IRAN AND THE GULF MILITARY BALANCE – II

The Missile and Nuclear Dimensions

WORKING DRAFT

By Anthony H. Cordesman and Alexander Wilner

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Anthony H. Cordesman
Arleigh A. Burke Chair in Strategy
acordesman@gmail.com

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COMPETITION OVER NUCLEAR THREATS, MISSILES, AND OTHER WEAPONS OF MASS DESTRUCTION

Iran's potential acquisition of nuclear weapons or other weapons of mass destruction, and Iran's future ability to arm its missiles and aircraft with such weapons, poses critical risks that shape every aspect of US, Arab, Israeli and other military competition with Iran. In the near term, they could trigger a major confrontation or war in the Gulf. In the mid to long-term, they could trigger a nuclear arms race in the region, coupled to the search for missile defenses and an accelerated arms race to improve conventional, asymmetric, and proxy forces as well.

The Short Term Risks of Confrontation or War

The short-term risks should not be exaggerated. It is one thing to posture and quite another to fight. Nevertheless, Iran is coming under steadily greater pressure from sanctions, is seeing a limited US build up in the Gulf, and faces a major build-up by key Southern Gulf states like Saudi Arabia and the UAE that is clearly targeted at Iran. It faces a different kind of competition for influence and control over Iraq, and growing uncertainty over the future of its alliance with the Assad regime in Syria and the Hezbollah in Lebanon.

So far, Iran has only talked provocatively about closing the Gulf, denying access to US carriers, and carrying out major exercises targeted against the US and less directly at the GCC states. In practice, all sides have been cautious not to take provocative military steps, and limit the risk of military confrontation. US and EU sanctions only went into full effect in July 2012, however, and it is not clear that Iran will remain passive if negotiations with the 5+1 do not succeed.

Iran might deliberately try to create a clash in an effort to force more favorable compromises, persuade the Iranian people they do face real foreign enemies, show how serious the impact could be on the global economy, or simply punish other powers. Tempers can grow short, given units can overreact, situations can be misunderstood, and one nation's view of how to escalate rarely matches another's once a crisis begins to spiral out of control. Moreover, the covert war that Israel; and Iran are already fighting over war are reported to be Israel's assassinations of Iranian nuclear scientists could escalate and come to include the US and European targets – as well as lead to Iranian or proxy attacks and operations in areas like Iraq and Afghanistan.

Preventive war is also a very real near-term risk. The complex situation surrounding Iran's nuclear programs involves what many Israelis see as "existential" risks. The US sees the situation as less urgent, but senior officials have made it repeatedly clear that US policy sees Iran's acquisition of nuclear weapons as "unacceptable." Both Israel and the US have mad it clear that they are planning and ready for military options that could include preventive strikes on at least Iran's nuclear facilities and at least US strikes might cover a much wider range of missile facilities and other targets.

A preventive war might trigger a direct military confrontation or conflict in the Gulf with little warning. It might also lead to at least symbolic Iranian missile strikes on US basing facilities, GCC targets or Israel. At the same time, it could lead to much more serious covert and proxy operations in Lebanon, Iraq, Afghanistan, the rest of the Gulf, and other areas. Furthermore, it could trigger a much stronger Iranian effort to actually acquire and deploy nuclear weapons and/or Iranian rejection of the NNPT and negotiations. The US, in contrast, might see it had no choice other than to maintain a military overwatch and restrike capability to ensure Iran could not carry out such a program and that Iran could not rebuild its nuclear capabilities or any other capabilities that were attacked.

The Mid to Long-Term Risks of a Nuclear Arms Race

The mid-to-longer term risks are equally complex. Far too much of the current confrontation between Iran and the US and other members of the 5+1 focuses on the arms control aspects of keeping Iran from having any nuclear weapons or – in some cases – a greater ability to rush forward in building its own bombs if chooses to do so. Much of this analysis ignores both the longer term arms control issues involved, and the fact there already is a de facto nuclear arms race in the region as Israel reacts to threat of Iranian nuclear capabilities by improving its own very real nuclear and missile strike capabilities and targeting Iran.

The arms control limits are reflected in the fact that there is almost now focus on the risk that Iran will seek other weapons of mass destruction. Iran is already a chemical weapons power and seems to have chemical cluster weapons. It has all of the technology and industrial base to produce advanced genetically engineered biological weapons if it chose to do so. It may be able to acquire terminal guidance systems for its long and medium-range ballistic and cruise missiles – making them "weapons of mass effectiveness" when targeted against critical infrastructure targets like the Gulf desalination plants.

Moreover, it is not clear how realistic the current negotiations are in looking beyond Iran's current efforts towards the future. They focus on enrichment rather than whether Iran could continue to develop steadily more advanced centrifuges and capability to manufacture them. They generally assume very high levels of enriched weapons grade material are needed – based on earlier weapons designs – and do not examine the full range of nuclear weapons design options. They do take account of Iranian activities at Parchim, but do not seem to pose credible barriers to other ways Iran could covertly develop nuclear weapons designs using simulated weapons that would be extremely difficult to detect.

A similar arms control focus on a Weapons of Mass Destruction Free Zone (WMDFZ) seems well-intentions, but to ignore the realities of Israel's commitment to nuclear armed-long range missiles, the political upheavals that could make any agreement suddenly useless, the fact Arab states like Syria have extensive stocks of chemical weapons as well as Iran, and the risks posed by biological weapons and "weapons of mass effectiveness." This does not mean a WMDFZ is not worth pursuing, but it does indicate it has a low probability of success, and that current efforts do not begin to effectively address the problem and risks involved.

As for a nuclear arms race in the region, as the following analysis show, it already exists. Israel almost certainly acquired nuclear-armed missiles that can target every major population center in Iran years ago. While Iran might have serious problems in creating safe, stable, reliable fission warheads and bombs that had predictable yields and could be reliably deployed on missiles and aircraft, Israel almost certainly has "boosted" fission weapons and may well have thermonuclear weapons.

In practice, Israel probably already poses a more serious existential threat to Iran than Iran can pose to Israel in the near term. This does not mean that Iran could not achieve massive political damage to Israel or any Gulf state simply by exploding even the crudest gun type nuclear device on a cargo or other civilian ship using a simple GPS trigger. It does not mean that Israel or Iran would ever engage in such a nuclear exchange or use nuclear weapons at all. Iran's more extreme rhetoric and threat to Israel seem designed as much to cloak its build up of military capabilities directed at the Arab states and US as anything else. It does mean, however, that Israel acquired a major lead in a nuclear arms race on region long ago, and that both sides are likely to pursue that race far more intensely – possibly with a Gulf state like Saudi Arabia joining in.

Such an arms race might push Iran into high risk nuclear missile deployment options early in its deployment efforts – involving mobile and silo-based nuclear armed system ties to warning and command and control system for either launch on warning (LOW) or launch under perceived attack (LUA). It would give Iran strong incentives to go from simple fissile weapons to the largest boosted and thermonuclear weapons it could design and build.

It could drive both Iran and Israel to acquire as many nuclear-armed delivery systems missile as possible -- including submarines and cruise missiles -- and to try to offset any perceived nuclear advantage on the other side by deploying biological weapons as well. This could be further complicated by US efforts to provide some form of extended deterrence, and a nuclear umbrella to cover the Arab Gulf states and Israel similar to the one it provide its ANATO allies during the Cold War.

There already is a matching race in missile and air defenses defense where the US, its Gulf allies, and Israel so far have an advantage over Iran. The US is deploying advanced missile defense ships with wide area theater missile and air defense capabilities. The Arab Gulf states are buying the PAC-3 and possibly THAAD. Israeli has the Arrow and PASC 3, and is working with the US to develop a far more advanced Arrow 3. Iran is countering with efforts to develop penetration aids and countermeasures for its missiles, but so far has been unable to buy any form of modern surface-to-air missile or missile defenses

In short, it is a future that could go from what may be a 100+ Israeli nuclear weapons and a potential Iranian weapon to a broad regional arms race that accelerated year-by-year for the indefinite future.

A Military Balance Driven by Unknowns

It should be stressed that these worst cases are worst cases, rather than the most probable courses of events. They do, however, present a mix of risks where any analysis of the current and future balance is further complicated by many unknowns and that fact that any analysis based on game theory and "rational bargaining" can fail because each side's perceptions of the threat the other

side poses can sometimes be so different and be as important as actual capabilities. It is also a reality that counting on deterrent because to worked for the US and FSU ignores the real world behavior that led to World War I and World War II, and several thousand years of human history.

There is little disagreement over the fact that Iran's actions pose a serious potential threat to the US and its allies, but there is far less agreement over the nature, scale and timing of this threat. At the same time, there are serious uncertainties affecting many aspects of both Iran's missile and nuclear capabilities, and the prospects for any form of US or Israeli preventive attack.

What is comes to Iran's long-range missiles, most US, European, Gulf, and Israeli policymakers and experts agree that Iran possesses a large and growing missile force, with some missiles capable of hitting Israel and Europe. They agree that Iran has begun developing longer range and solid fuel missiles.

At the same time, the Iranian missile program is in flux and many of Iran's missile systems are still in a development phase where their range, accuracy, warhead, and reliability are impossible to predict. There is no agreement as to when Iran may acquire missiles with homing warheads and the kind of terminal guidance that can hit point targets effectively with conventional warheads. There is no agreement on the reliability and accuracy of Iran's missiles under operational conditions, there is no agreement on Iran's ability to deploy systems with countermeasures to missile defenses.

As for Iran's nuclear programs, most US, European, Gulf, and Israeli policymakers and experts agree that Iran is actively working towards at least the capability to produce nuclear weapons. Similarly, they agree that Iran now possesses the technology and equipment necessary to produce fission weapons and has significant nuclear weapons design data.

However, estimates of the nature of Iran's nuclear weapons efforts vary more sharply. There is no agreement on when Iran might deploy a fully functional nuclear warhead. And, there is no agreement on the future size, character, and basing mode of Iran's missile forces once its long-range systems are deployed in strength.

There is no agreement as to exactly how far Iran has come in weapons design, over the nature of its nuclear weapons program if a dedicated program exists, how much is known about Iran's various nuclear facilities, its future enrichment programs and how they will be concealed and protected. There is no agreement as to when or whether Iran will carry out actual nuclear tests, produce bombs or warheads (although the spectrum of uncertainty is now generally felt to be 2-5 years), and no agreement as to how Iran will approach the storage and control of such weapons.

Iran's Ballistic Missile Program and its Role in US and Iranian Military Competition

Iran has been developing ballistic missile capabilities based on Russian, North Korean, and Chinese technology or weapons systems since the early 1980s. Iran currently possesses the

largest ballistic missile inventory in the Middle East, and the country's military and scientific establishments are working to increase the sophistication, scale, and reach of its missiles.[1]

Iran sees its missile capabilities as a way to compensate for its shortcomings in conventional forces, as well as a means to strike at high-value targets with little warning, such as population centers, and Western and Western-backed forces in the region, including US bases in the Gulf. As such, ballistic missiles play an integral role in Iran's asymmetric warfare doctrine. Given the emphasis Iran places on its missile program, it is clear that Iran considers its ballistic missile arsenal among its most important assets as both a deterrent to attack and leverage over other regional players.

Iran's Missile Programs

Iran's current missile efforts are summarized in the declassified version of a report the US Secretary of Defense sent to Congress in April 2012,[2]

> Regular Iranian ballistic missile training program continues throughout the country. Iran continues to develop ballistic missiles that can range regional adversaries, Israel, and Eastern Europe, including an extended-range variant of the Shahab-3 and a 2,000-km medium-range ballistic missile, the Ashura. Beyond the steady growth in its missile and rocket inventories, Iran has boosted the lethality and effectiveness of existing systems by improving accuracy and developing new submunition payloads.
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> During the last two decades, Iran has placed significant emphasis on developing and fielding ballistic missiles to counter perceived threats from Israel and Coalition forces in the Middle East and to project power in the region. With sufficient foreign assistance, Iran may be capable of flight-testing an intercontinental ballistic missile by 2015.
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>
> During the last 20 years, Iran has placed significant emphasis on developing and fielding ballistic missiles to counter perceived threats from Israel and Coalition forces in the Middle East and to project power in the region. In 2011, Iran launched several missiles during the NOBLE PROPHET 6 exercise, including a multiple missile salvo.
>
> Short-range ballistic missiles provide Tehran with an effective mobility to strike partner forces in the region. Iran continues to improve the survivability of these systems against missile defenses. It is also developing and claims to have deployed short-range ballistic missiles with seekers that enable the missile to identify and maneuver towards ships during flight. This technology also may be capable of striking land-based targets.

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[1] Statement for the Record on the Worldwide Threat Assessment of the U.S. Intelligence Community for the House Permanent Select Committee on Intelligence, James R. Clapper, 11 Feb. "11

[2] Taken from unclassified edition of the *Annual Report on Military Power of Iran, April 2012*, as transmitted in Letter from the Secretary of Defense to the Honorable Carl Levin, chairman of the Senate Armed Services Committee, June 29, 2012, pp. 1, 4.

> Iran has also developed medium-range ballistic missiles to target Israel and continues to increase the range, lethality, and accuracy of these systems.

One needs to be careful about open source material, although much of it is useful. A great deal more unclassified analysis exists of Iran's long-range rocket and family of ballistic missile programs than can be based on reliable data. While some systems like the Scud B are well known, many aspects of Iran's programs are not. Iran has not conducted the kind of extensive, realistic missile tests at operational ranges and carried through to strikes on target with the same configuration of its modified or Iranian-produced missiles to make reliable estimates of their war fighting capability or give any estimate of their performance "derived aim point" credibility to the data on accuracy and reliability.

Most estimates use a nominal payload that may bear no relation to the actual payload, and this casts serious doubt on both the range-payload data and any estimate of warhead lethality. They also do not consider Iranian advances in submunition warheads and possible advances in accuracy. Moreover, Iran keeps changing key aspects of its longer-range systems while moving towards warhead configurations large enough to either hold a nuclear weapon or more sophisticated conventional or CBW warhead. While Iran's Scud B and extended range Scud variants approach the status of a mature force, even the unclassified data on the extended range Scuds consists largely of estimates, and its Shahab program seems to undergo constant evolution in spite of the fact that a force is deployed.

There is, however, no question about Iran's ability to field short, medium, and long-range missiles and execute strikes with conventional warheads against large area targets, and while the following data are nominal, they do illustrate real world capabilities:

- **Figure IV.1** shows the ranges of Iran's ballistic missiles. While Iran does not yet possess missiles with a range of 4,000 km, the possibility exists that Iran may soon produce missiles with such a capability given the scale of R&D into its ballistic missile program.
- **Figure IV.2** provides a more conservative estimate for the range of Iran's current missile forces. According to the BPC's estimate, Iranian missiles could potentially strike Athens, Bucharest, or Moscow.
- **Figure IV.3** reflects key developments in Iran's ballistic missile program in the last several years. Key points include the possibility that Iran could produce an intercontinental ballistic missile by 2015, and indicators that Iran is developing a nuclear warhead for its Shahab-3 intermediate range ballistic missile.
- **Figure IV.4** provides a table that indicates the names, fuel types, estimated ranges, and likely payloads of the missiles in Iran's arsenal.

The Shahab 3

As **Figure IV.4** shows, Iran possesses a diverse arsenal of ballistic missiles, and substantial ability to launch even its longest-range missiles from disperse mobile launders. Of particular note are Iran's medium-range ballistic missiles (MRBMs), which include the Shahab-3 and its longer-range variants. Based on the North Korean Nodong-1, the Shahab-3 has a range of 1,000 to 1,500 km, and can potentially reach targets throughout the Middle East.[3] Other Iranian MRBMs

[3] U.S. Congressional Research Service. "Iran's Ballistic Missile Programs: An Overview." RS22758, 04 Feb. "09, Steven A. Hildreth.

include variants of the Shahab-3, such as the Shahab-3A, Shahab-3B, Shahab-4 (Ghadr-1), Sajjil, and the BM-25.

Basing on Mobile Launchers and in Silos

Iran has both mobile launchers and silos. Iran announced its silos publically by showing video on Press TV, its state television, in late June 2011. It did so as part of an exercise called "Great Prophet 6" and claimed they would allow it to launch missiles more quickly and reliably. These silos seem to have been in near Tabriz and Khorramabad in northwest Iran, but this is uncertain and other silos may well exist. [4]

The same video showed mobile launchers for the Shahab 3, and press reports indicated that the silos had C4I links linked to a missile control center – presumably commanded by the IRGC Aerospace Force. *The New York Times* quoted the commander of the Guards' Aerospace Force, Amir Ali Hajizadeh, as stating that the silos were a crucial asset in Iran's standoff with the West, and as saying that as a result, "we are certain that we can confront unequal enemies and defend the Islamic Republic of Iran." It also said that another Guards officer had said on state television that, "only few countries in the world possess the technology to construct underground missile silos. The technology required for that is no less complicated than building the missile itself." It reported that Iran claimed its designs were original and not copied from North Korea.[5]

Iran's Fars news service stated separately that,[6]

> The silos are a part of the swift reaction unit of the [IRGC] missile brigade; missiles are stored vertically, ready to be launched against pre-determined targets," Fars News Agency quoted the IRGC spokesman in charge of the drills, General Asghar Qelich-Khani, as saying on Monday.
>
> Qelich-Khani said the country has been using domestically-built missile silos for fifteen years and added that the newer generation silos are operational from a launch control center located far from the launch pads.
>
> The main advantage of missile silos is the reduced launch time as the weapons need not be moved or aligned prior to launch.
>
> On Sunday, Commander of the Aerospace Division of the IRGC Brigadier General Amir Ali Hajizadeh short-, medium- and long-range missiles, namely Khalij Fars (Persian Gulf), Sejjil (Baked Clay), Fateh (Conqueror), Qiam (Rising), Shahab-1 and Shahab-2 missiles would be fired during the war games.

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[4] William J. Broad, Iran Unveils Missile Silos as It Begins War Games, new York Times, June 27, 2011, http://www.nytimes.com/2011/06/28/world/middleeast/28iran.html; CNN, Iran unveils missile silos as military exercises open, June 27, 2011, CNN Wire Staff, ttp://articles.cnn.com/2011-06-27/world/iran.missiles_1_missile-silos-long-range-missiles-fire-missiles?_s=PM:WORLD.

