outside help in extending the payload and range capabilities of its ballistic missiles."[3] The Sejjil missile may have been largely produced indigenously. While Iran may not have the infrastructure of research institutions, industrial plants, or the cadre of scientists and engineers that characterized US and Russian ballistic missile programs in the 1950s and 1960s, which produced over 1000 ICBMs encompassing several different ICBM generations with improved capabilities, submarine-launched ballistic missiles, and numerous medium- and intermediate-range missiles within less than a decade, Iran may well have sufficient capacity to build enough ballistic missiles to cause Europe, Russia, and other states within the region considerable concern, especially if Iran decides to pursue nuclear weapons. Clearly, Israel already faces threats from liquid-propellant missiles (i.e., the Shahab 3 and an extended-range version of the Shahab 3) and will soon face solid-propellant missiles with comparable capability (i.e., the Sejjil).

Similarly, stating that the development and production of "modern" ballistic missiles requires "access to the world market for high-tech equipment, materials, and components; a general, diverse, and specialized system of education, research, and training institutions; a highly developed R&D and industrial base; and a sufficiently large force of highly qualified and skilled scientists, engineers, and industrial workers" is misleading because a large educational and technical/industrial base is not required for more modest ballistic missile programs. Perhaps the disagreement rests on what one means by "modern" ballistic missiles. Certainly no one expects Iran to produce a Topol M missile any time soon, nor for it to have a vast space and missile program like the Chinese. Hence, comparisons to the "hundreds of organizations" in Russia involved in the production of the Topol M ballistic missile, or the 200,000 employees of the Chinese missile and space industry are largely irrelevant.[4] More germane would be comparisons to the size of the Brazilian, Indian or Pakistani SLV and ballistic missile programs, each of which has produced space launch vehicles and/or intermediate-range ballistic missiles with a small or, in the Indian case, modest infrastructure.[5]

---

[3] JTA, pg. 8, paragraph 3.17

[4] JTA, pg. 9, paragraphs 3.18 and 3.19.

[5] Brazil's program, in particular, is interesting because of its small size, desultory pace, and the emphasis on domestic production (an estimated 80% of this rocket is produced indigenously). Brazil has invested approximately $250-$300 million since the early 1980s to develop the VLS-1 and VLM space launch vehicles based on HTPB solid-propellant motors derived, in turn, from their earlier experience with the Sonda series solid-propellant sounding rockets. The VLS-1 and VLM use monocoque steel casings, except for the third stage which uses an Aramid/Epoxy casing, have propellant fractions of 0.83-0.87, and specific impulses for the three motor stages of 265-282 seconds. These 1.0 meter diameter motors use gimbaled nozzles for thrust vectoring and the first stage produces 305 kN (vac) of thrust. These are modestly impressive specifications for indigenously developed solid-propellant motors. Moreover, Brazil had plans to produce two VLM rockets per year. To obtain access to some key components, specifically advanced guidance and control systems, Brazil joined the MTCR in 1995. However, to date, the Brazilian program has had only two launches, the first in November 1997 and the second in December 1999, both of which ended in failure. Future plans call for various VLS configurations with liquid- or solid-propellant upper

In addition, the report does not take into account two important points: 1) that much of the necessary technical data is readily available in open literature, e.g., for solid rocket motors based on hydroxy-terminated polybutadiene (HTPB) propellant, and 2) that it is much easier to do something that has already been accomplished by others. Both of these factors reduce the level of effort required to make initial progress on first generation ballistic missiles compared to the efforts the United States and the former Soviet Union made in the 1950s and 1960s.

Finally, Iran has already cleared at least three, if not four, of the "major scientific, technological and production problems that have to be solved in building an IRBM or an ICBM," namely, "a) The development of powerful rocket motors; b) Flight control, guidance systems, and telemetry; c) Reentry vehicle heat protection; d) Construction materials; and e) Flight testing."[6] One should note, parenthetically, that the JTA report minimizes the difference between the challenges involved in producing IRBMs with 4,000 km ranges and ICBMs with ranges over 10,000 km. The latter are more difficult. Hence, Iran may clear all five hurdles listed above for IRBMs in the not too distant future, but may have greater difficulty surmounting them for ICBMs, even though US ICBMs followed US IRBMs by only a few years in the late 1950s and early 1960s.