[5] William J. Broad, Iran Unveils Missile Silos as It Begins War Games, new York Times, June 27, 2011, http://www.nytimes.com/2011/06/28/world/middleeast/28iran.html; CNN, Iran unveils missile silos as military exercises open, June 27, 2011, CNN Wire Staff, ttp://articles.cnn.com/2011-06-27/world/iran.missiles_1_missile-silos-long-range-missiles-fire-missiles?_s=PM:WORLD.

[6] FARS, Iran unveils missile silos in war games, Mon Jun 27, 2011 5:12PM GMT, http://www.presstv.ir/detail/186506.html

> Hajizadeh stressed that Great Prophet 6 maneuver has completely defensive objectives and will be staged with the message of "peace and friendship."
>
> IRGC's naval, air and ground forces staged the Great Prophet 5 military drill in the Persian Gulf in April 2010.

Roughly a year later, a less open issue arose over Iran's missile launchers. While it had long been clear that Iran had such launchers, Iran showed a launcher at a parade that was strikingly similar to a Chinese TEL (transporter-erector-launcher.) It is not clear whether Iran did import the launcher, copied a North Korean modification of the Chinese launcher, or engineered its own design.

The Asura, Ashoura, Gadr 110A, Sejii, Seiji 2, Sajjill

It should be noted that **Figure IV.4** does not include the Ashura, Ashoura, or Gadr 110A missile – later renamed the Sejii (Backed Clay) or the Seiji 2 -- which are solid fueled missile designs. The Seiji is said to have a range of some 2,200 kilometers (1,375 miles) with a 750 kilogram payload.[7] Iran's defense minister at the time -- Minister Mostafa Mohammad-Najjar -- claimed Iran first tested the system in November 2007. Sources like *Jane's Defense Weekly* reported that the Sejii 2 was an inertially-guided, two-stage system, mobile, and more accurate than Iran's liquid fueled systems like the Shahab. It also reported that it was developed by Shahid Bagheri Industrial Group (SBIG) under the Sanam Industrial Group (Department 140), which is a subsidiary of the Defense Industries Organization (DIO) of Iran.[8]

Roughly a year later (November 18, 2008), Najjar claimed the missile had been tested for a second time and had been renamed the Seiji-2. President Mahmoud Ahmadinejad reported a further test in May 2009, and another test was reported in December. At least one source reported that the warhead closed more quickly than that of the Shahab and had a special coating to reduce detection by the radar of missile defense systems. [9] Iran reported other launches in 2010 and 2011, but with little detail.[10]

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[7] Michel Ellman, *Iran Primer: Iran's Missile Program*, Frontline, October 20, 2010, http://www.pbs.org/wgbh/pages/frontline/tehranbureau/2010/10/iran-primer-irans-ballistic-missile-program.html.

[8] Jane's Defense Weekly, November 26, 2007; Wikipewdia, "Ashoura," http://en.wikipedia.org/wiki/Ashoura_(missile); Ashoura/Gadr 110A, www.globalsecurity.org/wmd/world/iran/ashura.htm; Norbert Brügge, New Iranian two-stage solid propellant missile "Sejil"-- the renamed "Ashura" (Ghadr-110) , http://www.b14643.de/Spacerockets_1/Diverse/Sejil/index.htm;

[9] Norbert Brügge, New Iranian two-stage solid propellant missile "Sejil" -- the renamed "Ashura" (Ghadr-110) , http://www.b14643.de/Spacerockets_1/Diverse/Sejil/index.htm. Some sources claim technology transfer from North Korea. Others mention the Pakistani Shaheen 2, and some see similarities to the Chinese Dong Feng. None of these reports can be confirmed.

[10] See NTI, *Iran Missile Chronology*, August 2011, http://www.nti.org/media/pdfs/iran_missile.pdf?_=1316474223;

It has since become clear that the probable sabotage that caused an explosion at an Iranian missile base on November 12, 2011 was aimed at impairing or crippling Iran's development of solid fuel rocket motors for larger missiles such as the Sejjil-2.[11] According to some reporting, a senior IRGC commander killed in the attack, General Hassan Moghaddam, "built Iran's solid-propellant industry from the ground up beginning in the mid-1980s."[12]

Some US and Israel experts believe at least some Seiji 2s are operational The IISS does not, however, treat the system as operational. [13] It reported in May 2012 that,

> "Iran is also developing a new medium-range, solid-propellant missile, the *Sajjil*-2, potentially capable of delivering a 750kg warhead to a range of about 2,200km. Iran is the only country to have developed a missile of this reach without first having developed nuclear weapons. The solid-fuelled system offers many strategic advantages, including being less vulnerable to pre-emption thanks to its shorter launch-preparation time. The *Sajjil*-2, which was successfully flight-tested for the first time in November 2008, is still two to three years of flight testing away from becoming an operational system that can be deployed to military units. Iran has yet to demonstrate that the missile's individual stages perform consistently and reliably under a variety of operational conditions. If deemed necessary, this new missile could conceivably be used for combat in late 2010 or early 2011. However, the history of solid-propellant missile programmes elsewhere suggests an initial deployment of the *Sajjil*-2 in 2012 or later is more likely."[14]

Iran's Possible Search for an ICBM

There have been reports that Iran may be developing an ICBM. Iran has been developing and testing rocket motor technology and multi-stage boosters since 2008 that could serve this purpose. Iran launched its first satellite, the Omid (Hope) satellite in February 2009, and its second, the Omid (Hope) satellite in February 2009, in June 2011. These seem to have use a Safire solid-fuel rocket booster with limited payload capability.[15] Iran had another launch fail in October 2001, but did launch another small satellite in February 2012. It has prepared large satellites for launch later in 2012.

The NTI also reports that Iran announced in February 2010 that it had, "created a new satellite launch vehicle (SLV), the Simorgh" in February 2010. The NTI report indicates that this was a larger, "'a 27-meter-long, multi-stage, liquid-fuel missile with a thrust of 143 metric tons.' The

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[11] Ellemen, Michael. "Mysterious Explosions at Iran Missile Base." December 18, 2011. http://iranprimer.usip.org/blog/2011/dec/18/mysterious-explosion-iran-missile-base

[12] Ellemen, Michael. "Mysterious Explosions at Iran Missile Base." December 18, 2011. http://iranprimer.usip.org/blog/2011/dec/18/mysterious-explosion-iran-missile-base

[13] Dr. John Chipman, "Iran's Ballistic Missile Capabilities: A net assessment, IISS, May 2012, http://www.iiss.org/publications/strategic-dossiers/irans-ballistic-missile-capabilities/press-statement/.

[14] Dr. John Chipman, "Iran's Ballistic Missile Capabilities: A net assessment, IISS, May 2012, http://www.iiss.org/publications/strategic-dossiers/irans-ballistic-missile-capabilities/press-statement/.

[15] NTI, *Iran Missile Chronology*, August 2011; Julian Borger, "Iran Launches Second Satellite," The Guardian, 17 June 2011; Yaakov Katz," Iran Launches Rasad 1 'Observation' Satellite," Jerusalem Post, 16 June 2011.

Simorgh is designed to carry a 60kg (132lb) satellite into low earth orbit (LEO) and could be enhanced to carry a 700kg satellite."[16]

These "space" efforts could allow Iran to develop an ICBM capability as early as 2015-2020. In February 2012, Israel's Finance Minister, Yuval Steinitz, stated that Iran could develop an ICBM that could reach the East Coast of the US within the next two to three years,[17]

> "They (the Iranians) are working now and investing a lot of billions of dollars in order to develop intercontinental ballistic missiles… And we estimate that in two to three years they will have the first intercontinental ballistic missiles that can reach the East Coast of America. So their aim is to put a direct nuclear ballistic threat ... to Europe and to the United States of America."

Given what is known about Iran's ballistic missile technology, these claims probably represent a worst case for any date before 2015. US intelligence sources have not yet announced that Iran has a full-scale ICBM program at present. The Secretary of Defense stated in his April 2012 report to Congress that,[18]

> Since 2008, Iran has launched multistage space launch vehicles that could serve as a test bed for developing long-range ballistic missile technologies.
>
> …During the last two decades, Iran has placed significant emphasis on developing and fielding ballistic missiles to counter perceived threats from Israel and Coalition forces in the Middle East and to project power in the region. With sufficient foreign assistance, Iran may be technically able of flight-testing and intercontinental ballistic missile by 2015.

Without such an effort, it seems unlikely that Iran will reach reached the level of guidance or re-entry technology necessary to effectively strike at the East Coast of the US or anywhere else of similar range with an ICBM in less that 4-10 years.[19] The longer time frame seems more likely and Iran would then need a nuclear or extremely effective biological warhead to do serious damage, and testing and deployment might well trigger US preventive strikes or preemption in any crisis.

Weighting the Importance of the Uncertainties in the Iranian Missle Program

The uncertainties involved in estimating Iran's medium and long-range missile capabilities should not be exaggerated. Iran clearly has operational missiles that are mobile and in silos with

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[16] Excerpted from NTI, *Iran Missile Chronology*, August 2011, http://www.nti.org/media/pdfs/iran_missile.pdf?_=1316474223. Also see Aron Ben-David, "Iran Tests New Launcher," Aviation Week, 17 February 2010; "Launch Sight-Iranian Rocket Capabilities Advance," Jane's Information Group, 16 March 2010; "Iran Building Potential ICBM Launch Facility with Help from North Korea," World Tribune, 8 March 2010; Parisa Hafezi and Reza Derakhshi, "Iran Says Launches Satellite Rocket," Reuters, 3 February 2010; Adam Gabbatt, "Iran Rocket Launch Opens Can of Worms in Space Race with West," The Guardian, 3 February 2010.

[17] "Iran Progressing Toward ICBM Capability, Israeli Finance Minister Says." NTI. February 22, 2012. http://www.nti.org/gsn/article/iran-progressing-toward-icbm-capability-israel-says/

[18] Taken from unclassified edition of the *Annual Report on Military Power of Iran, April 2012*, as transmitted in Letter from the Secretary of Defense to the Honorable Carl Levin, chairman of the Senate Armed Services Committee, June 29, 2012, pp. 1,4.

[19] "Experts Question Predictions on Iranian ICBM." NTI. February 24, 2011. http://www.nti.org/gsn/article/experts-question-iranian-icbm-capabilities/

ranges of 1,500 to 2,500 km, and are thought to be able to strike at targets throughout the Middle East, Turkey, and southeast Europe.[20] Although Iran's missiles do not possess the precision accuracy necessary for conventionally armed missiles to be effective against point or high value targets, even conventionally armed missiles can be used as tools of terror and intimidation and to strike at targets throughout the region with little, if any, warning.

Moreover, both Israeli and US experts feel Iran is improving the accuracy of its missiles, is arming them with submunitions that can achieve better lethality with conventional and chemical munitions, and is developing at least limited countermeasures to missile defenses. An April 2012 report to Congress by the US Secretary of Defense stated that,[21]

> …Regular Iranian ballistic missile training occurs throughout the country. Iran continues to develop ballistic missiles that can range regional adversaries, Israel, and Eastern Europe – including an extend range version of the Shahab 3 and a 2,000-kilomter range medium range ballistic missile, the Ashura. Beyond steady growth in missile and rocket inventories, Iran has boosted the lethality and effectiveness of existing systems by improving accuracy and developing new submunition payloads.

Nevertheless, there are a number of issues that anyone assessing Iran's missile programs must consider:

- The operational readiness and capability of both Iran's operators and missiles remain uncertain. Almost all launches seem to be "white suit" launches prepared by technical expert with long warning and time to both check out and ready the system. There is no way to know what real world combat preparation time and readiness really is.
- Many systems are destroyed in flight during the test. This deprives Iran of the ability to know what ordinary operators and forces can do, as well as outside observers.
- Declassified sources mention efforts reduce vulnerability to missile defenses but give no details.
- Iran seems to be seeking some form of GPS guidance and terminal homing capability, but it is far from clear what progress it has made – if any. A truly precision-guided missile would be far more lethality with even a conventional warhead.
- The possible use of volleys to compensate for accuracy and reliability exists, but it is unclear if any test data really demonstrate whether Iran has a serious capability at more than short ranges.
- There are no meaningful unclassified reports on the details of Iran's warning systems; command, control, computer and intelligence (C4I), and intelligence, surveillance, and reconnaissance systems (IS&R), command structures, or operational doctrine.
- There are no useful data on Iranian target doctrine, targeting capability, and damage assessment capability.
- Iran does have long-range Russian cruise missiles it can reverse engineer, could convert combat aircraft in high payload unmanned combat aerial vehicles (UCAVs), and used medium-range UCAVs during the Israeli-Hezbollah War in 2006. It is unclear, however, whether Iran is moving forward in long-range, high payload cruise missiles and UCAVs.

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[20] U.S. Congressional Research Service. "Iran's Ballistic Missile Programs: An Overview." RS22758, 04 Feb. "09, Steven A. Hildreth.

[21] Taken from unclassified edition of the *Annual Report on Military Power of Iran, April 2012*, as transmitted in Letter from the Secretary of Defense to the Honorable Carl Levin, chairman of the Senate Armed Services Committee, June 29, 2012, pp. 1,4.

- While it is an outlier, much depends on the warhead and if Iran goes nuclear, on how quickly it can achieve reliable fission weapons, move on to boosted weapons, and then to thermonuclear weapons

What Iran's Actions and Statements Say About Its View of Competition: Ballistic Missiles

Iran does issue official statements on its missile programs, but most are more propaganda than anything else. Iran continues to deny it is seeking nuclear weapons but it is much more forthright about its missile programs, and it has made missile test firings a major part of its televised military exercises:

- *"Our missiles have tactically offensive and strategically deterrent and defensive features… Our fingers are still kept on the trigger, but the number of these triggers has increased."* – Brigadier General Hossein Salami, Lieutenant Commander of the IRGC, June 28, 2011.
- *"We feel to be threatened by no county but the US and the Zionist regime and the ranges of our missile have been designed based on the distances between us and the US bases in the region and the Zionist regime."* – Brigadier General Amir Ali Hajizadeh, commander of the IRGC's Aerospace Division, June 28, 2011.
- *"The mass production of the Qiyam missile, the first without stabilizer fins, shows the Islamic Republic of Iran's self-sufficiency in producing various types of missiles."* – Iranian Defense Minister Ahmad Vahidi, May 22, 2011.
- *"As the enemy's threats will likely come from the sea, air, and by missiles, the Revolutionary Guard has been equipped to neutralize the enemy's advanced technology."* – Mohammed Ali Jafari, commander of the IRGC on a new anti-ship ballistic missile that Iran has allegedly developed, February 7, 2011.
- *"Iran is mass producing a smart ballistic missile for sea targets with a speed three times more than the speed of sound."* – Major General Mohammed Ali Jafari, commander of the IRGC, February 7, 2011.
- *"The operational capabilities of the missile unit of the IRGC Aerospace Force will be remarkably enhanced."* – Iranian Minister of Defense Ahmad Vahidi regarding the new indigenously produced Fateh-110 ballistic missile, September 21, 2010.
- *"Those who are hostile to the Islamic Republic of Iran definitely have the right to be concerned about the drills, but we didn't hear any feeling of concern from the side of the regional countries since our moves and actions have always been in pursuit of defensive goals.*

  We are entitled to the right to growingly strengthen ourselves to protect the Islamic Iran and we naturally increase our power on a daily basis until we acquire full (power of) deterrence." – General Amir Ali Hajizadeh, commander of the IRGC's Aerospace Division in reference to Iran's most recent missile tests, July 9, 2011.[22]

What is clear from such statement is that Iran views its ballistic missiles as a critical component of its national defense. In addition to an effective means for delivering a nuclear warhead, Iran's military establishment firmly believes that an effective ballistic missile program provides the country with increased strategic and asymmetric capabilities.

Missiles as a Form of Deterrence

Iranian officials regularly make references to their missile forces as an effective deterrent to attack, and the Iranian leadership is not shy about its country's advancements concerning

[22] Quotes taken from a number of Iranian news sources such as Fars News, PressTV, the Tehran Times, and others. Also included are quotes from Western news outlets such as CNN, the New York Times, and the Washington Post.

ballistic missile technology. High-ranking officials in Iran's political and military establishments regularly boast of their country's progress in this field.

During the Great Prophet 6 war games in late June 2011, the commander of the IRGC's Aerospace Division, Brigadier General Amir Ali Hajizadeh, stated that,

> "We feel to be threatened by no county [sic] but the US and the Zionist regime and the ranges of our missile [sic] have been designed based on the distances between us and the US bases in the region and the Zionist regime."[23]

Later, on July 9, 2011, General Hajizadeh stated the following about the war games:

> "Those who are hostile to the Islamic Republic of Iran definitely have the right to be concerned about the drills, but we didn't hear any feeling of concern from the side of regional countries since our moves and actions have always been in pursuit of defensive goals.
>
> We are entitled to the right to growingly strengthen ourselves to protect the Islamic Iran and we naturally increase our power on a daily basis until we acquire full (power of) deterrence."[24]

On June 28, 2011, Lieutenant Commander of the IRGC, Brigadier General Hossein Salami, also made reference to the deterrent that Iran perceives in its missile forces:

> "Our missiles have tactically offensive and strategically deterrent and defensive features… Our fingers are still kept on the trigger, but the number of these triggers has increased."[25]

Remarks made by such a high-ranking figure are revealing. They are a direct indication of the Iranian regime's continued willingness to improve its ballistic missile arsenal as a component of its asymmetric warfare capabilities and the deterrent it generates against the US and regional US allies. Given Iran's foreign policy objectives, conventional shortcomings, and ever-expanding missile program, it is clear that Iran sees its missile program as an effective tool to improve its strategic standing and assert itself in the region.

The Warfighting Capabilities of Iran's Current Missile Force

Given this background, the many aspects of the war fighting capability of Iran's missile forces, and the effect of Iran's improvements in its ballistic missiles relative to US, Arab Gulf and israeli efforts a missile defense efforts remain uncertain. Although Iran boasts the large arsenal of conventionally-armed missiles of varying ranges and payloads shown in **Figure IV.3** and **Figure IV.4**, Iran's lack of terminal guidance and highly lethal warheads sharply reduce their military effectiveness.