Regarding these five hurdles, Iran arguably already has the capability to develop powerful rocket motors, using either liquid or solid-propellants. For example, the No Dong rocket engine used on the Shahab 3 ballistic missile could be clustered together, as North Korea has done on its Unha-2 rocket, to boost very large missiles. This is not to suggest that Iran will pursue large liquid-propellant long-range ballistic missiles. Solid-propellant missiles are more likely. In this regard, Iran's production of a 1.25 m diameter solid-propellant rocket motor for the Sejjil, with twice the thrust of the No Dong rocket engine, demonstrates that powerful solid-propellant rocket motors are within Iran's current capability and still larger solid-propellant rocket motors are within their reach (see discussion below on the Sejjil missile).

The successful launch of the Safir-2 SLV that injected the Omid satellite into low-earth orbit demonstrated the use of thrust vectoring and adequate flight control and telemetry systems that are probably sophisticated enough for use on long-range ballistic missiles. The requirement for precision guidance and control may be beyond Iran's current capability. However, accuracies sufficient to hold at risk large urban areas, e.g., similar to that achieved by first generation US inertial guidance systems (i.e., 1.4 km circular error probable for the 18,500 km range Atlas E/F ICBM and 1 km circular error probable for the 2,400 km range Thor IRBM), are probably within Iran's reach and certainly are sufficient for deterrence.[7]

Iran is experimenting with reentry vehicles and, at the current time, it is not clear if they have developed a reentry vehicle that can survive the thermal and mechanical stresses of reentry over ranges sufficient to threaten Europe (i.e., 3500 km to 5000 km), much less the 10,000 km ranges characteristic of ICBMs. Nor is it clear that they can

---

stages. See Steven J. Isakowitz, Joshua B. Hopkins, and Joseph P. Hopkins Jr., *International Reference Guide to Space Launch Systems, 4th Edition*, American Institute of Aeronautics and Astronautics, Reston, VA, 2004, pp 525-537.

[6] JTA, page 9, paragraph 3.20.

[7] http://en.wikipedia.org/wiki/SM-65_Atlas and http://en.wikipedia.org/wiki/PGM-17_Thor, accessed on August 7, 2009.

develop a nuclear weapon small enough to meet the mass and dimension constraints of such a reentry vehicle. This may be their greatest remaining challenge.

The launch of the Safir-2 SLV, as well as the Sejjil IRBM, demonstrates that Iran has access to the materials from which to build modestly effective ballistic missiles, especially the ingredients for solid-propellant rocket motors. In terms of airframes, high-strength steel casings are sufficient for solid-propellant motor casings, although titanium, fiberglass or filament wound cases would be better for the upper stages. It is not clear whether Iran has mastered, or can master, the production techniques for more advanced motor casings.

Finally, Iran has carried out six major ballistic missile flight tests in a period of 18 months, demonstrating a modestly sophisticated flight test program.[8] Therefore, contrary to the JTA assessment that these areas "would pose major scientific, technological, and production problems for Iran," we believe Iran is well along in mastering each of the necessary steps.

Iran's Liquid-Propellant Missile Program

The JTA report accurately chronicles, to the best of our knowledge, Iran's development of the Shahab 1, Shahab 2, and Shahab 3 liquid-propellant single-stage ballistic missiles, based on the SCUD B, SCUD C, and No Dong ballistic missiles, respectively. The development of these ballistic missiles is consistent with a country that has modest indigenous capability for ballistic missile development and production using ballistic missile designs and components imported from abroad. Even the indigenous development of the extended range Shahab 3 does not demonstrate tremendous advances in ballistic missile capability because, as discussed in a JTA Technical Addendum, this missile has been created simply by elongating slightly the fuel and oxidizer tanks of the Shahab 3 missile.

However, we disagreed that the Safir-2 SLV does not represent a "fundamental technological breakthrough." While it is true that the Safir-2 SLV is based on the Shahab 3 ballistic missile with a low thrust second stage, the fact remains that Iran successfully demonstrated missile staging technology, thrust vectoring, and sufficiently accurate guidance and control to place a satellite into low earth orbit, an accomplishment that North Korea has yet to achieve. Moreover, this was accomplished within less than four years from the time the Iran announced a forthcoming satellite launch attempt (March 2005-May 2005).[9] Two failed launch attempts occurred in February 2008, when the Safir-2 SLV was first tested, and in August 2008 prior to the first successful Safir-2 launch on February 2, 2009. To regard this successful demonstration of staging technology as "a step in the development of staging technology, which is *critical* for the construction of two- and three-stage ballistic missiles..." (italics added) seems inconsistent with the earlier claim that this SLV launch does not represent "a fundamental

---

[8] The first Ashura/Sejjil flight test occurred around November 2007, a Kavoshgar flight test occurred in February 2008, the first Safir flight test occurred in August 2008, the second Ashura/Sejjil flight test occurred in November 2008, the second Safir-2 flight test occurred in February 2009 and the third Ashura/Sejjil flight test occurred in May 2009.

[9] FBIS, "Official Says Iran's Mesbah Satellite To Be Launched in May 2005," Tehran Vision of the Islamic Republic of Iran Network 1 in Persian 0930 GMT 01 Sep 04; Amir Paivar, "Iran to launch test satellite with missile," Reuters, September 20, 2004.

technological breakthrough," although such a statement can easily turn on what the JTA authors mean by the word "fundamental."[10]

The Safir-2 SLV certainly does not represent an ideal ballistic missile, and we are not suggesting that Iran will base any future ballistic missiles on this SLV airframe. Nevertheless, modifications to the second stage of the Safir-2 would allow this rocket to carry a 1000 kg payload to a range of approximately 2000 km to 2,500 km, depending on the second stage one assumes, as discussed in the Technical Addendum,[11] and it has given Iran some experience with more efficient rocket engines, storable liquid-propellants and lighter airframe materials.

An example of the unwarranted pessimism expressed in the JTA report can be found in paragraph 3.22. Here it is argued that Iran would face difficulties in developing longer-range liquid-propellant ballistic missiles because this would require multistage missiles with clustered rocket motors for the first stage. The report states that:

> "These are both *serious* challenges, requiring *extensive* research and development and testing to gain the proper results and experience. Iran would also have to make *significant* advances in turbopump-related and airframe manufacturing technologies, as well as in system integration and component reliability. It would also need to solve *difficult* problems in flight control and guidance technology, and it would face *particular problems* in controlling the thrust vectors of the motors in the various stages. The design of warheads able to withstand reentry into the atmosphere would also present problems. Mastering the necessary technologies without external assistance would be a *major undertaking*, requiring perhaps 10 years of concerted and visible effort." (italics added)[12]

What is noteworthy about this assessment is that it fails to mention that Iran already has demonstrated modestly sophisticated guidance and control, as well as staging technology and thrust vectoring in the Safir-2 SLV and the Sejjil IRBM. Moreover, given the close cooperation between Iran and North Korea regarding past ballistic missile activities, and the fact that North Korea has successfully demonstrated that it can cluster up to four No Dong rocket engines in the first stage of the Unha-2 rocket, it seems prudent to assume that Iran could acquire this capability relatively easily, albeit with North Korean assistance. As the JTA report notes, "the two countries' [North Korea's and Iran's] missile programs should not be treated as unconnected."[13]

On April 4, 2009 North Korea launched the Unha-2 SLV, the first stage of which contained four clustered No Dong rocket motors and the second stage used a Russian SS-N-6 missile with an efficient main engine using storable liquid-propellants and lighter airframe materials. Both stages operated successfully, but the third stage failed to place a satellite into orbit. North Korea also has produced indigenously several hundred Scud B

---

[10] JTA, pg. 8 paragraphs 3.11 and 3.14.

[11] Theodore Postol, *Technical Addendum to the Joint Threat Assessment on Iran's Nuclear and Missile Potential: A Technical Assessment of Iran's Ballistic Missile Program*, May 6, 2009, pg. 24.

[12] JTA, pg. 9, paragraph 3.22.