It is unclear that Iran has the warfighting ability to translate its current medium and long-range missile forces into anything more than a limited "terror" weapon. While Iran is improving its guidance technology and its rockets and medium range missiles are relatively accurate, they

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[23] "All US, Israeli Bases Within Iran's Missile Range." Islamic Republic of Iran Broadcasting. June 28, 2011, http://english.irib.ir/voj/news/top-stories/item/79921-all-us-israeli-bases-within-irans-missile-range

[24] "Iran Reiterates Deterrent Nature of Recent Missile Drills." Fars News. July 9, 2011, http://english.farsnews.com/newstext.php?nn=9004183678

[25] "Commander: IRGC Able to Launch Rapid, Massive Missile Strikes." Fars News, June 28, 2011, http://english.farsnews.ir/newstext.php?nn=9004074141

remain area weapons systems that can hit a broad area but not a key point target – and then only if they are properly targeted and fired, and function reliably.

The Accuracy and Reliability Challenge

Iran's longer-range systems sometimes have had too little consistent testing to produce accurate engineering estimates of their reliable circular errors of probability (CEPs) under deployed and operational conditions.

It is important to understand the difference between t*heoretical* CEP and accuracy based on a statistically large enough sample to establish a reliable *operational* estimate. CEP is defined as the level of accuracy that *should* occur if the system is perfectly aimed, functions perfectly, and every aspect of the design functions as exactly as it should. It then estimates the radius of the circle that half the rockets of missiles will hit within a given distance from the target determined by the technology of the guidance platform. It is not a real world measurement in the sense it does not normally include any input from statistically relevant test and evaluation that establishes the real-world reliability of the system and the ability to aim a ballistic missile without terminal guidance, of suitable guidance modifications perfectly at long distances, given the fact the world is not perfectly round.

In practice, Iran has not conducted enough realistic tests of its systems to provide enough data to calculate accuracy and reliability, particularly under realistic field conditions. It is also true in general that missiles rarely achieve their stated CEP in practice. As a result, many of Iran's longer-range systems will be lucky to hit within a one kilometer distance of their target even if they function perfectly.

The Range-Payload Challenge

Most of the data on Iran's missiles use computer models to guess the range of Iran's missiles by assuming a nominal payload on 750 to 1,000 kilograms. These models normally have at least an uncertainty of +/- 30%, even assuming such a normal payload. It the real world, missile behavior is dictated by the actual payload which may be much heavier or lighter than the nominal payload. Missiles that use conventional or CBR warheads, or early nuclear designs, may well have much higher payloads than the nominal 750 or 1,000-kilogram warhead. They may also require less stable warhead shapes and increase reentry and stability problems

The Warhead Lethality Challenge

A high explosive warhead on a long-range missile also presents design problems that limit its lethality compared to bombs, air launched missiles, and cruises missiles. Unless it is almost perfectly fused and designed – or uses cluster munitions that are explosively disseminated at exactly the right altitude and are designed and fused so they are actually lethal against the target type being struck — the damage effect tends to be limited by the fact the explosion of a unitary warhead is deflected upwards as the warhead hits the earth.

As a result, the damage effect is significantly less than that caused by a bomb or artillery shell of the same general size. Iran may have cluster munitions on some of its systems, but the presence, character, and effectiveness of such warheads is not clear from unclassified data and it is not clear that Iran could have conducted enough suitable tests of its longer range systems for even it to have reliable data.

Moreover, unless these submunitions are armed with chemical, radiological, or biological agents, they present the problem that a warhead on a medium to long-range warhead places serious limits on the weight and size of each submunition, the accuracy of the missile means they may miss any militarily relevant target even in a military area target, and the lethality of a given submunition may be limited even if it hits a building in a civilian or urban area.

The lethality of conventional cluster munitions could be substantially higher where shorter-range missiles or rocket could be fired in volley and line of sight observations are possible, but it is one thing to use cluster munitions with a precision-guided air launched bomb or missile, or unguided cluster munitions against exposed infantry – an quite another to fire them almost at random. Until -- and if – Iran acquires medium to long-range missiles with precise terminal guidance and/or truly effective warheads using some form of weapon of mass destruction, the lethality of its missiles will be sharply limited.

These conditions obviously do not apply if a missile warhead has reliable and accurate terminal homing of the kind the US deployed on the Pershing II, the level of accuracy of US cruise missiles, or have truly reliable and effective cluster weapons. Even then, however, the probable lethality will at best be that of a single bomb of the same size, and it is far from clear that the terminal guidance of a ballistic missile will really achieve the same accuracy as a cruise missile or precision guided bomb, The problems imposed by range, far greater levels of acceleration and reentry buffeting are simply too great.

The CBR Challenge

These conditions also do not apply if a missile is armed with a nuclear warhead or a truly effective chemical or biological weapon. Once again, however, even nuclear weapons need to be part of a warhead with a reliable height of burst to reach maximum, predictable effectiveness. The conditions are far more challenging for chemical and biological weapons (CBW). The closing velocities of missile warheads are so great, and getting a broad dissemination of chemical agents at the right height is a major engineering challenge. This is equally true of biological agents, some of which are also extremely sensitive to sunlight. CBW warheads are much easier to design in the computer than to make work in the field.

Designing chemical and radiological warheads that can achieve anything like the potential lethality of the agents they carry under operational conditions is extremely difficult. Under many real world conditions they would have more of an area denial, psychological, or panic impact than actual lethality and chemical weapons and all but the most advanced radiological weapons have lethalities several orders of magnitude less lethal than nuclear weapons and the most lethal biological weapons.

Biological warheads also present critical problems for missile warhead design, and again, the theoretical lethality of the agent is no indication of operational lethality. Moreover, short of extensive testing against live humans under realistic urban or combat conditions, real world lethality is extremely difficult to predict. Animal testing can help with some biological agents, but many can only be used against humans, and past testing warns that selective use of agents against animals under simulated operational conditions cannot be scaled up or reliability predict lethality.

Nevertheless, chemical, biological, or radiological (CBR) warheads would provide a much more effective deterrent to attack and provide Tehran with the ability to strike at major population centers. Given such payloads, even a small number of missiles armed with CBRN warheads that bypassed US and Arab Gulf defenses and countermeasures could potentially cause serious to massive casualties – although much would still depend on the ability to design truly effective chemical and radiological submunitions, solving the problem of dispersing effective biological weapons, or having truly reliable nuclear warheads.

Under worst-case conditions, such weapons could still do considerable damage to the militaries, economies, and critical infrastructure of regional countries. These capabilities, in combination with the deterrent and the psychological impact they would produce, would have a profound impact on the strategic balance between Iran and the US and its Arab Gulf allies.

The Missile Defense Challenge

Iran already must deal with the fact that the US and Southern Gulf states are steadily improving their missile defenses. The US has long agreed to provide the Gulf states and Israel with data that warns them of missile launches and the missile's target. Most Gulf states have greatly improved versions of the Patriot missile defense system that can defend against Iran's Scuds and Scud variants, and have some capability against high speed closures from larger missiles like the Ashura and Shahab.

The US is deploying four guided missile defense destroyers to the Mediterranean, working with Turkey to improve missile warning coverage, working with the Arab Gulf states to develop missile defenses in the Gulf, and creating new targeting and strike capabilities to attack the Iranian missile threat. While it has received less attention than the US statements about its priorities for Asia, the new US strategy announced in January 2012 also made it clear that the US saw the Middle East broadly and Gulf is particular as an area that had the highest priority in the future, and that the threat from Iran was seen as a critical issue.

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

There is no clear way, however, to estimate real world defense capabilities since there have been no operational cases to show the relative effectiveness of the improvement in missile defenses versus Iran's missiles and the real-world success of Iran's efforts to improve its missile countermeasures to missile defenses is both classified and untested against Gulf and US missile defenses.

It does seem likely that the latest US missile defense destroyers and cruisers can defend against any of Iran's missiles over a relatively wide area, and are acquiring steadily more capable anti-missile missiles. The Gulf states may well follow. The UAE is considering buying and deploying the THAAD wide area defense system, and all of the Southern Gulf states are being briefed on possible buys of the SM-2 series or THAAD. The US cooperates closely with Israel in missile defense, and Israel is steadily upgrading its Arrow missile defense system.

No system is likely to be leak proof – and it may be argued that any exchange would be one between missiles and anti-missile with unproven and unpredictable performance – but Iran's missile threat grows steadily less credible as these missile defenses improve. Moreover, it is one thing to be threatened by the risk that one nuclear-armed missile gets through to a key target area, and quite another to face the risk a few far less lethal missile get through. Conventional or even CB-armed missiles become steadily less credible as "terror" or psychological weapons as missile defenses improve.

Furthermore, if Iran were to arm its missiles with more effective warheads with accurate and reliable terminal guidance – or develop long-range cruise missiles with such capability – this would significantly change such war fighting calculations. Key export, power, desalination, and military targets could then become targets or hostages. Similarly, even the credible threat – much less use of – CBRN warheads might dramatically upset the regional balance. Such capabilities would provide Iran with a much more solid deterrent, and a greater capability to exercise a bolder and more aggressive regional foreign policy

Political and Psychological Warfighting

At the same time, it is important to note that Iran can use its missiles politically and strategically, and not simply to damage targets. Selective firings and "volleys" of conventionally armed, unguided long-range missiles and rockets can and might well be used as political symbols or terror weapons. Iran might use its missiles to strike Israel after an Israeli preventive strike, or to strike at Israel in some other contingency where it felt the political symbolism inside Iran and the Arab and Islamic worlds were worth the cost. It might take the same approach in an asymmetric war with the US and Arab Gulf states, or after a US preventive strike on Iran. Even a few missile strikes might be seen as a demonstration of Iran's willingness to escalate even further, or growing future ability to strike with far more effectiveness. Moreover, even token strikes can be used for internal political propaganda purposes.

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

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

These psychological effects, however, wore off relatively quickly. There were not enough missile firings to sustain a high degree of popular fears, and people were soon reported to be going to their roofs at night to "watch the show." There is simply too much empty area in a given urban complex or large military base for largely random strikes to either produce critical damage or kill enough people to shock or intimidate the population.

The Impact of Retaliatory Threats and Retaliation

Regardless of how or why Iran uses its missile and other delivery system, Iran cannot operate in an environment where there will be no response. Israel has a wide range of retaliatory and escalatory options. Saudi Arabia already has long-range, conventionally armed Chinese missiles that can strike area targets in Iran. There are questions about the status, reliability, readiness, and accuracy of the Saudi missiles, but these same questions apply to Iran's forces. This raises the specter of any missile "war of the cities" of the kind observed between Iran and Iraq.

Iran also faces the risk of retaliation by the best air forces of Gulf states like Saudi Arabia and the UAE as they acquire steadily better strike fighters with sophisticated stand-off, air-to-surface weapons. Iran is becoming more vulnerable to Southern Gulf air forces as they acquire missile defenses and become less vulnerable to Iranian missiles.

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

Moreover, the first time Iran uses even a conventionally armed missiles, it may create conditions that lead to some form of US guarantees and "extended deterrence." The US has stated that it will not accept an Iran with nuclear weapons, but even if does, this scarcely offers Iran security or freedom from preemption and retaliation.

These risks will also increase if Iran does deploy missiles with weapons of mass destruction even if it does not use them. The US Director of National Intelligence, James R. Clapper, touched on this case in his Worldwide Threat Assessment for 2012 statement:[26]

> We judge Iran would likely choose missile delivery as its preferred method of delivering a nuclear weapon. Iran already has the largest inventory of ballistic missiles in the Middle East, and it is expanding the scale, reach, and sophistication of its ballistic missile forces, many of which are inherently capable of carrying a nuclear payload.
>
> We judge Iran's nuclear decision-making is guided by a cost-benefit approach, which offers the international community opportunities to influence Tehran. Iranian leaders undoubtedly consider Iran's security, prestige, and influence, as well as the international political and security environment, when making decisions about its nuclear program.

[26] James R. Clapper, Director of National Intelligence, Unclassified Statement for the Record on the Worldwide Threat Assessment of the US Intelligence Community for the Senate Select Committee on Intelligence, January 31, 2012, http://www.dni.gov/

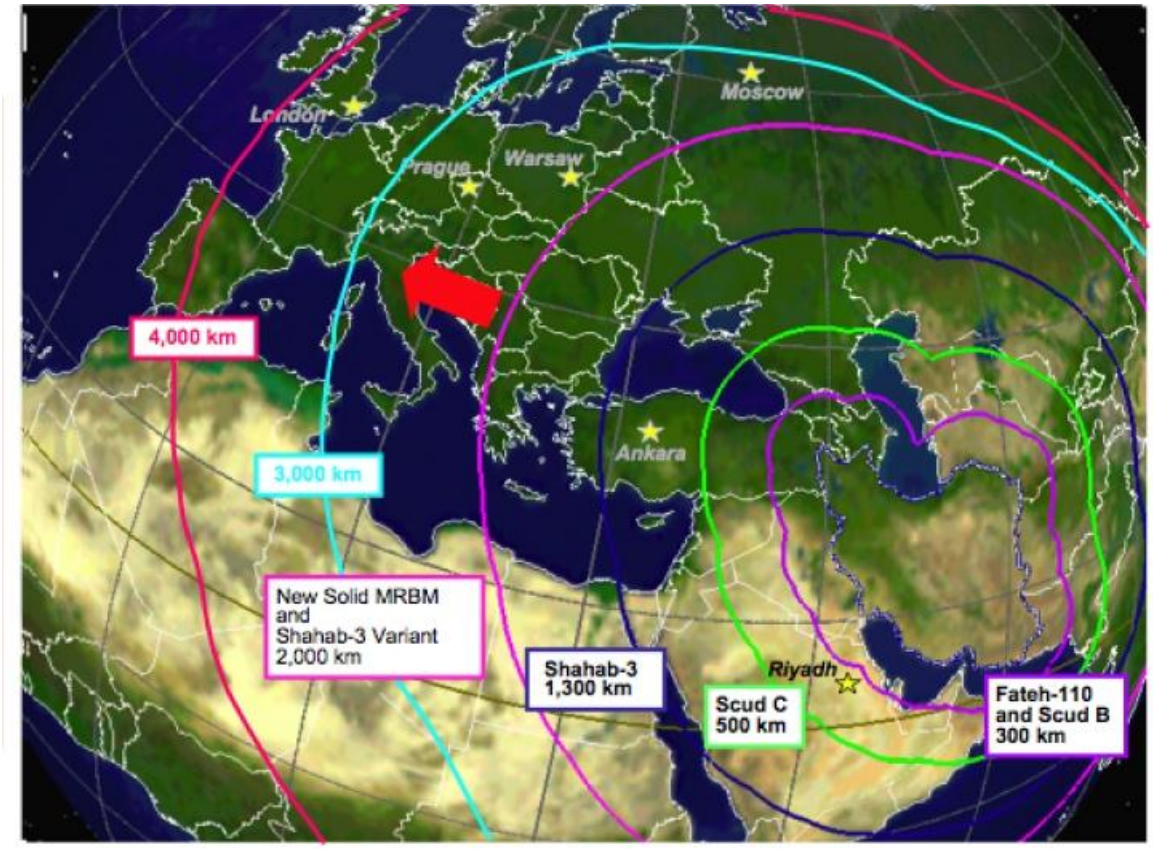
> Iran's growing inventory of ballistic missiles and its acquisition and indigenous production of anti-ship cruise missiles (ASCM) provide capabilities to enhance its power projection. Tehran views its conventionally armed missiles as an integral part of its strategy to deter—and if necessary retaliate against—forces in the region, including US forces. Its ballistic missiles are inherently capable of delivering WMD, and, if so armed, would fit into this strategy.

Clapper was also reported to have said during his testimony that Iran might get a nuclear device in a time period as short as a year under worst case conditions and arm a missile in as little as two more years.

As bas already been mentioned and is discussed in more detail later in this analysis, Iran cannot win either an arms race where the US takes part, or any process of escalation that involves the US and Israel. Iran's actions have almost certainly already provoked Israel into developing the capability to target thermonuclear warheads on every major Iranian city, creating an "existential" threat to Iran long before Iran will pose one to Israel. Saudi Arabia and the GCC states may well have the option of turning to Pakistan for nuclear-armed missiles, and senior Saudi officials have said Saudi Arabia has examined nuclear options. The US has also officially offered its regional friends and allies "extended deterrence" of the kind it once provided to Europe during the Cold War – essentially confronting Iran with an open-ended threat of US retaliation.

Even if Iran does go nuclear as part of this aspect of its competition with the US and its Gulf, neighbors, it is far from clear that it will not suffer more than any nations it attacks. No one can downplay the psychological and political impact of even the threat of nuclear strikes, the deterrent impact it might have in limiting a response to Iran's use of asymmetric warfare, or the risk of some "accident" or miscalculation. The worst moments in history rarely occurred because of accurate calculations by rational bargainers.

Figure IV.1: Estimated Range of Iranian Long-Range Missile Forces



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

Figure IV.2: Estimated Range of Iranian Long-range Missile Forces -2

Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.3: Iran's Ballistic Missile Arsenal

Shahab-3 ("Meteor")	800-mile range. The Defense Department report of April 2010, cited earlier, has the missiles as "deployed." Still, several of its tests (July 1998, July 2000, and September 2000) reportedly were unsuccessful or partially successful, and US experts say the missile is not completely reliable. Iran tested several of the missiles on September 28, 2009, in advance of the October 1 meeting with the P5+1.
Shahab-3 "Variant"/Sajjil	1,200-1,500-mile range. The April 2010 Defense Department report has the liquid fueled Shahab-3 "variant" as "possibly deployed." The solid fuel version, called the Sajjil, is considered "not" deployed by the Defense Department. The Sajjil is alternatively called the "Ashoura." These missiles potentially put large portions of the Near East and Southeastern Europe in range, including US bases in Turkey.
BM-25	1,500-mile range. On April 27, 2006, Israel's military intelligence chief said that Iran had received a shipment of North Korean-supplied BM-25 missiles. Missile said to be capable of carrying nuclear warheads. The *Washington Times* appeared to corroborate this reporting in a July 6, 2006 story, which asserted that the North Korean-supplied missile is based on a Soviet-era "SS-N-6" missile. Press accounts in December 2010 indicate that Iran may have received components but not the entire BM-25 missile from North Korea.
ICBM	US officials believe Iran might be capable of developing an intercontinental ballistic missile (3,000 mile range) by 2015, a time frame reiterated by the April 2010 DOD report.
Other Missiles	On September 6, 2002, Iran said it successfully tested a 200 mile range "Fateh-110" missile (solid propellant), and Iran said in late September 2002 that it had begun production. Iran also possesses a few hundred short-range ballistic missiles, including the *Shahab-1* (Scud-B), the *Shahab-2* (Scud-C), and the *Tondar-69* (CSS-8). In January 2009, Iran claimed to have tested a new air-to-air missile. On March 7, 2010, Iran claimed it was now producing short-range cruise missiles that it claimed are highly accurate and can destroy heavy targets. At a February 8, 2011 press conference, IRGC chief Mohammed Ali Jafari announced that Iran had developed the Khalij Fars ("Persian Gulf"), a "smart" anti-ship ballistic missile based on the Fateh-110 that is allegedly able to hit high-value targets throughout the Gulf.
Space Vehicle	In February 2008, Iran claimed to have launched a probe into space, suggesting its missile technology might be improving to the point where an Iranian ICBM is realistic. Following an August 2008 failure, in early February 2009, Iran successfully launched a small, low-earth satellite on a Safir-2 rocket (range about 155 miles). The Pentagon said the launch was "clearly a concern of ours" because "there are dual-use capabilities here which could be applied toward the development of long-range missiles." Additionally, Iran has embarked on an ambitious satellite launch program since early-mid 2011.
Warheads	A *Wall Street Journal* report of September 14, 2005, said that US intelligence believes Iran is working to adapt the Shahab-3 to deliver a nuclear warhead. Subsequent press reports say that US intelligence captured an Iranian computer in mid-2004 showing plans to construct a nuclear warhead for the Shahab. The IAEA is seeking additional information from Iran.