[13] JTA, pg. 10, paragraph 3.27.

and Scud C engines and approximately 100 No Dong engines that are 40 percent larger in size than the Scud B engine. In addition, there are indications that it is planning to launch rockets with even larger engines than the cluster of four No Dong engines used on the Unha-2.[14] Therefore, it seems odd that the Technical Addendum to the JTA report concludes that "North Korea probably does not have the industrial base and knowhow to improve on these components [Scud B liquid-propellant rocket engines] and it seems likely that they as well lack the ability to manufacture these components."[15]

The Sejjil Solid-Propellant Ballistic Missile

The most important counterexample to the JTA assessment is the existence of Iran's Sejjil IRBM, a two-stage solid-propellant ballistic missile. The Iranian Ministry of Defense first announced the successful development of two large solid-propellant rocket motors in May 2005.[16] After successful ground tests (and perhaps some failures), Iran conducted two flight tests, one in late 2007 and the second on November 18, 2008, both of which ended in failure. The first successful Sejjil missile flight test occurred on May 19, 2009; approximately five years after Iran first announced its solid-propellant ballistic missile program. Iran announced that the range of the Sejjil is approximately 2,000 km.[17]

One should recall that the US Minuteman I solid-propellant ICBM program took 3 years from program inception (1958) until the first successful flight test in February 1961. The first Minuteman I ICBM became operational in February 1962 and the fist 10 Minuteman I ICBMs becoming operational in October 1962. And, this was after Thiokol, the company responsible for building the Minuteman I first stage, suffered two motor failures in 1959 in initial tests and a string of five failures in a row, each with unique failure modes, in October 1959—one a week for a period of five weeks—that totally destroyed both motor and test stand. By December 1959, Thiokol had solved these problems with sufficient confidence that Aerojet General, the second company competing to build the Minuteman I first stage motor, was phased out of the competition.[18]

Whether, or the extent to which, the Iranian solid-propellant ballistic missile program benefited from foreign assistance is an important question to which there is no readily available answer in the open literature, although American officials claim the missile was developed largely indigenously, perhaps with initial help from Russia.[19] Iranian officials claim the missile was developed and produced indigenously.[20] Therefore, while it is true that indigenous ballistic missile programs may require "tremendous intellectual and material efforts and many years to achieve results," Iran appears to be on the verge of achieving precisely this result, contradicting the JTA assessment that "Iran is unable to develop or produce most of the listed items

---

[14] Evidence for larger North Korean rocket engines comes from the analysis of North Korea's space launch activities, including the construction of a new launch complex near Pongdong-ni in northwestern North Korea, by Lew Franklin and Nick Hansen (personal communication).

[15] Op Cit, *Technical Addendum: A Technical Assessment of Iran's Ballistic Missile Program*, pg. 2.

[16] Uzi Rubin, *The Global Reach of Iran's Ballistic Missiles*, Institute for National Security Studies, Tel Aviv University, Memorandum 86, November 2006.

[17] Interview with Iranian Minister of Defense Mohammad Najjar on MEMRI TV, November 12, 2008.

[18] Tony Lin, "Development of U.S. Air Force Intercontinental Ballistic Missile Weapon Systems," *Journal of Spacecraft and Rockets*, Vol. 40(4), July-August 2003, pp 491-509.

[19] Nicholas Kralev, "Gates Confirms Iranian Missile Test," *Washington Times*, May 21, 2009.

[20] "Defense Minister: Iran's Long-Range Missiles Produced by Domestic Experts," Tehran Voice of the Islamic Republic of Iran Radio 1 in Persian 1037 GMT 27 Nov 07 (FBIS translation).

domestically," referring to items controlled under the Missile Technology Control Regime (MTCR).[21]

The development and production of solid-propellant rocket motors requires access to suitable chemicals for solid-propellants, i.e., oxidizers, metal powders, binder agents, possible additives, and curing agents. In addition, one must have the means to mix these chemicals in large tanks, cast them into suitable shapes, and cure the solid-propellant grains without cracking. Each of these steps is hazardous and requires careful production methods. After solid-propellant motor grains have been cured, they usually are inspected for imperfections using large x-ray machines and other quality control techniques. (While much of this equipment is included on the MTCR control list, Iran apparently has been able to acquire or indigenously produce these items, or do without them. If Iran does not have adequate measures for quality control, the reliability of their solid-propellant ballistic missiles would suffer, especially as the motors age.) Iran also has demonstrated that it has mastered the process of insulating the motor case and casting the propellant grain into the motor case, potentially difficult steps in the construction of large solid-propellant motors. In addition, Iran has demonstrated the ability to make strong motor casings, most likely using steel in the Sejjil missile, and the ability to design solid-propellant rocket nozzles—a step that is complicated because of the highly erosive exhaust gases in solid-propellant rocket motors. Finally, Iran has demonstrated the use of suitable igniters and thrust termination ports, both of which are required for reliable solid-propellant ballistic missile performance.[22] Having successfully demonstrated all of these steps for a 1.25 m diameter rocket motor, it is straightforward to expand the diameter of future rocket motors by 20%, if not more, making rocket motors with a diameter of 1.6 m easily within reach of current Iranian technology, contrary to the conclusion of the Technical Addendum on the Sejjil ballistic missile which states that "Iran would have to make major advances in understanding how to produce a much larger solid-propellant rocket motor."[23]