Sources: US Congressional Research Service. "Iran: US Concerns and Policy Responses." RL32048, 14 Feb. '11, Kenneth Katzman, Iranian Reporting

Figure IV.4: Iranian Rockets and Missiles

Missile	Translation	Fuel Type	Estimated Range	Payload
Fajr-3	*Dawn-3*	Solid	45 km	45 kg
Fajr-5	*Dawn-5*	Solid	75 km	90 kg
Fateh-110	*Victorious*	Solid	20 km	500 kg
Ghadr-1	*Powerful-1*	Liquid	1600 km	750 kg
Iran-130/Nazeat	*Removal*	Solid	90-120 km	150 kg
Kh-55		Liquid	2500-3000 km	400-450 kg
Nazeat-6	*Removal-6*	Solid	100 km	150 kg
Nazeat-10	*Removal-10*	Solid	140-150 km	250 kg
Oghab	*Eagle*	Solid	40 km	70 kg
Sajjil-2	*Baked Clay-2*	Solid	2200-2400 km	750 kg
Shahab-1	*Meteor-1*	Liquid	300 km	1000 kg
Shahab-2	*Meteor-2*	Liquid	500 km	730 kg
Shahab-3	*Meteor-3*	Liquid	800-1000 km	760-1100 kg
Shahin-1	*Hawk-1*	Solid	13 km	
Shahin-2	*Hawk-2*	Solid	20 km	
Zelzal-1	*Earthquake-1*	Solid	125 km	600 kg
Zelzal-2	*Earthquake-2*	Solid	200 km	600 kg

Source: 2010 IISS Iran's Ballistic Missile Capabilities: A Net Assessment

Nuclear Competition: Estimating and Reacting to the Iranian Nuclear Threat

Iran's nuclear programs represent the most controversial and uncertain aspect of its military efforts and competition with the US and its neighbors. Iran continues to deny that it is seeking nuclear weapons, but every new IAEA and media report documents further indicators that it is actively developing at least the capability to manufacture and deploy nuclear weapons if it chooses to do so.

Iran's Statements about Its Nuclear Program

While Iran denies it is seeking nuclear weapons, it has made statements regarding the nature of its nuclear program and its role in competition with the US and other countries that provide useful insights into Iranian attitudes:

- *"(A) constructive and positive attitude towards the Islamic Republic of Iran's new initiatives in this round of talks could open positive perspective for our negotiation. Therefore...I propose to resume our talks in order to take fundamental steps for sustainable cooperation in the earliest possibility in a mutually agreed venue and time."* -Iranian chief negotiator Saeed Jalili, February 16, 2012. http://www.reuters.com/article/2012/02/16/us-iran-idUSTRE81E0RF20120216

- *"The era of bullying nations has past. The arrogant powers cannot monopolize nuclear technology. They tried to prevent us by issuing sanctions and resolutions but failed. Our nuclear path will continue."* – President Mahmoud Ahmadinejad, February 15, 2012. http://www.reuters.com/article/2012/02/15/us-iran-idUSTRE81E0RF20120215

- *"Iran will load the first home-made nuclear fuel rods into the Tehran research reactor on Wednesday."* - Ali Baqeri, Undersecretary of Iran's Supreme National Security Council, February 15, 2012. http://english.farsnews.com/newstext.php?nn=9010174934

- *"The U.N.'s chief nuclear inspector arrived in Iran on Sunday on a mission to clear up "outstanding substantive issues" on Tehran's atomic program, and called for dialogue with the Islamic state. We have always had a broad and close cooperation with the agency and we have always maintained transparency as one of our principles working with the agency."* –Iranian Foreign Minister Ali Akbar Salehi, January 29, 2012.

  http://www.alarabiya.net/articles/2012/01/29/191187.html

- *"Iranian nation cannot be defeated. Not only should we be able to use all our capacities and potentials in nuclear technology, we should also export nuclear know-how."* – Iranian President Mahmoud Ahmadinejad, April 11, 2011.

- *"Iran plans to build four to five new reactors with a capacity of 10 to 20 megawatts in different provinces within the next few years to produce radio-medicine and perform research…Fuel production or uranium enrichment to a purity level of 20 percent will not be halted. Iran will produce fuel for the Tehran Research Reactor in due course….To provide the fuel for these reactors, we need to continue with the 20-percent enrichment of uranium."* – Fereydoon Abbasi, head of the Atomic Energy Organization of Iran, April 12, 2011.

- *"We will transfer the 20 percent enrichment from Natanz to the [Qum] site this year, under the supervision of the (International Atomic Energy) Agency.*

We will also triple the (production) capacity. The 20 percent enrichment will not be stopped at Natanz until the production level is three times higher than its current rate." – Fereydoon Abbasi, head of the Atomic Energy Organization of Iran, June 8, 2011.

- *"The day after the first Iranian nuclear test for us Iranians will be an ordinary day, but in the eyes of many of us, it will have a new shine, from the power and dignity of the nation."* – Excerpt from a text entitled "The Day After the First Iranian Nuclear Test -- a Normal Day," which was posted on the IRGC-run Gerdab website, June 9, 2011.

- *"No offer from world leaders could stop Iran from enriching uranium."* – Iranian President Mahmoud Ahmadinejad, June 7, 2011.

- *"When we say we do not want to make bomb it means we do not want to. If we want to make a bomb we are not afraid of anyone and we are not afraid to announce it, no one can do a damn thing."* – Iranian President Mahmoud Ahmadinejad, June 23, 2011. [27]

It is difficult to draw any certain conclusions regarding Iran's goals, given the opacity and controversial nature of Iran's nuclear program. More often than not, Iranian officials make blanket statements that insist that their country's nuclear program is for solely peaceful purposes, namely research and the production of nuclear power and medical isotopes. It is clear, though, that Iran perceives its nuclear program as a source of national pride.

Other statements made by Iranian officials regarding the nature of the country's nuclear program, however, are often ambiguous and contradictory. While Iranian officials often affirm that the program is peaceful, they also regularly make defiant statements about increasing the production of uranium enriched to 20%, and implied, indirect statements about producing a nuclear weapon.

Iranian President Mahmoud Ahmadinejad stated the following at a June 23, 2011 inauguration of a sewage treatment plant in southern Tehran:

> "When we say we do not want to make bomb it means we do not want to. If we want to make a bomb we are not afraid of anyone and we are not afraid to announce it, no one can do a damn thing."[28]

On June 9, 2011, the IRGC-run website Gerdab published a text entitled "The Day after the First Iranian Nuclear Test – a Normal Day," which stated the following:

> "The day after the first Iranian nuclear test for us Iranians will be an ordinary day, but in the eyes of many of us, it will have a new shine, from the power and dignity of the nation."[29]

The text also contained the following excerpt from the Quran,

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[27] Quotes taken from a number of Iranian news sources such as Fars News, PressTV, the Tehran Times, and others. Also included are quotes from Western news outlets such as CNN, the New York Times, and the Washington Post.

[28] Pouladi, Farhad. "Ahmadinejad Insists Iran Not Seeking Nuclear Bomb." AFP, June 23, 2011. http://www.google.com/hostednews/afp/article/ALeqM5hH8mB4iW9MJ6ElbozG5o8-QlZDqA?docId=CNG.34a096065d43eb06d18ea86500b8f1a9.01

[29] Timmerman, Ken. "Iran Eager for Nuclear Test." Newsmax.com, June 10, 2011. http://www.newsmax.com/KenTimmerman/RevolutionaryGuards-iran-nuclear-powerplant/2011/06/10/id/399582

> "And prepare against them whatever you are able of power and of steeds of war by which you may terrify the enemy of Allah."[30]

Such statements, while indirect, hypothetical, and lacking in specifics, have a hostile bent, and indicate that Iran does not perceive its nuclear program as solely for peaceful purposes. Contrarily, such statements can be construed as defiant, veiled threats leveled at Iran's perceived enemies.

Although such statements seem plainly indicative as to Iran's nuclear intentions, they must be kept in context, as the tone and the nature of Iranian statements regarding the country's nuclear problem often vary depending on the audience. Consequently, it is difficult to discern which statements actually reflect Iran's true intentions as opposed to posturing to serve its foreign policy goals. Although Iran's exact intentions regarding its nuclear program are uncertain, the above statements and others like them reflect that Iran has at the very least contemplated producing nuclear weapons, and perceives its nuclear program as having a military dimension.

Analyzing the Details of What Is Known and What Is Uncertain

Over the last half decade, a great deal of information has surface that directly contradicts Iran's claims that it is not seeking a weapon – or at least moving to the "threshold" level where it has all of the technology needed to produce a weapon, and has – or can rapidly produce – the highly enriched weapons grade material needed for a bomb.

In February 2012, a trove of secret telexes dating to 1992 emerged that reveal Iranian attempts to procure 220 pounds of highly caustic fluorine gas – a material used in uranium enrichment – in addition to other materials used in nuclear programs such as mass spectrometers and other equipment. These items were purportedly ordered by the Iran's Sharif University for use in research. These telexes reveal, however, that these materials were intended for a secret research program under the control of the Iranian military.[31]

While not an absolute indicator of weaponized nuclear research, these telexes and Iran's attempt at masking the true destination of these materials and equipment indicate that Iran has been operating a clandestine nuclear program for 20 years. Furthermore, they establish that Iran has engaged in a pattern of deception regarding its nuclear activity since the early 1990s.

Iran's constant efforts to describe every new discovery by the IAEA and the outside world as either a peaceful research or nuclear activity, or as a defensive effort to protect its civil nuclear programs, do leave many question open. So does the fact that some intelligence analysts believe Iran broke up its formal nuclear program in 2003, and has never resumed an integrated weapons development program. There seem to be serious differences within the US intelligence community – and between US, Israeli, and other experts – over this issue. Many believe Iran has resumed a covert program or never really disbanded its program in 2003 – simply changing the cover structure concealing the program and some key personnel.

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[30] Timmerman, Ken. "Iran Eager for Nuclear Test." Newsmax.com, June 10, 2011. http://www.newsmax.com/KenTimmerman/RevolutionaryGuards-iran-nuclear-powerplant/2011/06/10/id/399582

[31] Warrick, Joby. "Formerly secret telexes reveal Iran's early use of deceit in nuclear program." February 23, 2012. http://www.washingtonpost.com/world/national-security/formerly-secret-telexes-offer-window-into-irans-nuclear-deceit/2012/02/11/gIQAOiBlTR_story.html?tid=pm_pop

The difficulty in making such assessments is compounded by the fact that Iran can carry out every part of a nuclear weapons development program except final integration as a series of parallel technology and manufacturing development efforts. It can also create a whole new set of layers to hide a covert program, and it can carry on creating new technologies like improved centrifuges and reactor development which it later can use to set up new enrichment sites in much smaller deep mountain shelters or surface buildings in the nuclear equivalent of a shell game. Virtually every such activity can be explained away if discovered, or denied with varying levels of credibility. Many can also have legitimate dual uses in civil programs or research or actually be for civil uses.

There also is no magic point where a nation reaches the "threshold level," and there are many different stages at which Iran can bring its nuclear program to readiness. Going on to enrich material to the level where a weapon can be assembled leaves great ambiguity as to Iran's intentions and what it may conceal, as well as presents major problems in terms of outside assessments of how far Iran has actually progressed. Similarly, assembling – or claiming to assemble – a device does not require testing. Iran can leave its ability to design a functioning weapon through modeling and simulation a matter of speculation. Non-critical testing of a weapons design or subcritical testing of a fractional explosion is an issue. A nuclear underground test does not reveal the level of progress in weapons design. The testing of simulated warheads may not be detected and does not require telemetry.

Iran can create a complex network of deception, denial, fears, and false claims throughout the process of developing and deploying a nuclear weapon. Moreover, as IAEA reports have now shown over the last decade, Iran can comply with most – or all – of the terms of the NNPT and IAEA inspection and still move forward at a slower, more parallel pace.

Understanding the Patterns and uncertainties in Iran's Efforts

In short, it is easy to select the evidence to match a given thesis about Iran's programs and progress. *But,* although the evidence of a weapons program does steadily accumulate, all of these real world uncertainties must be kept constantly in mind. **Figure IV.4** through **Figure IV.54** address these issues and uncertainties by providing a range of data and views of developments in the Iranian nuclear and missile programs, Iran's lack of cooperation with the IAEA, and indicate the possible weaponization of Iran's nuclear program.

These Figures deliberately provide a high level of detail to help distinguish sources and the individual aspects of Iran's programs. It should be stressed, however, that they have many uncertainties and that there are still many aspects of the Iranian nuclear and missile programs that remain uncertain and controversial. Hard data are lacking on many aspects of Iran's current efforts, and experts are forced to speculate. There are still experts who question whether Iran is seeking nuclear weapons, and there is no consensus over exactly how soon Iran will be able to get the weapons-grade fissile material it needs.

Nevertheless, these figures shows patterns of Iranian activity, and potential future Iranian capabilities, that could have a massive impact on US and Iranian competition, and the security of the Arab states, Turkey, Israel, and Iran's other regional neighbors.

- **Figure IV.5** provides the ISIS' projection of Iran's potential future capabilities to make weapon-grade uranium.

- **Figure IV.6** provides ISIS' estimates regarding the different probabilities of Iranian paths to nuclear explosive materials. Each probability reflects the likelihood that Iran would pursue each method, based on a judgment of its technical capabilities to do so and a range of factors that deter its pursuit of this method.
- **Figure IV.7** reflects Iran's total enriched uranium stockpile by the level to which it is enriched, quantities at each site, as well as the gross and net total estimations of Iran's enriched uranium.
- **Figure IV.8** reflects the cumulative production of low-enriched uranium (LEU) at Iran's principal enrichment site, Natanz. As of May 2012, more than 6,197 kg of LEU has been produced. As of February 2008, less than 200 kg had been produced.
- **Figure IV.9** reflects the likely impact that Stuxnet had on the production of LEU at the Natanz enrichment site. The figure reflects the fact that as of January 31, 2010, 11 cascades in Module A26 were disconnected. There were 1,804 IR-1 centrifuges in these 11 cascades. As of May 24, 2010, five cascades were disconnected. It also reflects that in the time period between August 12, 2009 and August 29, 2010, between 14 and 18 cascades were installed but not under vacuum, and up to two had their centrifuges disconnected.
- **Figure IV.10** shows trends in the number of centrifuges operating at Natanz. While the number has increased dramatically since February 2007, the number of centrifuges in operation since August 2009 has fluctuated, possibly due to the Stuxnet virus. In May 2012, however, the IAEA reported that Iran is operating almost all of its available centrifuges, and is enriching uranium at the site at an accelerated rate.
- **Figure IV.11** shows trends in the number of cascades enriching uranium, the amount of LEU produced monthly, and the amount of UF6 produced monthly. Note that there has been a general increase in each, with intermittent drops in production starting in June 2008. It is likely that equipment restrictions due to sanctions and the effects of the Stuxnet virus are to blame for the sporadic drops in production.
- **Figure IV.12** indicates Iran's monthly rate of production of LEU at the Natanz Fuel Enrichment Plant (FEP). It indicates a steady increase in monthly LEU production at the FEP since June 2007. Notably, it also reflects a dramatic increase in Iran's monthly production of LEU as of March 2012.
- **Figure IV.13** reflects the key points of the IAEA's reporting as of May 2012. Points of note are that a) Iran's production of 3.5% LEU has increased significantly, b) Iran continues to increase its stock of 19.75% LEU, c) Iran's advanced centrifuge program still troubled but makes some progress, d) Iran currently possesses 6,196 kg of 3.5% LEU – enough to produce five nuclear weapons if further enriched to weapon grade.
- **Figure IV.14** reflects Iran's progress and describes LEU production at the Natanz FEP as of May 2012. Iran's total 3.5 percent LEU production at the FEP through May 11, 2012 is reported to be 6,197 kg, including 746 kg estimated by Iran to have been produced since February 4, 2012. This total amount of 3.5 percent low enriched uranium hexafluoride, if further enriched to weapon grade, is enough to make over five nuclear weapons. Moreover, the average production of 3.5 percent LEU at the FEP was 229 kg per month of LEU hexafluoride, a rate that has increased significantly from the last reporting period, when Iran produced on average 170 kg per month. Notably, Iran used nearly the same number of centrifuges as the last reporting period to enrich at a much higher level. Though Iran had installed the majority of its current set of enriching centrifuges by the February 2012 IAEA report increased level of enrichment likely indicates that Iran was not feeding 8,808 centrifuges with UF6 for the duration of the November – February reporting period.
- **Figure IV.15** describes Iran's recent installation of 6,177 empty IR-1 centrifuge casings at the Natanz FEP.
- **Figure IV.16** describes the problems and setbacks Iran has encountered while attempting to install advanced centrifuge designs at the PFEP, although some progress has occurred. Over the last reporting period, it maintained one 164-machine cascade of IR-2m centrifuges in cascade 5. All 164 IR-2m machines remained under vacuum but continued to be only intermittently fed with uranium hexafluoride. In a potential breakthrough, Iran continued installing IR-4 centrifuges in cascade 4, increasing their number as of May 18, 2012 to 129 IR-4 centrifuges out of 164 planned. As of February 21, 2012 it had only installed

58 of 164 IR-4 centrifuges. In a further advancement, since March 1, 2012, it has been intermittently feeding up to 104 of these IR-4 centrifuges with uranium hexafluoride.