In short, it seems reasonable to assume that Iran will pursue solid-propellant ballistic missiles due to their mobility or their ability to be launched quickly from underground silos and, hence, reduced vulnerability to preemptive attack compared to liquid-propellant systems. Threatening Europe would require missiles with twice the demonstrated range of the Sejjil; however, such a missile would not have to be the 3-stage 65 ton missile mentioned in the Technical Addendum on the Sejjil missile.[24] In fact, a 2-stage 34,500 kg missile with essentially the same characteristics assumed in the Technical Addendum for the Sejjil missile, but with a 1.6 m diameter first stage, would have a range of approximately 3,500 km, sufficient to reach a large portion of Europe with a 1,000 kg throw weight (see Table 1 and Figure 1).[25] Using a slightly larger 1.8 m

---

[21] JTA, pp. 8-9, paragraph 3.18; and JTA, pg. 10, paragraph 3.24.

[22] For a good discussion of solid-propellant rocket basics, see Sutton, G.P. and Biblarz, O., *Rocket Propulsion Elements, Seventh Edition*, John Wiley & Sons, New York, 2001, chapters 11-14.

[23] Theodore Postol, *Technical Addendum to the Joint Threat Assessment on Iran's Nuclear and Missile Potential: The Sejjil Ballistic Missile*, May 31, 2009, pg. 1.

[24] Op cit, *Technical Addendum: The Sejjil Ballistic Missile*, pg. 1.

[25] For space launch vehicles the "payload" refers to the useful lift capability of the vehicle for placing satellites into orbit, excluding the mass associated with the fairing, guidance and control section, and any structural mass associated with the payload section of the vehicle. In contrast, the "throw weight" of a

Table 1 - Possible Iranian Solid-Propellant IRBM Characteristics*

	JTA Sejjil	1.6 m Sejjil 2 based on JTA data	1.8 m Sejjil 3
Range (km) †	2,500	3,500	4,900
Throw weight (kg)‡	1,000	1,000	1,000
Launch Mass (kg)	21,500	34,500	40,600
Boost Time (sec)	106	120	135
1st Stage			
Stage Mass (kg)	14,720	27,700	33,820
Propellant Fraction	0.85	0.85	0.88
Stage Diameter (m)	1.25	1.6	1.8
Stage Length (m)	7.4	8.5	8.2
CS Area (m^2)	1.23	2.01	2.55
Nozzle Area (m^2)	0.785	1.3	1.63
Vacuum Thrust (kN)	625	932	1,035
Vacuum Isp (sec)	252	256	262
Burn time (sec)	49.5	63.4	73.8
2nd Stage			
Stage Mass (kg)	5,780	5,780	5,780
Propellant Fraction	0.85	0.85	0.85
Stage Diameter (m)	1.25	1.25	1.25
Stage Length (m)	2.96	2.96	2.96
CS Area (m^2)	1.23	1.23	1.23
Nozzle Area (m^2)	0.785	0.785	0.785
Vacuum Thrust (kN)	214	214	214
Vacuum Isp (sec)	250	250	270
Burn time (sec)	56.3	56.3	60.8

*These missiles do not necessarily have optimized stages

†Assumes a 310° launch azimuth from Iran with a rotating earth

‡The throw weigh includes the mass of the reentry vehicle (nuclear warhead plus thermal protection), avionics, and inter-stage mass. No fairing is included on these missiles.