- **Figure IV.17** describes the status of Iran's 19.75% LEU production as of May 2012. In total, Iran has fed 990.3 kg of 3.5% LEU to produce 110.1 kg of 19.75% uranium since the beginning of operations in February 2010.
- **Figure IV.18** provides the status of uranium enrichment at the Fordow Fuel Enrichment Plant (FFEP) as of May 2012. The Fordow site has four cascades of 174 IR-1 centrifuges each operating in two, tandem sets producing 19.75 percent LEU. As of May 9, 2012, Iran had installed 174 centrifuges in both cascades five and six, and had also installed 20 centrifuges in cascade 7. None of these additional machines were enriching at that time.
  Between February 18, 2012 and May 13, 2012, the two sets of tandem cascades produced approximately 21.7 kg of 19.75 percent enriched uranium at a combined rate of 7.65 kg 19.75 percent LEU hexafluoride per month. This represents a slight increase over the previous reporting period, when Iran produced 13.8 kg of 19.75 percent enriched uranium at a rate of 6.46 kg/month; however, Iran did not enrich in both sets of tandem cascades for the totality of the IAEA reporting period. Each set of cascades is producing 19.75 percent enriched uranium at a rate of 3.8 kg per month, a rate slightly lower than that achieved by the tandem set of cascades at the PFEP. Additionally, the centrifuges at the FFEP are achieving a lower average swu per centrifuge value than those at the PFEP, with each plant achieving 0.73 swu/centrifuge-year and 0.93 swu/centrifuge-year respectively.

- **Figure IV.19** provides information regarding elevated enrichment levels at the Fordow site. The IAEA has found traces of uranium enriched up to 27 percent at Iran's Fordow enrichment plant. This elevation is likely due to improved cascade design. The cascades at Fordow making 19.75 percent LEU have 17 stages instead of 15 as in the old cascade design. An effect is to overshoot 20 percent when 3.5 percent LEU is fed into the tandem cascades at the old feed rate for 15 stage cascades. To avoid this problem, Iran likely increased the feed rate of 3.5 percent LEU, which lowered the enrichment level of the product back to 19.75 percent. It also increased slightly the amount of 19.75 percent LEU produced.

- **Figure IV.20** provides an overview of the IAEA's primary concerns and observations of Iran's uranium enrichment as of May 2012. Between Iran's two primary enrichment sites, Iran has produced 145.6 kilograms of 19.75 percent LEU hexafluoride. Of that total, Iran has downblended 1.6 kilograms of 19.75 percent LEU hexafluoride into LEU enriched to less than five percent. Iran has also sent an unknown amount of 19.75 percent LEU to the Uranium Conversion Facility at Esfahan to make into fuel for the Tehran Research Reactor. Between December 17, 2011 and May 15, 2012, the IAEA reported that Iran has fed into the process line at the Fuel Plate Fabrication Plant at Esfahan 43 kilograms of uranium hexafluoride enriched up to 20 percent uranium-235, and it has produced 14 kilograms of uranium enriched up to 20 percent in the form of U_3O_8. Some has been manufactured into TRR fuel assemblies and a portion sent to the TRR. It appears that up to 43 kilograms of 19.75 percent LEU is no longer in the form of uranium hexafluoride and could be considered as not available in a breakout, at least in its initial stage. The exact amount sent to this plant, however, is not clearly specified in the IAEA report. In summary, about 101 kilograms of 19.75 percent LEU hexafluoride remains as of May 15.

- **Figure IV.21** provides information regarding differences over resolving the possible military dimensions of Iran's nuclear program, as well as Iran's refusal to grant the IAEA access to the Parchin complex, which the IAEA suspects to have been used in modeling and designing explosive detonators for nuclear weapons.

- **Figure IV.22** describes Iran's progress in its development of the IR-40 heavy water moderated research reactor at Arak. The IAEA reports that construction of the IR-40 heavy water moderated research reactor at Arak is still ongoing. In an unexplained development, the IAEA stated that "no major components had been installed since the previous DIV [design information verification visit]." The manufacture of fuel pellets for the IR-40 reactor using natural UO_2 is ongoing. It also continues to manufacture dummy assemblies for the IR-40 reactor. Iran told the Agency that startup of the reactor is planned for late 2013. Whether Iran can operate the reactor by this date is unclear. However, once this reactor operates, it can make weapon-grade plutonium, if Iran decided to do so.

- **Figure IV.23** provides an ISIS analysis of the suspected "sanitation" of the Parchin complex, which is purported to have been used to design nuclear detonators and carry out other weapons-related research. The fact that the IAEA has not been granted access to the site is of note, as an inspection of the complex could provide definitive evidence that Iran is carrying out R&D into nuclear weapons development.
- **Figure IV.24** reflects the history of Iran's monthly production of low enriched uranium until February 2012. It shows that Iran's rate of low enriched uranium production is accelerating, and has never been as high as it was during February 2012.
- **Figure IV.25** provides the main points stressed in the IAEA report of February 24, 2012. It shows that Iran has achieved a near three-fold increase in production of 19.75 percent LEU at Natanz and Fordow, has increased the number of centrifuges enriching at Natanz by nearly 50%, and has installed 8,000 additional IR-1 centrifuge casings at Natanz and Fordow.
- **Figure IV.26** provides information regarding the Fuel Enrichment Plant (FEP) at Natanz as of February 2012. Iran's total LEU production at the FEP through February 4, 2012 is reported to be 5,451 kg of low enriched uranium hexafluoride, including 580 kg estimated by Iran to have been produced since October 17, 2011. This total amount of low enriched uranium, if further enriched to weapon grade, is enough to make over four nuclear weapons. The average production of LEU at the FEP was 170 kg per month of LEU hexafluoride, a rate that has increased significantly from the last reporting period, where Iran produced 145 kg per month. The number of centrifuges enriching at the FEP has increased by about 50 percent, but centrifuge performance remains below par.
- **Figure IV.27** provides information regarding the deployment of advanced centrifuge designs at the Pilot Fuel Enrichment Plant (PFEP) at Natanz as well as information concerning uranium enriched to 19.75% as of February 2012. Iran appears to be encountering problems in its testing of production-scale cascades of advanced centrifuge at the Pilot Fuel Enrichment Plant. Over the last reporting period, it maintained one 164-machine cascade of IR-2m centrifuges in cascade 5. All 164 IR-2m machines were under vacuum and only being intermittently fed with uranium hexafluoride, an unexpected development. Iran continued work on its installation of IR-4 centrifuges in cascade 4, but, as of February 21, 2012 it had only installed 58 of 164 centrifuges in its planned IR-4 cascade, a decrease of 8 centrifuges from the end of the last reporting period. No uranium hexafluoride was introduced into the IR-4 centrifuges. According to IAEA information, Iran moves the IR-4 centrifuges in and out of the PFEP in a noticeable manner. This may imply significant problems with the IR-4 centrifuge design.
- **Figure IV.28** provides information concerning the status and progress of Iran's fuel enrichment facility at Fordow. The Fordow site now has four cascades of 174 IR-1 centrifuges each operating in two, tandem sets producing 19.75% LEU. Between December 14, 2011, when the first set started producing LEU, until February 17, 2012, these sets of cascades produced approximately 13.8 kg of 19.75% enriched uranium at a rate of 6.46 kg 19.75% LEU hexafluoride per month. With the stockpile of 19.75% uranium produced at the Pilot Fuel Enrichment Plant at Natanz, Iran now has approximately 110 kg of 19.75% uranium. Its monthly production has increased to about 11 kilograms per month of 19.75% LEU hexafluoride, somewhat less than a three-fold increase. However, this level of production far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

- **Figure IV.29** provides the ISIS' overview and analysis of developments at Natanz and Fordow as of February 2012. Between the two enrichment sites, Iran has produced 109.2 kilograms of 19.75% LEU hexafluoride. Of that total, Iran has sent an unknown amount of 19.75% LEU to the Uranium Conversion Facility at Esfahan. Typically, transport containers would contain about 25 kilograms of such LEU. As of February 19, 2012, Iran had converted about 8 kilograms into U_3O_8 for use in Tehran Research Reactor fuel, which it is making at the nearby Fuel Manufacturing Plant. So, about 101.2 kilograms of 19.75% LEU remains in the form of hexafluoride as of that date.

  Iran has produced a total of 5,451 kilograms of 3.5% LEU hexafluoride. About 985 kilograms has been used to make the 19.75% LEU hexafluoride.

- **Figure IV.30** indicates that as of October 22, 2011, Iran has installed a 164-machine cascade of IR-2 centrifuges, all of which are under vacuum. 66 IR-4 centrifuges have been installed, but none are being fed with uranium hexafluoride. It also indicates that during the reporting period, Iran produced 19.75% enriched uranium at a rate of 3.94 kg/month, approximately a 20% decrease from the previous reporting period. In total, Iran has fed 765.5 kg of 3.5% LEU to produce 79.7 kg 19.75% uranium since the beginning of operations in February 2010. Such an increase in the production of 19.75% enriched uranium accelerates Iran's ability to reach a nuclear breakout capability, and would allow the country to produce more nuclear weapons in a shorter period of time.
- **Figure IV.31** indicates that Iran is moving forward with uranium enrichment at the Fordow Fuel Enrichment Plant. Moreover, Iran has indicated that it will follow through with its plans to use the facility to enrich uranium to 19.75%.
- **Figure IV.32** shows the Bipartisan Research Center's timeline of Iran's monthly enrichment rate as well as Iran's IAEA-confirmed 3.5% LEU stockpile. It reveals that the Stuxnet worm did not have any kind of significant effect on the country's ability to enrich uranium, and that the country's enrichment rate has nearly doubled in comparison to the pre-Stuxnet rate. Moreover, it shows that Iran's LEU stockpile surpassed the 1,850 kg needed for one nuclear explosive device in August 2010.
- **Figure IV.33** provides the Bipartisan Policy Center's timeline of Iran's enrichment rate vs. the number of operational centrifuges it has at the Natanz FEP. It reveals that Stuxnet may have had a deleterious effect on the number of operational centrifuges Iran operated, but that Iran's rate of enrichment has nevertheless increased, as has the number of operational centrifuges since the last major Stuxnet attack in May of 2010.
- **Figure IV.34** reflects the growth of Iran's 3.5% enriched uranium stockpile. It indicates that Iran could perhaps produce enough 3.5% enriched LEU to produce two fission devices by May 2012 at a minimum.
- **Figure IV.35** shows the location of Iran's major/principle nuclear facilities that are concentrated in the west-central part of the country.
- **Figure IV.36** shows the Bipartisan Policy Center's projections for the growth of Iran's stockpile of 19.75% enriched uranium. At its current average rate of enrichment, Iran could produce enough 19.75% enriched uranium to produce one fission weapon. Iran's enrichment rate, however, is increasing, and it is likely that it could produce this quantity sooner. At 300% of the 2011 rate, Iran could produce enough 19.75% uranium to build a fission device by December 2012.
- **Figure IV.37** gives the Bipartisan Policy Center's projections for the time it would take for Iran to produce the necessary 20 kg of 90% HEU for a nuclear device. The estimate given is 62 days.
- **Figure IV.38** provides the Bipartisan Policy Center's projections for the time it would take Iran to produce 20 kg of HEU at Natanz given variable stockpile enrichment levels, centrifuge efficiency, and number.
- **Figure IV.39** indicates that Iran might be able to produce 20 kg of 90% HEU at Natanz using a two-step batch recycling method to enrich its stockpiles of 3.5% and 19.75% uranium in as little as 62 days.
- **Figure IV.40** indicates that Iran might be able to produce 20 kg of 90% HEU at Natanz using a three-step batch recycling method to enrich its stockpiles of 3.5% and 19.75% uranium in approximately 181 days.
- **Figure IV.41** contrasts the different estimates of both the Bipartisan Policy Center and the IISS of Iran's nuclear breakout ability. According to the BPC itself, its estimate is vastly lower than that of the IISS for the following reasons:
    1) IISS assumes Iran will use a slower enrichment process because it is more efficient, our analysis is based on a faster method;
    2) IISS assumes Iran will only use 3,936 centrifuges, while they have 5,184 currently operational at Natanz;
    3) IISS estimates that Iran will need 37.5kg of HEU for a nuclear weapon, compared to our estimate of 20kg;

4) The IISS assessment is of the time to go from LEU stockpile to a manufactured, spherical uranium metal core for a nuclear device Our calculations only include enriching LEU into HEU. When updated with our assumptions (faster enrichment, more centrifuges, less HEU), the IISS calculation is actually closely in line with our own: 2.5 months to produce HEU at Natanz.

- **Figure IV.42** shows the amount of fissile material needed to build a basic fission weapon.
- **Figure IV.43** summarizes the February 25, 2011 IAEA report. It shows that Iran continues to refuse to cooperate with the IAEA regarding weaponization issues, heavy water production, R&D into uranium enrichment, and enrichment locations.
- **Figure IV.44** provides a detailed account of Iran's lack of cooperation with the IAEA in matters pertaining to weapons production and the militarization of its nuclear program as of February 25, 2011. These areas include production of LEU up to 20% U-235 at Natanz; construction of the Fordow Fuel Enrichment Plant; heavy water production; locations, equipment, persons, or documentation related to the possible military dimensions of Iran's program; high explosives manufacturing and testing, exploding bridgewire detonator studies, particularly involving applications necessitating simultaneity, and missile re-entry vehicle redesign activities for a new payload assessed as being nuclear in nature; IR-40 reactors.
- **Figure IV.45** shows that Iran continued to show a lack of cooperation with the IAEA on seven key matters related to weaponization as of May 24, 2011 that were objects of the IAEA's concern in February 2011.
- **Figure IV.46** provides details regarding enrichment activities at the Fuel Enrichment Plant (FEP) and Pilot Fuel Enrichment Plant (PFEP) as of May 24, 2011. Both the FEP and PFEP are located at the Natanz enrichment facility.
- **Figure IV.47** provides details on Iran's efforts to increase the production of 19.75% enriched uranium. Stockpiling uranium enriched to 19.75% would enhance Iran's ability to achieve a fast nuclear breakout capability.
- **Figure IV.48** provides information regarding the purpose and the capabilities of the Fordow enrichment plant Iran is constructing near Qom. Iran stated that the purpose of this facility would be the production of UF6 enriched to 5.0%, and that it would contain roughly 3,000 centrifuges.
- **Figure IV.49** details Iran's plans to install 64-centrifuge cascades at the previously hidden Fordow facility, and triple its enrichment output of 19.75% LEU. Such a move would provide Iran with a much faster breakout ability should it choose to produce nuclear weapons.
- **Figure IV.50** describes continuing work on heavy water-related projects as of May 24, 2011, contrary to the resolutions of the IAEA Board of Governors and the UN Security Council. Moreover, Iran had not allowed access to these facilities as of May 24, 2011.
- **Figure IV.51** describes IAEA concerns as of June 2011. Yukiya Amano, the head of the IAEA, makes it clear that certain undisclosed nuclear-related activities in Iran seem to indicate military dimensions to the program. He also indicates that Iran has repeatedly rebuffed IAEA requests to inspect its facilities.
- **Figure IV.52** shows that as of September 2, 2011, Iran's total LEU production at the FEP is reported to be 4,543 kg of low enriched uranium. If enriched further to weapons grade, it would be enough to produce four nuclear weapons. It also indicates that as of August 28, 2011, Iran was enriching uranium using 5,860 IR-1 centrifuges in 35 cascades. Moreover, it indicates that Iran has not installed any new centrifuges since the last reporting period, and that Iran has approximately 8,000 centrifuges installed total.
- **Figure IV.53** indicates that Iran has installed two cascades of advanced centrifuges at the PFEP as it said it would. As of August 28, 2011, Iran had installed 136 IR-2m centrifuges in cascade 5, and 27 IR-4 centrifuges in cascade 4. It also indicates that Iran produces 19.75% enriched uranium at a rate of 4.80%/month, a 23% increase from 3.91%/month in the last reporting period.
- **Figure IV.54** indicates that Iran told the IAEA during an August 9, 2011 visit to the Arak IR-40 reactor that the start of the operation of the reactor is planned for 2013. On August 17, 2011, the IAEA visited the Arak Heavy Water Production Plant for the first time since 2005. Iran informed the IAEA that the plant

was operational, and had produced a total of 60 tons of heavy water to that date. Iran continues to deny the IAEA access to the heavy water it has produced.

The data in these Figures are constantly evolving, and they contain many detailed uncertainties, such as how many nuclear facilities Iran really has and how far it has gotten in producing more advanced centrifuges like the IR-2 and IR-4. Many experts estimate, for example, that the IR-2 could be much more reliable and have some six times the output of the IR-1, making it far easier to disperse and conceal.

"Guesstimates" are notoriously unreliable – particularly in their worst-case form. As of November 8, 2011, for example, the IAEA reported that Iran had installed 164 IR-2 centrifuges at the Pilot Fuel Enrichment Plant at Natanz, all of which were under vacuum. The Agency also discovered 66 IR-4 centrifuges at the facility, but none had been fed with UF6 at the time.[32] On February 15, 2012, Iranian President Mahmoud Ahmadinejad stated publicly Iran had installed 3,000 new centrifuges at Natanz, increasing its LEU production by half.[33] The NTI calculated that this would bring the number of operational centrifuges at Natanz to 9,000. [34] A day later, a US government spokesman strongly implied on background that Ahmadinejad was exaggerating.

[32] IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[33] Iran Claims 3,000 New Uranium Centrifuges." NTI: Global Security Newswire. February 15, 2012. http://www.nti.org/gsn/article/iran-claims-3000-new-uranium-centrifuges/

[34] Iran Claims 3,000 New Uranium Centrifuges." NTI: Global Security Newswire. February 15, 2012. http://www.nti.org/gsn/article/iran-claims-3000-new-uranium-centrifuges/

Figure IV.5: ISIS Timeline of Potential Future Capabilities to Make Weapon-Grade Uranium: Modest Growth Projection

	2012	2013	2014	2015
Natanz FEP (3.5% and 19.75% LEU)	6,000-9,000 IR-1s enriching	6,000-12,000 IR-1s enriching	4,000-15,000 centrifuges enriching	4,000-15,000 centrifuges enriching
Fordow (19.75% LEU; 3.5% LEU; HEU?)	2-4 IR-1 tandem cascades (with 696-1044 IR-1 centrifuges); another 1,000 IR-1 centrifuges (advanced centrifuges?)	2-4 IR-1 tandem cascades; another 2,000 IR-1 centrifuges; (or 500-1,000 advanced centrifuges)	3,000 IR-1 or 1,000-2,000 advanced centrifuges	2,000-3,000 advanced centrifuges
Third enrichment site	Under construction	500-1,000 centrifuges	1,000 centrifuges	1,000-2,000 centrifuges
Covert, parallel site (3,000 centrifuges maximum)	Under construction?	Under construction?	Under construction?	1,000 centrifuges?
Covert uranium supply and conversion facility	Under construction?	Under construction?	Operational?	Operational?
Covert laser separation facility	Under development?	Under development?	Under construction?	Operational?

Source: ISIS Report. Albright, David; Brannan, Paul; Stricker, Andrea; Walrond, Christina; Wood, Houston. "Preventing Iran from Getting Nuclear Weapons: Constraining its Future Nuclear Options." March 5, 2012. http://www.isis-online.org/uploads/isis-reports/documents/USIP_Template_5March2012-1.pdf

Figure IV.6: Probabilities of Iranian Paths to Nuclear Explosive Materials – ISIS (Each probability reflects the likelihood that Iran would pursue each method, based on a judgment of its technical capabilities to do so and a range of factors that deter its pursuit of this method)

Method	Probability 2012	2013	2014-2015
Dash at declared centrifuge sites to highly enriched uranium (HEU) using safeguarded LEU			
Natanz:	Low	Low	Low
Fordow:	Low	Low-medium	Low-medium
Dash at undeclared, covert centrifuge site using the safeguarded LEU stockpile	Low	Low-medium	Medium
HEU production under safeguards at declared centrifuge plants	Low	Low	Medium
Parallel covert centrifuge program	Low	Low	Medium
Secret production of HEU at declared safeguarded sites	Low	Low	Low
Arak reactor and secret, undeclared reprocessing plant (reactor to be operational in 2014)	-	-	Low
Laser enrichment to produce HEU	Low	Low	Low
Illicitly acquire fissile material overseas for use in nuclear weapons	Low	Low	Low
II. NPT withdrawal			
Legal withdrawal from NPT and then weapons production	Low	Low	Low-medium

Source: ISIS Report. Albright, David; Brannan, Paul; Stricker, Andrea; Walrond, Christina; Wood, Houston. "Preventing Iran from Getting Nuclear Weapons: Constraining its Future Nuclear Options." March 5, 2012. http://www.isis-online.org/uploads/isis-reports/documents/USIP_Template_5March2012-1.pdf

Figure IV.7: Cumulative Totals of Natural and Enriched Uranium Feed and 3.5 and 19.75 Percent Product in Iran

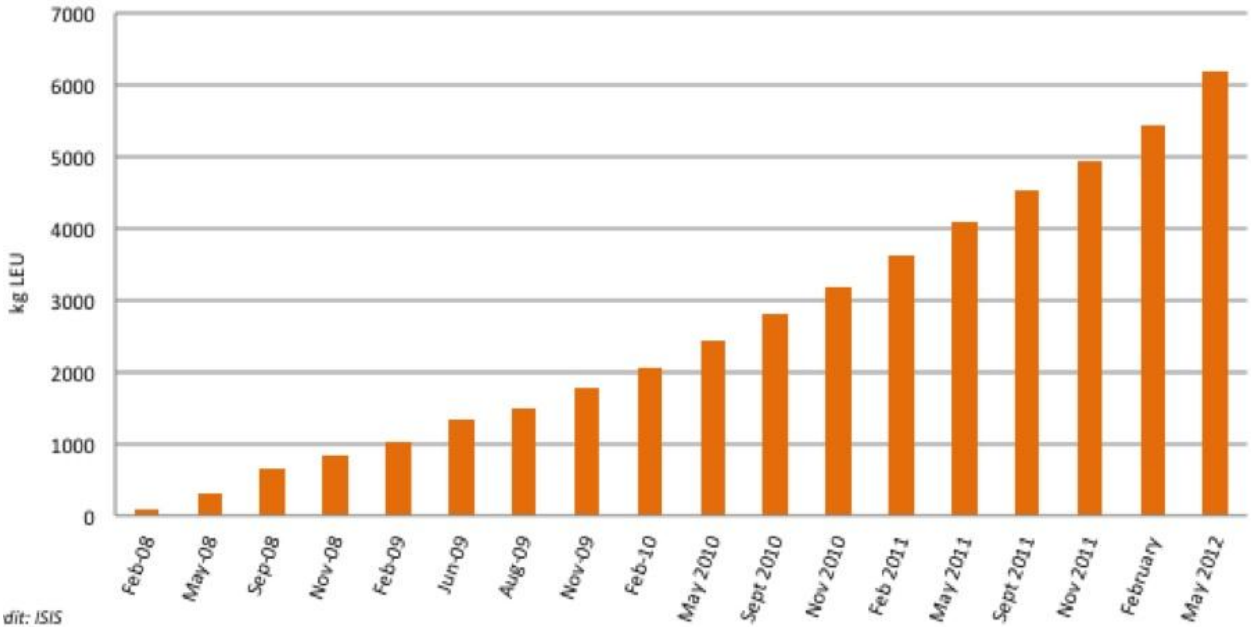
LOCATION	0.711 percent feed	3.5 percent LEU product	3.5 percent LEU feed	19.75 percent LEU product
FEP	Unreported	6,197 kg	N/A	N/A
PFEP	N/A	N/A	990.3 kg	110.1 kg
FFEP	N/A	N/A	259 kg	35.5 kg
GROSS TOTAL	N/A	6,197 kg	1,249.3 kg	145.6 kg
NET TOTAL	Unavailable	4,948 kg*	1,249.3 kg	101 kg**

*Number is less 3.5 percent enriched uranium hexafluoride used as feedstock at the PFEP and FFEP as well as 3.5 percent LEU hexafluoride converted to uranium oxide.

**Number is less 43 kg of 19.75 percent LEU hexafluoride converted to U_3O_8 and 1.6 kg 19.75 percent LEU hexafluoride downblended.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

Figure IV.8: Cumulative LEU Production at Natanz



Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

Figure IV.9: Number of Centrifuge Cascades enriching, under vacuum, installed, or with centrifuges disconnected, January 31, 2010

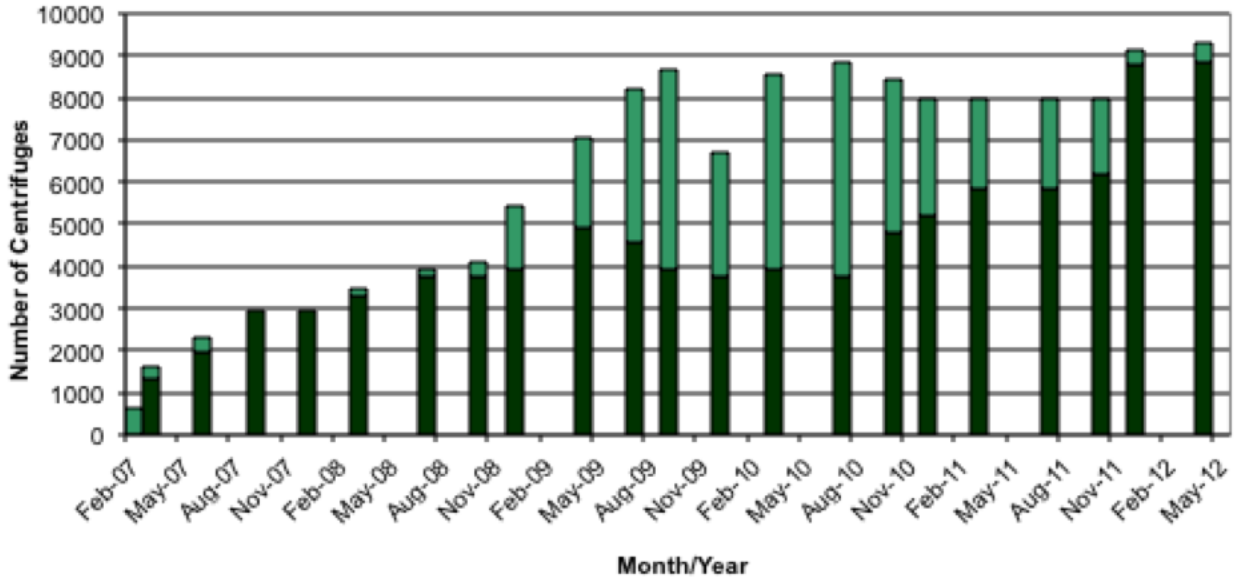
	Fed with UF_6	Under Vacuum	Installed, not Under vacuum	With Centrifuges Disconnected	Total
Module A24					
Aug. 12, 2009	18	0	0	0	18
Nov. 2, 2009	18	0	0	0	18
Jan. 31, 2010	17	1	0	0	18
May 24, 2010	18	0	0	0	18
Aug. 28, 2010	17	0	1?	0	18
Module A26					
Aug. 12, 2009	10	8	0	0	18
Nov. 2, 2009	6	12	0	0	18
Jan. 31, 2010	6	1	0	11	18
May 24, 2010	6	7	0	5	18
Aug. 28, 2010	6	6	6	?	18
Module A28					
Aug. 12, 2009	0	0	14-15	0	14-15
Nov. 2, 2009	0	0	17 (1 being installed)	0	18
Jan. 31, 2010	0	0	16	2*	18
May 24, 2010	0	0	16	2?	18
Aug. 28, 2010	0	0	18	0	18

* In these two cascades in module A28, Iran had removed all the centrifuges in one cascade and was removing the ones in the other one.

ISIS Report: *Did Stuxnet Take Out 1,000 Centrifuges at the Natanz Enrichment Plant?*

David Albright, Paul Brannan, and Christina Walrond. December 10, 2010, http://isis-online.org/isis-reports/detail/did-stuxnet-take-out-1000-centrifuges-at-the-natanz-enrichment-plant/

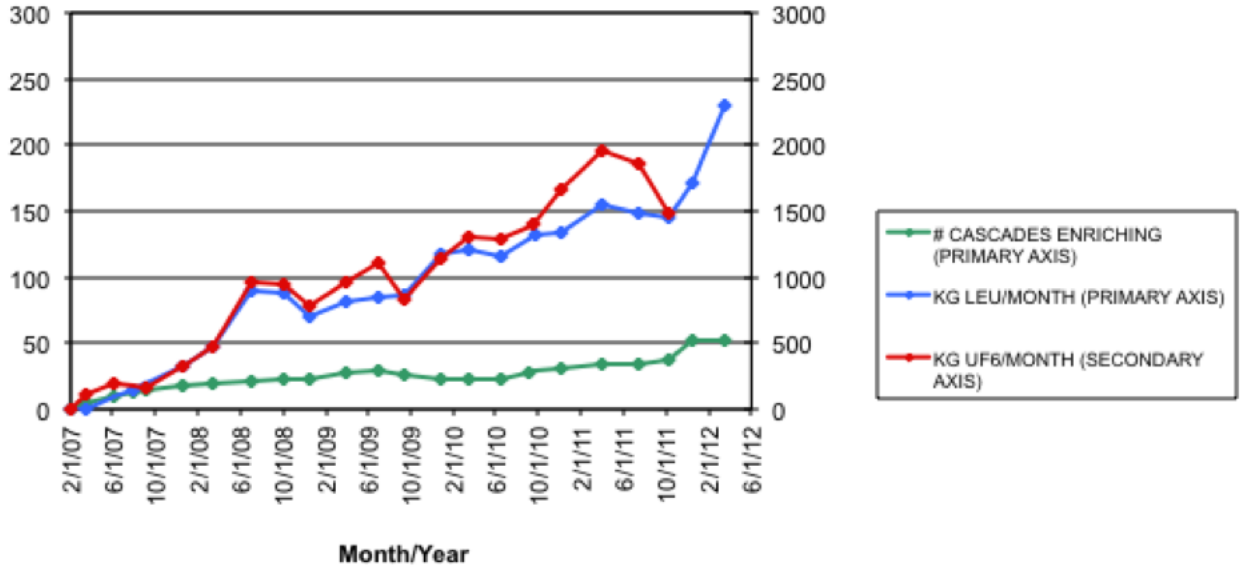
Figure IV.10: Centrifuge Trends at Natanz



The dark green bar represents the number of centrifuges enriching, while the light green bar represents the number of centrifuges installed but not enriching. The sum of the two represents the total number of centrifuges installed at the FEP

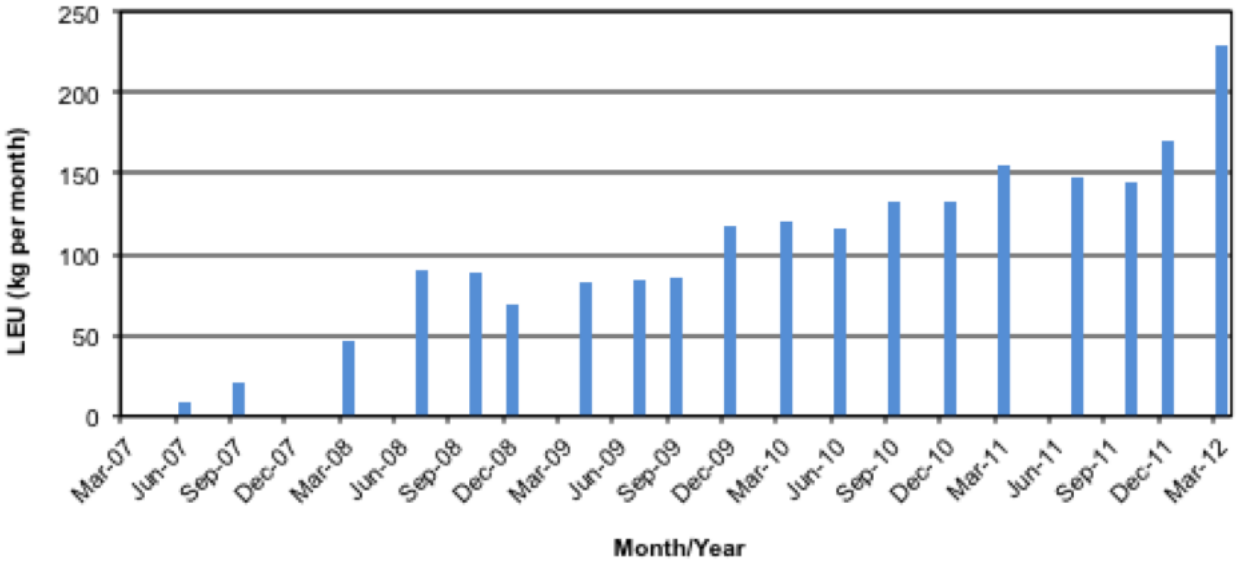
Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

Figure IV.11: ISIS Estimate of Monthly Trends at Natanz



Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

Figure IV.12: Kilograms of Low Enriched Uranium (LEU) per Month



Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

Figure IV.13: IAEA Reporting as of May 25, 2012 – Main Points

- **Production of 3.5% enriched uranium increases significantly.**
- **Iran continues to increase its stock of 19.75% LEU.**
- **Advanced centrifuge program still troubled but makes some progress.**
- **Iran currently possesses 6,196 kg of 3.5% LEU – enough to produce five nuclear weapons if further enriched to weapon grade.**

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.14: IAEA Reporting as of May 25, 2012 – LEU Production and Centrifuge Levels at Natanz Fuel Enrichment Plant (FEP)

Iran's total 3.5 percent LEU production at the FEP through May 11, 2012 is reported to be 6,197 kg, including 746 kg estimated by Iran to have been produced since February 4, 2012. This total amount of 3.5 percent low enriched uranium hexafluoride, if further enriched to weapon grade, is enough to make over five nuclear weapons. The FEP is Iran's primary enrichment facility, where the majority of its IR-1 centrifuges are installed. Activity at the Pilot Fuel Enrichment Plant (PFEP), where Iran is enriching uranium up to the 20 percent level, is discussed below.

The average production of 3.5 percent LEU at the FEP was 229 kg per month of LEU hexafluoride, a rate that has increased significantly from the last reporting period, when Iran produced on average 170 kg per month. Notably, Iran used nearly the same number of centrifuges as the last reporting period to enrich at a much higher level. Though Iran had installed the majority of its current set of enriching centrifuges by the February 2012 IAEA report increased level of enrichment likely indicates that Iran was not feeding 8,808 centrifuges with UF6 for the duration of the November – February reporting period.

As of May 19, 2012, Iran had 55 centrifuge cascades installed with 9,330 IR-1 centrifuges and was enriching in 52 cascades containing a total of 8,818 IR-1 centrifuges. The IAEA noted that "not all of the centrifuges in the cascades being fed with uranium hexafluoride may have been working." Uranium hexafluoride feed rates are not given for this reporting period.