diameter first stage motor and movable nozzles as opposed to vanes for thrust vectoring, as demonstrated by Brazil with its VLS-1 and VLM launch vehicles (and, hence, higher Isp values), one obtains a 40,600 kg missile with a range of approximately 4,900 km on a 310° launch azimuth from Iran (the typical launch azimuth from Iran to central Europe) and a 1,000 kg throw weight. Such a missile could reach all of Europe if launched from northwestern Iran, as shown in Fig. 1. Both of these extended-range missiles are light enough to be mobile and compact enough to be deployed in reinforced concrete silos. Therefore, we disagree with the JTA assessment that "the development of missiles that could strike targets throughout Europe would require either the production of large and vulnerable system [i.e., large liquid-propellant ballistic missiles] or major advances

---

missile refers to the mass of everything beyond the last stage of the rocket. In other words, the throw weight measures the useful lift capacity of a rocket including all inert weights on the end of the missile such as the reentry vehicle, the faring (if any), guidance and control components, and any structural masses associated with the payload section.

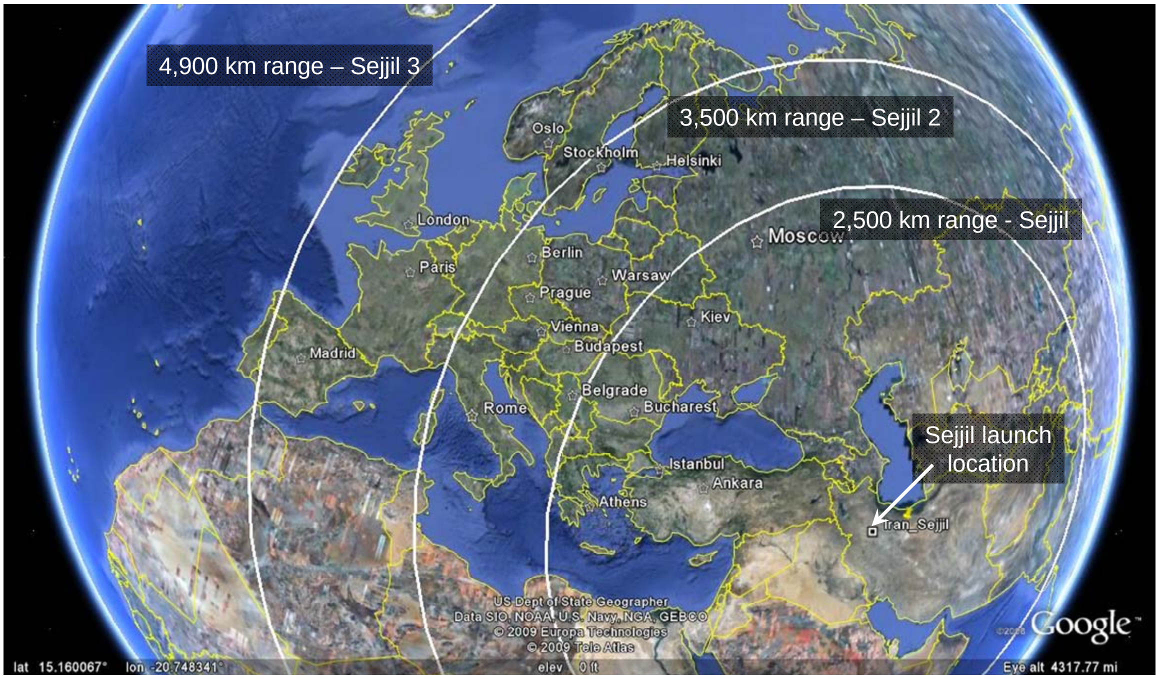

Fig. 1 – Range Arcs for Different Sejjil Missiles

beyond the technology Iran has so far demonstrated."[26]

In summary, we disagree with the conclusion in the Technical Addendum that the Sejjil missile "does not demonstrate technologies that could rapidly evolve into ballistic missiles with ranges that could threaten Northern and Western Europe."[27] Moreover, such a missile being much lighter than the 65 ton missile mentioned in the Technical Addendum would not be "large, cumbersome, and heavy" and, hence, would not be difficult to operate or hide.[28] An Iranian ICBM would require a 3-stage missile, perhaps with further improvements in solid-propellant rocket motors, and would take longer to develop. How long is difficult determine but certainly would depend, among other factors, on the level of effort expended by Iran. However, such a missile would not have to be as large as the US MX missile (88,000 kg), as claimed in the Technical Addendum. The technology demonstrated by the Sejjil ballistic missile could readily be used to build longer-range missiles and would not be limited to use in ballistic missiles "with ranges in the 1000 to 2000 km range" as claimed in the Technical Addendum.[29]

To the extent Iran received substantial help from foreign sources in the production of the Sejjil missile, efforts should be made to halt such cooperation, e.g., using diplomatic means such as the MTCR, to prevent further advances in Iran's solid-propellant missile program. However, one must acknowledge that if the Sejjil is largely indigenous, it may be too late for effective export controls on this technology, at least to Iran.

---

[26] JTA, page 11, paragraph 3.36.

[27] Op cit, *Technical Addendum: The Sejjil Ballistic Missile*, pg. 2.

[28] Op cit, *Technical Addendum: The Sejjil Ballistic Missile*, pg. 2.

[29] Op cit, *Technical Addendum: The Sejjil Ballistic Missile*, pg. 4.

Summary

The conclusions regarding Iran's ballistic missile potential contained in the JTA report and the accompanying two Technical Addendums underestimate Iran’s ballistic missile potential, especially in the area of large solid-propellant ballistic missiles. In particular, Iran's ability to threaten Europe does not require a 3-stage IRBM with a launch mass of approximately 66.5 tons. A mobile 4,000 km range 2-stage solid-propellant IRBM may be within their reach within five years, depending on the level of effort Iran expends toward this goal. We certainly do not see any technical barriers to such an accomplishment. The JTA assessment that it would take Iran 6 to 8 years to develop a missile capable of carrying a 1,000 kg warhead to a range of 2,000 km is clearly overly pessimistic, unless this time frame is intended to reflect the time it would take Iran to develop a nuclear warhead suitable for placing on an IRBM, and not the IRBM itself.[30] Regarding when Iran might be able to produce a credible ICBM, an estimate of 10 to 15 years seems unduly pessimistic; unless this assessment turns on what the authors mean by “modern, credible ICBM.”[31] Certainly Iran will not be developing a missile like the Topol M or Minuteman III any time soon. However a 3-stage ICBM like the Minuteman I may be within their reach at an earlier date.

We also disagree that it would take “at least ten to fifteen years to master independently the ‘critical technologies’ for advanced mobile or silo-based IRBMs and ICBMs because it does not have the scientific, economic, and industrial infrastructure for developing these critical technologies.”[32] At the very least, a distinction should be made between IRBMs with the range to threaten Europe or Russia and ICBMs with the range to threaten the United States; the former are easier and more likely to be within Iran’s reach. Iran already has demonstrated sufficient mastery of the technologies, necessary for solid-propellant IRBMs, perhaps with some improvements in reentry vehicle design and guidance and control still required. Hence, with the technology currently available to it, Iran could build solid-propellant IRBMs that would not be “large, visible and cumbersome systems with serious drawbacks as military missiles…”[33]

In summary, we believe the Iranian ballistic missile threat is more advanced, and should be taken more seriously, than is suggested by the analysis presented in the JTA report and, in particular, in the Technical Addendums to that report. This conclusion does not immediately lead one to conclude that a particular US, Russian or international response, e.g., diplomacy, deterrence or ballistic missile defense, is better than another. This requires further analysis.

We agree that controlling ballistic missile proliferation requires the vigorous enforcement of diplomatic agreements between states that possess specialized ballistic missile technologies.[34] However, we are less sanguine about the ability of these diplomatic measures to prevent the proliferation of IRBMs and ICBMs to Iran. It may be too late. Nor is it clear that Iran is critically dependent on foreign sources for advancing its ballistic missile program.[35]

---

[30] JTA, pg. 12, paragraph 3.39b.
[31] JTA, pg. 11, paragraph 3.37.
[32] JTA, pg. 12, paragraph 3.39c.
[33] JTA, pg. 12, paragraph 3.39d.
[34] JTA, pg. 11, paragraph 3.38.
[35] JTA, pg. 12, paragraph 3.39e.