Iran's centrifuge performance at the FEP can be evaluated in terms of separative work units (swu). ISIS derives this value from the declared LEU production. In the most recent reporting period, the LEU value is used with an assumption that the material is 3.5 percent enriched and the waste has a tails assay of 0.4 percent. The IAEA did not provide updated numbers in this report, but these older numbers can be used. Using standard enrichment calculators, 746 kg LEU translates to 1,834 kg of separative work units (swu), or 18.71 kg swu/day. On an annualized basis, this is about 6,832.8 kg swu per year. The number of centrifuges declared as enriching was 8,808 at the beginning of the reporting period and stayed approximately the same at 8,818 at the end of the reporting period, corresponding with an average swu/centrifuge-year of 0.77. For most of 2010, this value was about 0.9 kg U swu per year per centrifuge. While not all of Iran's centrifuges listed as enriching may actually be operational, these data show that Iran was likely enriching in the majority of its enriching cascades for the totality of this reporting period. Although the separative work in Iran's centrifuges has not yet rebounded to 2010 values, Iran has increased its capacity by successfully deploying and bringing online thousands of centrifuges.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.15: IAEA Reporting as of May 25, 2012 – Empty IR-1 Casings

During the last reporting period, over a few weeks, Iran placed an additional 6,177 empty IR-1 centrifuge casings at the FEP into two separate enrichment units. Bolting the casings to the floor is typically followed by the insertion of the centrifuge rotor assembly, which is loaded from the top of the casing. Thus, Iran may have sought to imply that it intended to rapidly install these centrifuge assemblies. As of May 19, 2012, however, only one cascade, for a total of 174 centrifuges, had been installed in these two units. This means that only 2.8 percent of the recently installed casings have centrifuge rotors in them. This may mean that Iran continues to have a shortage of raw materials for the IR-1 rotor assemblies, which require more advanced and difficult to acquire raw materials. On the other hand, centrifuge casings can be made quickly and involve raw material, namely soft aluminum, which is easier to acquire abroad or make domestically. Nonetheless, the installation of IR-1 centrifuge rotor assemblies requires careful monitoring.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.16: IAEA Reporting as of May 25, 2012 – Advanced Centrifuges

Iran appears to be continuing to encounter problems in its testing of production-scale cascades of advanced centrifuges at the Pilot Fuel Enrichment Plant, although some progress has occurred. Over the last reporting period, it maintained one 164-machine cascade of IR-2m centrifuges in cascade 5. All 164 IR-2m machines remained under vacuum but continued to be only intermittently fed with uranium hexafluoride. In a potential breakthrough, Iran continued installing IR-4 centrifuges in cascade 4, increasing their number as of May 18, 2012 to 129 IR-4 centrifuges out of 164 planned. As of February 21, 2012 it had only installed 58 of 164 IR-4 centrifuges. In a further advancement, since March 1, 2012, it has been intermittently feeding up to 104 of these IR-4 centrifuges with uranium hexafluoride.

Although Iran had declared to the IAEA that it would install three new types of centrifuges, called the IR-5, IR-6, and IR-6s, as single machines at the PFEP, as of May 18, 2012, no such machines had been installed. The designs of these centrifuges are not disclosed in the report. Iran continues to feed natural uranium hexafluoride into single machines as well as ten and twenty machine cascades of IR- 1, IR-2m, and IR-4 centrifuges.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.17: IAEA Reporting as of May 25, 2012 – 19.75% LEU Production

Iran has designated two, tandem cascades at the smaller, above-ground pilot fuel enrichment plant for the production of LEU enriched to nearly 20 percent uranium-235, ostensibly for the Tehran Research Reactor (TRR). One of these cascades enriches from 3.5 percent LEU to almost 20 percent LEU, while the second one takes the tails from the first and outputs about 10 percent LEU and a tails of natural uranium. The ten percent material is fed into the first cascade in addition to 3.5 percent LEU. This process allows Iran to more efficiently use its 3.5 percent LEU stock.

Between February 12, 2012 and May 18, 2012, 104.6 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades, a slight decrease from the last reporting period. Iran withdrew from the tandem cascades a total of 14.7 kg of nearly 20 percent LEU hexafluoride during this reporting period. **Thus, although the PFEP continued to produce 19.75 percent enriched uranium at a rate of approximately 4.6 kg/month, Iran's production of 19.75 percent enriched uranium at the PFEP has seemed to level off at this rate. In total, Iran has fed 990.3 kg of 3.5% LEU to produce 110.1 kg of 19.75% uranium since the beginning of operations in February 2010.**

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.18: IAEA Reporting as of May 25, 2012 – Fordow Fuel Enrichment Plant (FFEP)

The Fordow site has four cascades of 174 IR-1 centrifuges each operating in two, tandem sets producing 19.75 percent LEU. As of May 9, 2012, Iran had installed 174 centrifuges in both cascades five and six, and had also installed 20 centrifuges in cascade 7. None of these additional machines were enriching at that time.

Between February 18, 2012 and May 13, 2012, the two sets of tandem cascades produced approximately 21.7 kg of 19.75 percent enriched uranium at a combined rate of 7.65 kg 19.75 percent LEU hexafluoride per month. This represents a slight increase over the previous reporting period, when Iran produced 13.8 kg of 19.75 percent enriched uranium at a rate of 6.46 kg/month; however, Iran did not enrich in both sets of tandem cascades for the totality of the IAEA reporting period. Each set of cascades is producing 19.75 percent enriched uranium at a rate of 3.8 kg per month, a rate slightly lower than that achieved by the tandem set of cascades at the PFEP. Additionally, the centrifuges at the FFEP are achieving a lower average swu per centrifuge value than those at the PFEP, with each plant achieving 0.73 swu/centrifuge-year and 0.93 swu/centrifuge-year respectively.

Combined with its production at the PFEP at Natanz, Iran has produced approximately 145.6 kg of 19.75 percent uranium. Its total monthly production of 19.75 percent LEU has increased slightly from the last reporting period to about 12.25 kilograms per month of 19.75 percent LEU hexafluoride. If Iran begins enriching in the additional deployed cascades, this rate is expected to increase even further. Yet, even the current rate of production far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

Over a brief period last winter, Iran installed 2,088 empty IR-1 centrifuge outer casings as well as all the associated feed and withdrawal piping at the Fordow facility. These are enough centrifuge casings for 12 cascades of 174 IR-1 centrifuges. The plant is slated to hold 16 cascades, of which four are already enriching uranium to 19.75 percent.

With regard to these 12 other cascades, Iran has installed so far only enough centrifuge rotor assemblies for two more cascades and is working on installing rotor assemblies in another cascade. Iran has refused to tell the IAEA how many of these cascades will be dedicated to making 19.75 percent LEU or when these empty casings will be loaded with rotor assemblies and become operational.

The Fordow plant appears to be receiving a higher priority than the Natanz FEP in terms of the installation of the IR-1 centrifuges. But the rate of installation of IR-1 centrifuges is slower than expected based on Iran's rapid installation of outer casings at the facility. As discussed above, Iran may have a shortage of raw materials to build so many IR-1 rotor assemblies.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.19: IAEA Reporting as of May 25, 2012 – Elevated Enrichment Levels at Fordow Fuel Enrichment Plant (FFEP)

The IAEA has found traces of uranium enriched up to 27 percent at Iran's Fordow enrichment plant. This elevation is likely due to improved cascade design. The cascades at Fordow making 19.75 percent LEU have 17 stages instead of 15 as in the old cascade design. An effect is to overshoot 20 percent when 3.5 percent LEU is fed into the tandem cascades at the old feed rate for 15 stage cascades. To avoid this problem, Iran likely increased the feed rate of 3.5 percent LEU, which lowered the enrichment level of the product back to 19.75 percent. It also increased slightly the amount of 19.75 percent LEU produced.

This development is an embarrassment for Iran but it is not a sign of Iran moving to higher enrichment levels. Nonetheless, its deployment of a 17-stage cascade reflects a reconfiguration of the cascades that can make breakout faster and more efficient.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.20: IAEA Reporting as of May 25, 2012 – Taking Stock

Between the two enrichment sites, Iran has produced 145.6 kilograms of 19.75 percent LEU hexafluoride. Of that total, Iran has downblended 1.6 kilograms of 19.75 percent LEU hexafluoride into LEU enriched to less than five percent. Iran has also sent an unknown amount of 19.75 percent LEU to the Uranium Conversion Facility at Esfahan to make into fuel for the Tehran Research Reactor. Between December 17, 2011 and May 15, 2012, the IAEA reported that Iran has fed into the process line at the Fuel Plate Fabrication Plant at Esfahan 43 kilograms of uranium hexafluoride enriched up to 20 percent uranium-235, and it has produced 14 kilograms of uranium enriched up to 20 percent in the form of U3O8. Some has been manufactured into TRR fuel assemblies and a portion sent to the TRR.

It appears that up to 43 kilograms of 19.75 percent LEU is no longer in the form of uranium hexafluoride and could be considered as not available in a breakout, at least in its initial stage. The exact amount sent to this plant, however, is not clearly specified in the IAEA report. In summary, about 101 kilograms of 19.75 percent LEU hexafluoride remains as of May 15.

Iran has produced a total of 6,197 kilograms of 3.5 percent LEU hexafluoride. About 1,249 kilograms has been used to make the 19.75 percent LEU hexafluoride.

Iran has achieved varying rates of separative work in the IR-1 centrifuge in its enrichment plants. Although it continues to install and enrich in additional centrifuges at the FEP, the swu/centrifuge- year at this plant has varied wildly and declined overall. The separative work achieved at both the PFEP and FFEP indicates that Iran has been using tandem cascades to enrich to 19.75 percent comparably effectively. However, it is unknown whether Iran could maintain this level of output if it deployed these centrifuges on a broader scale.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.21: IAEA Reporting as of May 25, 2012 – Differences Over Resolving Military Dimensions and Access to the Parchin Site

The IAEA report contains information available in earlier press reports regarding an agreement being worked out between Iran and the IAEA for the resolution of concerns about the military dimensions of Iran's nuclear programs that were laid out in an annex to the November 2011 IAEA safeguards report. More recently, the IAEA has sought access to the Parchin site, where Iran may have conducted tests in the early 2000s related to the development of nuclear weapons.

The current report indicates that "progress was made on a draft document focused on the issues outlined in the Annex to the Director General's November 2011 report." During talks from May 14-15 in Vienna with the IAEA, in response to the Agency's request for access to Parchin, Iran stated that "such access would not be possible before an agreement had been reached on a structured approach." Director General Amano visited Iran for further discussions on May 21, during which an agreement was made to take a structured approach to resolving issues regarding the military dimensions of Iran's nuclear program.

While "some differences" remain which are preventing a final agreement, according to the IAEA report, Iran's chief nuclear negotiator, Saeed Jalili, apparently made clear that "these were not obstacles to reaching agreement." However, whether these differences can be bridged quickly is unclear. The IAEA called on Iran to "expedite final agreement on the structured approach...and urges Iran to engage the Agency on the substance of the issues as soon as possible, including by providing early access to the Parchin site."

With regard to recent activities at Parchin, the IAEA also reports, "based on satellite imagery, at this location, where virtually no activity had been observed for a number of years, the buildings of interest to the Agency are now subject to extensive activities that could hamper the Agency's ability to undertake effective verification." ISIS recently published satellite imagery and assessed that these activities could include possible sanitization of the Parchin site, a practice Iran has carried out at other sites in order to attempt to conceal past nuclear work.

Given the questionable activities at the Parchin site and the fact that the IAEA says that it continues to receive information since its November 2011 report which corroborates its analysis in that report, Iran's timely cooperation and agreement over the structured approach with the IAEA is imperative.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.22: IAEA Reporting as of May 25, 2012 – IR-40 Development

The IAEA reports that construction of the IR-40 heavy water moderated research reactor at Arak is still ongoing. In an unexplained development, the IAEA stated that "no major components had been installed since the previous DIV [design information verification visit]." The manufacture of fuel pellets for the IR-40 reactor using natural UO2 is ongoing. It also continues to manufacture dummy assemblies for the IR-40 reactor. Iran told the Agency that startup of the reactor is planned for late 2013. Whether Iran can operate the reactor by this date is unclear. However, once this reactor operates, it can make weapon-grade plutonium, if Iran decided to do so.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Andrea Stricker, Christina Walrond. May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_25May2012.pdf

IAEA Safeguards Report as of May 25, 2012. http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_25May2012.pdf

Figure IV.23: ISIS on Parchin

Iran's ongoing activities at the Parchin site continue to raise concerns about efforts to destroy evidence of possible nuclear weapons-related work. Since the last image ISIS provided on June 7, 2012 several activities have taken place.

Debris from one of the previously demolished buildings located just north of the explosives testing building appears to have been removed from the site. The layout of the site has been heavily altered by earth displacement, and there is no remaining trace of one of the previously demolished buildings or the roads within the complex perimeter.

An object that was previously placed near the alleged explosive chamber building and was suspected to be the origin of the water flow in the June 7 satellite imagery has now been moved to a nearby building just south of the testing chamber structure. Once again, traces of water flow are visible. This suggests the object may be a water tank and is being moved around the site, possibly to clean the buildings.

The area around the northernmost building on the site that was previously unchanged now shows evidence of new earth movement since the June 7 image. A clearly visible geometrical layout to the right of the building is no longer recognizable suggesting earth displacement or heavy machinery activity.

Since the first signs of a possible clean up at Parchin emerged in the April 9, 2012 satellite imagery, the site containing the suspect activity has undergone very noticeable changes with two buildings demolished, excavation of earth including most of the surrounding vegetation and roads covered or removed, dismantlement of the security perimeter around the site, and evidence of water usage potentially for cleaning the insides of buildings.

As ISIS has previously noted, water could be used as part of a process to attempt to wash out radiological evidence from hydrodynamic testing which used natural uranium metal as a surrogate material for highly enriched uranium. The process could involve grinding down the surfaces inside the building, collecting the dust and then washing the area thoroughly. This could be followed with use of new building materials and paint. Washing alone runs the risk of contaminating the wider area outside. Removal of the surrounding, contaminated earth suggests recognition of the need to remove the layer of soil that was contaminated by water runoff.

Some have raised the possibility that, if the explosive chamber had been used to test a neutron initiator, this type of test would leave behind a radioactive signature in the steel. According to Süddeutsche Zeitung (article in German language), the chamber could have been used to test a uranium deuteride initiator at the center of a sphere of tungsten used as a surrogate material, all of which would have been compressed by high explosives. If successful, the resulting fusion of deuterium would have produced a small spurt of neutrons. In this case, a tiny fraction of these neutrons would have activated elements in the steel chamber. This has led to the question whether the induced radiation could now be detected by the IAEA. However, in such a neutron initiator test, the number of neutrons is very small and many of the activated materials would have had relatively short half-lives. Although long lived radionuclides should have been produced in such a test, they would exist in very small quantities. Claims that such radioactive materials would be easily detectable today appear doubtful. Moreover, the detection of minute amounts of long-lived radionuclides in the steel chamber may not provide definitive proof of an initiator test. Iran could claim that the steel was already contaminated when it purchased it. In addition, Iran could have removed the chamber altogether, preventing any risk of such detection, even if it were possible to accomplish.

Source: ISIS Report. *Activity at Parchin Explosive Testing Site Continues: Time Is Running Out for a Sound IAEA Inspection.* David Albright, Robert Avagyan. July 2, 2012. http://isis-online.org/uploads/isis-reports/documents/Parchin_test_site_imagery_2July2012.pdf

Figure IV.24: IAEA Reporting as of February 24, 2012 – Main Points

- **Iran achieves a near three-fold increase in production of 19.75 percent LEU at Natanz and Fordow.**
- **Iran installs approximately 8,000 additional IR-1 centrifuge casings at Natanz and Fordow.**
- **Iran increases the number of centrifuges enriching at Natanz by nearly 50%.**
- **The testing of advanced centrifuge production-scale cascades at the Natanz pilot testing is going far more slowly than expected.**
- **IR-1 centrifuge performance remains below par.**

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Paul Brannan, Christina Walrond. February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Rerport_24Feb2012.pdf

IAEA Safeguards Report of February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_24February2012.pdf

Figure IV.25: IAEA Reporting as of February 24, 2012 – LEU Production and Centrifuge Levels at the Natanz Fuel Enrichment Plant (FEP)

Iran's total LEU production at the FEP through February 4, 2012 is reported to be 5,451 kg of low enriched uranium hexafluoride, including 580 kg estimated by Iran to have been produced since October 17, 2011. **This total amount of low enriched uranium if further enriched to weapon grade is enough to make over four nuclear weapons.** The FEP is Iran's primary enrichment facility, where the majority of its IR-1 centrifuges are installed. Activity at the Pilot Fuel Enrichment Plant, where Iran is enriching uranium up to the 20 percent level, is discussed below.

The average production of LEU at the FEP was 170 kg per month of LEU hexafluoride, a rate that has increased significantly from the last reporting period, where Iran produced 145 kg per month. However, Iran also used significantly more centrifuges to produce a marginal additional amount of product.

As of February 19, 2012, Iran had 54 centrifuge cascades installed with 9,156 IR-1 centrifuges and was enriching in 52 cascades containing a total of 8,808 IR-1 centrifuges. The IAEA noted that "not all of the centrifuges in the cascades being fed with uranium hexafluoride may have been working." At the end of the last reporting period, Iran was enriching in 15 fewer cascades and 2,600 fewer centrifuges. To achieve this increase in enriching centrifuges, Iran has re-connected about 1,000 IR-1 centrifuges, which had originally been installed and under vacuum in 2009.

In a new development, Iran placed an additional 6,177 empty IR-1 centrifuge casings at the FEP. It is unknown if Iran has enough raw materials to actually install this number of centrifuge rotor assemblies into the outer casings and make the centrifuges operational.

Uranium hexafluoride feed rates are not given for this reporting period.

The number of centrifuges enriching at the FEP has increased by about 50 percent, but centrifuge performance remains below par. This situation can be understood by evaluating centrifuge output at the FEP in terms of separative work units (swu). ISIS derives this value from the declared LEU production. In the most recent reporting period, the LEU value is used with an assumption that the material is 3.5 percent enriched and the waste has a tails assay of 0.4 percent. The IAEA did not provide updated numbers in this report, but these older numbers can be used. Using standard enrichment calculators, 580 kg LEU translates to 1,426 kg of separative work units (swu), or 12.96 kg swu/day. On an annualized basis, this is about 4,732 kg swu per year. The number of centrifuges declared as enriching was 6,208 at the beginning of the reporting period and rose to 8,808 at the end of the reporting period, corresponding with a swu/centrifuge-year of 0.76 and 0.53 respectively. For most of 2010, this value was about 0.9 kg U swu per year per centrifuge. These numbers imply that not all of Iran's centrifuges in cascades fed with uranium are actually enriching, and that these centrifuges are enriching less efficiently. **Despite the overall increase in LEU production during this reporting period, Iran's IR-1 centrifuges are performing no better.**

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Paul Brannan, Christina Walrond. February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Rerport_24Feb2012.pdf

IAEA Safeguards Report of February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_24February2012.pdf

Figure IV.26: IAEA Reporting as of February 24, 2012 – Deployment of Advanced Centrifuges at Pilot Fuel Enrichment Plant (PFEP) Delayed; 19.75 Percent Enrichment Continues

Advanced Centrifuges: Iran appears to be encountering problems in its testing of production-scale cascades of advanced centrifuge at the Pilot Fuel Enrichment Plant. Over the last reporting period, it maintained one164-machine cascade of IR-2m centrifuges in cascade 5. All 164 IR-2m machines were under vacuum and only being intermittently fed with uranium hexafluoride, an unexpected development. Iran continued work on its installation of IR-4 centrifuges in cascade 4, but, as of February 21, 2012 it had only installed 58 of 164 centrifuges in its planned IR-4 cascade, a decrease of 8 centrifuges from the end of the last reporting period. No uranium hexafluoride was introduced into the IR-4 centrifuges. According to IAEA information, Iran moves the IR-4 centrifuges in and out of the PFEP in a noticeable manner. This may imply significant problems with the IR-4 centrifuge design.

Iran also declared to the IAEA its plans to install three new types of centrifuges, called the IR-5, IR-6, and IR-6s as single machines at the PFEP. The designs specifications for the centrifuges are not disclosed in this report. Iran continues to feed natural uranium hexafluoride into single machines as well as ten and twenty machine cascades of IR-1, IR-2m, and IR-4 centrifuges.

19.75 percent LEU production: Iran has designated two cascades at the smaller, above-ground pilot fuel enrichment plant for the production of LEU enriched to nearly 20 percent uranium-235 for the Tehran Research Reactor (TRR). One of these cascades enriches from 3.5 percent LEU to almost 20 percent LEU, while the second one takes the tails from the first one and outputs about 10 percent LEU and a tails of natural uranium. The ten percent material is fed into the first cascade in addition to 3.5 percent LEU. This process allows Iran to more efficiently use its 3.5 percent LEU stock.

Between September 14, 2011 and February 11, 2012, 164.9 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades, a slight decrease from the last reporting period. Iran withdrew a total of 21.7 kg of nearly 20 percent LEU hexafluoride. **During the reporting period, Iran produced 19.75 percent enriched uranium at a rate of 4.5 kg/month, about a 20 percent increase from the last reporting period but equal to the rate reported by the IAEA in May 2011. In total, Iran has fed 885.7 kg of 3.5% LEU to produce 95.4 kg 19.75% uranium since the beginning of operations in February 2010.**

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Paul Brannan, Christina Walrond. February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Rerport_24Feb2012.pdf

IAEA Safeguards Report of February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_24February2012.pdf

Figure IV.27: IAEA Reporting as of February 24, 2012 – Fordow Fuel Enrichment Plant

The Fordow site now has four cascades of 174 IR-1 centrifuges each operating in two, tandem sets producing 19.75 percent LEU. Between December 14, 2011, when the first set started producing LEU until February 17, 2012, these sets of cascades produced approximately 13.8 kg of 19.75 percent enriched uranium at a rate of 6.46 kg 19.75 percent LEU hexafluoride per month. With the stockpile of 19.75 percent uranium produced at the Pilot Fuel Enrichment Plant at Natanz, Iran now has approximately 110 kg of 19.75 percent uranium. Its monthly production has increased to about 11 kilograms per month of 19,75 percent LEU hexafluoride, somewhat less than a three-fold increase. However, this level of production far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

In a new development, Iran installed 2,088 empty IR-1 centrifuge outer casings as well as all the associated feed and withdrawal piping at the Fordow facility. It is unclear whether and when Iran will install the rotor assemblies necessary to create operational IR-1 centrifuges. Fully outfitting the Fordow facility with centrifuges ready to enrich would have been a significant development. As in the case of the newly installed casings at the FEP, it is unknown if Iran has enough raw materials to actually install this number of centrifuge rotor assemblies into the outer casings at the Fordow site. However, given the international sensitivity about the deeply buried Fordow site, by installing the outer casings for over 2,000 machines and the associated piping, Iran is in effect sending a warning to the international community that it intends to fully outfit the Fordow site. If it cannot do so with advanced centrifuges, it appears to be willing to do so with IR-1 centrifuges. Only time will tell if Iran can actually install the critical centrifuge rotors and operate the machines.

Iran also submitted to the IAEA a new Design Information Questionaire (DIQ), revising yet again the stated purpose of the Fordow enrichment facility. Iran originally stated that Fordow would be used to make 3.5 percent enriched uranium, and later said that Fordow would also be used for R&D purposes. Then Iran submitted a new DIQ declaring that Fordow would be used to make 19.75 percent enriched as well. In the latest DIQ, Fordow will be used for only 19.75 and 3.5 percent enriched uranium production but Iran left open how many of the centrifuges will be dedicated to making 19.75 percent LEU. That Iran has changed the stated purpose of the Fordow facility so many times over such a short period of time raises significant questions regarding the original purpose of the facility. Iran's decision to build a relatively small enrichment facility without informing the IAEA suggested that Fordow was intended to be used to quickly and securely make highly enriched uranium for nuclear weapons.

In summary, Iran is being ambiguous over the number of its centrifuges at Fordow that will make 19.75 percent LEU. It is signaling that it intends to fully outfit the plant with centrifuges, despite having no credible civilian need for the LEU that these machines would produce.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Paul Brannan, Christina Walrond. February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Rerport_24Feb2012.pdf

IAEA Safeguards Report of February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_24February2012.pdf

Figure IV.28: IAEA Reporting as of February 24, 2012 – Taking Stock of Fordow and Natanz

Between the two enrichment sites, Iran has produced 109.2 kilograms of 19.75 percent LEU hexafluoride. Of that total, Iran has sent an unknown amount of 19.75 percent LEU to the Uranium Conversion Facility at Esfahan. Typically, transport containers would contain about 25 kilograms of such LEU. As of February 19, 2012, Iran had converted about 8 kilograms into U3O8 for use in Tehran Research Reactor fuel, which it is making at the nearby Fuel Manufacturing Plant. So, about 101.2 kilograms of 19.75 percent LEU remains in the form of hexafluoride as of that date.

Iran has produced a total of 5,451 kilograms of 3.5 percent LEU hexafluoride. About 985 kilograms has been used to make the 19.75 percent LEU hexafluoride.

Iran has achieved varying rates of separative work in the IR-1 centrifuge in its enrichment plants. Although it continues to install and enrich in additional centrifuges at the FEP, the swu/centrifuge-year at this plant has varied wildly and declined overall. The separative work achieved at both the PFEP and FFEP indicates that Iran has been using tandem cascades to enrich to 19.75 percent comparably effectively. However, it is unknown whether Iran could maintain this level of output if it deployed these centrifuges on a broader scale. Table 3 compares the SWU/year-centrifuge at the FEP, PFEP, and FFEP.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report*. David Albright, Paul Brannan, Christina Walrond. February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Rerport_24Feb2012.pdf

IAEA Safeguards Report of February 24, 2012. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_24February2012.pdf

Figure IV.29: ISIS on the IAEA's November 8, 2011 Report on Iran – LEU production and Centrifuge Levels at Natanz Fuel Enrichment Plant (FEP)

Iran's total LEU production at the FEP through November 1, 2011 is reported to be 4,922 kg of low enriched uranium hexafluoride, including 379 kg estimated by Iran to have been produced since August 14, 2011. **This amount of low enriched uranium if further enriched to weapon grade is enough to make four nuclear weapons. The FEP is Iran's primary enrichment facility, where the majority of its IR-1 centrifuges are installed.**

The average production of LEU at the FEP was 145 kg per month of LEU hexafluoride a rate that has fallen slightly from the last reporting period, where Iran produced 148 kg per month.

As of November 2, 2011, Iran was enriching in 37 cascades containing a total of 6,208 IR-1 centrifuges. The IAEA noted that "not all of the centrifuges in the cascades being fed with uranium hexafluoride may have been working." At the end of the last reporting period, Iran was enriching in two fewer cascades and 348 fewer centrifuges. While Iran is enriching in more cascades, Iran has also not installed any new centrifuges since the last reporting period. According to the report, the total number of centrifuges installed is about 8,000 centrifuges, the same as in the last two reports. Uranium hexafluoride feed rates are not given.

This situation can also be understood by using an equivalent method that is easier to compare to historical enrichment output at the FEP, namely the output measured in separative work units (swu). ISIS derives this value from the declared LEU production. In the most recent reporting period, the LEU value is used with an assumption that the material is 3.5 percent enriched and the waste has a tails assay of 0.4 percent.

The IAEA did not provide updated numbers in this report, but these older numbers can be used. Using standard enrichment calculators, 379 kg LEU translates to 932 kg of separative work units (swu), or 11.65 kg swu/day. On an annualized basis, this is about 4,252 swu per year (see Figure 6).

The number of centrifuges declared as enriching was 5,860 at the beginning of the reporting period and rose to 6,208 at the end of the reporting period, corresponding with a swu/centrifuge-year of 0.73 and 0.68 respectively. For most of 2010, this value was about 0.9 kg U swu per year per centrifuge. These numbers imply that not all of Iran's centrifuges in cascades fed with uranium are actually enriching, and that these centrifuges are enriching less efficiently.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report: Part 1.* David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. November 8, 2011, http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_08Nov2011.pdf

Figure IV.30: ISIS on the IAEA's November 8, 2011 Report on Iran – Deployment of Advanced Centrifuges at Pilot Fuel Enrichment Plant (PFEP), 20 Percent Enrichment Continues

Over the last reporting period, Iran completed its installation of one, 164-machine cascade of IR-2m centrifuges and continued to install a cascade of IR-4 centrifuges. As of October 22, 2011, Iran had installed 164 IR-2m centrifuges in cascade 5 and 66 IR-4 centrifuges in cascade 4.

All 164 IR-2m machines were under vacuum, and the IAEA report does not state whether they are being fed uranium hexafluoride. None of the IR-4 centrifuges had been fed with uranium hexafluoride. The purpose of operating these cascades is likely to demonstrate performance prior to installation of such cascades at Natanz, Fordow, or other enrichment sites. Iran continues to feed natural uranium hexafluoride into single machines as well as ten and twenty machine cascades of IR-1, IR-2m, and IR-4 centrifuges.

Iran has designated two cascades at the smaller, above-ground pilot fuel enrichment plant for the production of LEU enriched to nearly 20 percent uranium-235 for the Tehran Research Reactor (TRR).

One of these cascades enriches from 3.5 percent LEU to almost 20 percent LEU, while the second one takes the tails from the first one and outputs about 10 percent LEU and a tails of natural uranium. The ten percent material is fed into the first cascade in addition to 3.5 percent LEU. This process allows Iran to more efficiently use its 3.5 percent LEU stock.

Between August 21, 2011 and October 28, 2011, 93 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades, an slight decrease from the last reporting period. Iran withdrew a total of 8.9 kg of nearly 20 percent LEU hexafluoride.

During the reporting period, Iran produced 19.75 percent enriched uranium at a rate of 3.94 kg/month, approximately a 20 percent decrease from the previous reporting period. In total, Iran has fed 765.5 kg of 3.5% LEU to produce 79.7 kg 19.75% uranium since the beginning of operations in February 2010.

Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report: Part 1*. David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. November 8, 2011, http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_08Nov2011.pdf

Figure IV.31: ISIS on the IAEA's November 8, 2011 Report on Iran – Fordow Fuel Enrichment Plant

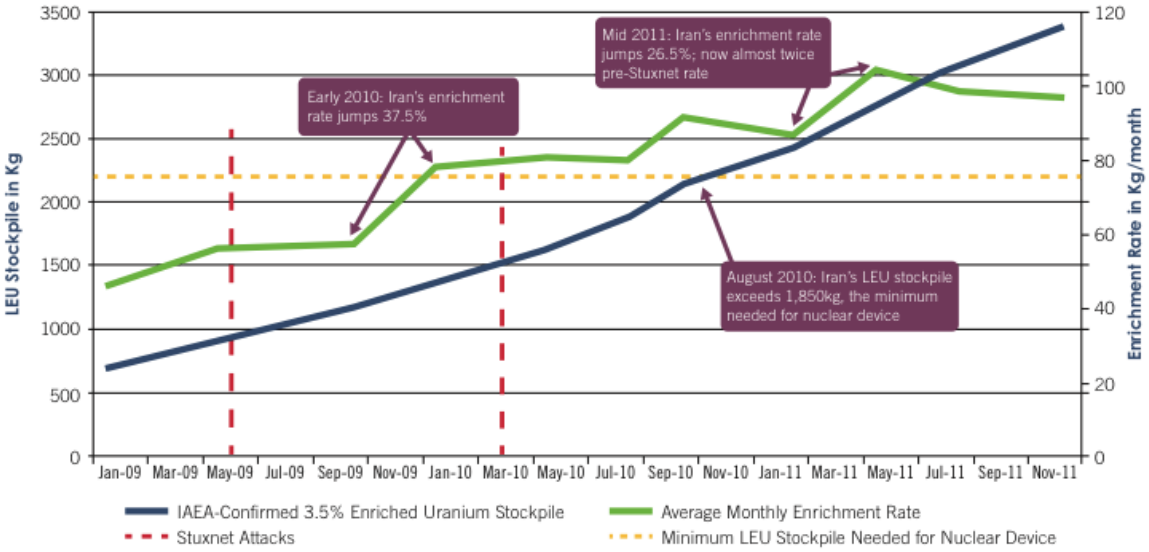
On October 17, 2011, Iran transferred from the FEP at Natanz a large cylinder of LEU in the form of uranium hexafluoride and a smaller cylinder containing depleted uranium. Iran informed the Agency of this action in an October 11, 2011 letter and stated that LEU will be used as feed at Fordow. Iran also requested that the IAEA remove the seal on the cylinder containing LEU on November 8, 2011.

During an inspection on October 23 and 24, 2011, the IAEA observed that Iran had installed all 174 IR-1 centrifuges in two tandem cascades in accordance with the third revised design information questionnaire (DIQ) from June 25, 2011. Iran plans to install a fourth cascade. This latest revised DIQ states that these cascades will be used for the production of 19.75 percent enriched uranium. The IAEA also noted that 64 IR-1 centrifuges had been installed in a third cascade. Iran informed the IAEA that the main power supply had been connected to the Fordow facility.

That Iran was caught building the Fordow plant in secret, and since Iran has subsequently changed the DIQ for this facility three times, raises concerns that the plant was built in order to provide Iran with the ability to quickly and securely make highly enriched uranium in the event of a breakout to make nuclear weapons. The IAEA has asked Iran for clarification on the circumstances that led to the construction of this facility.

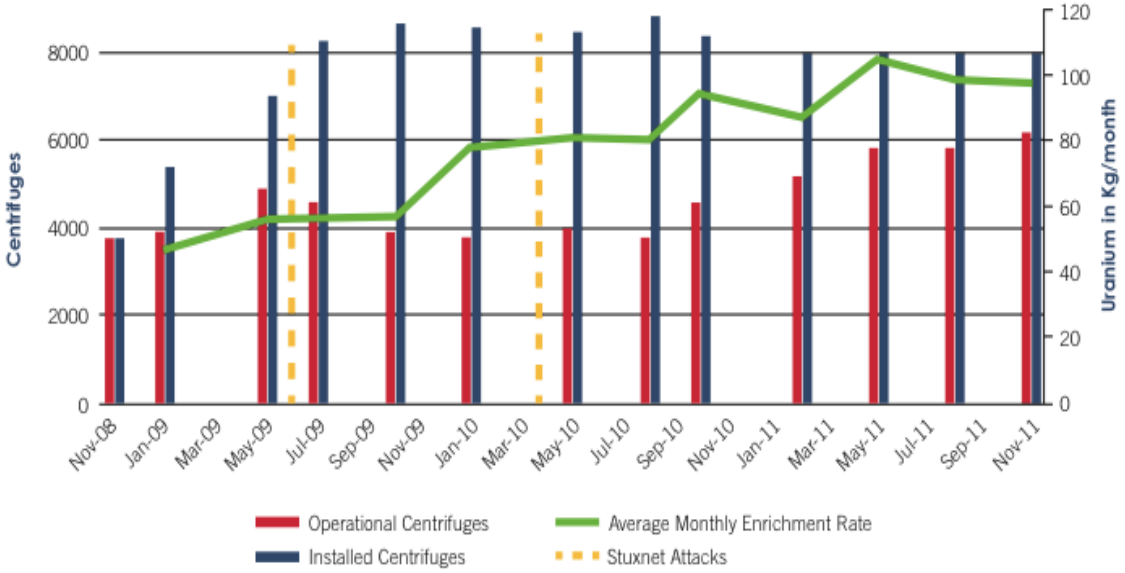
Source: ISIS Report. *ISIS Analysis of IAEA Iran Safeguards Report: Part 1.* David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. November 8, 2011, http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_08Nov2011.pdf

Figure IV.32: Iran's LEU Stockpile and Enrichment Rate



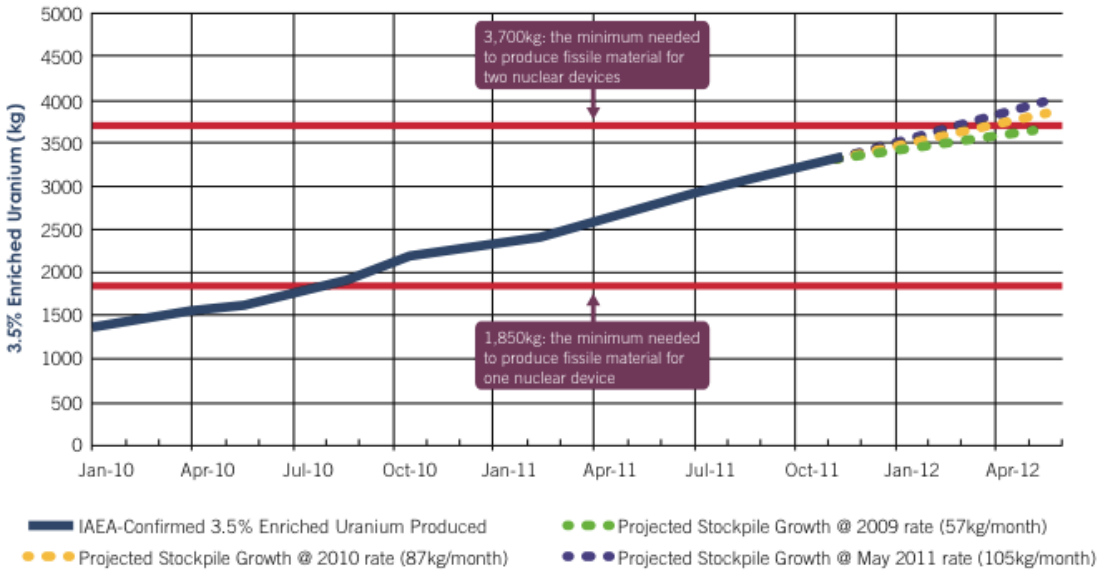
Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.33: Enrichment Rate vs. Operational Centrifuges at Natanz Fuel Enrichment Plant



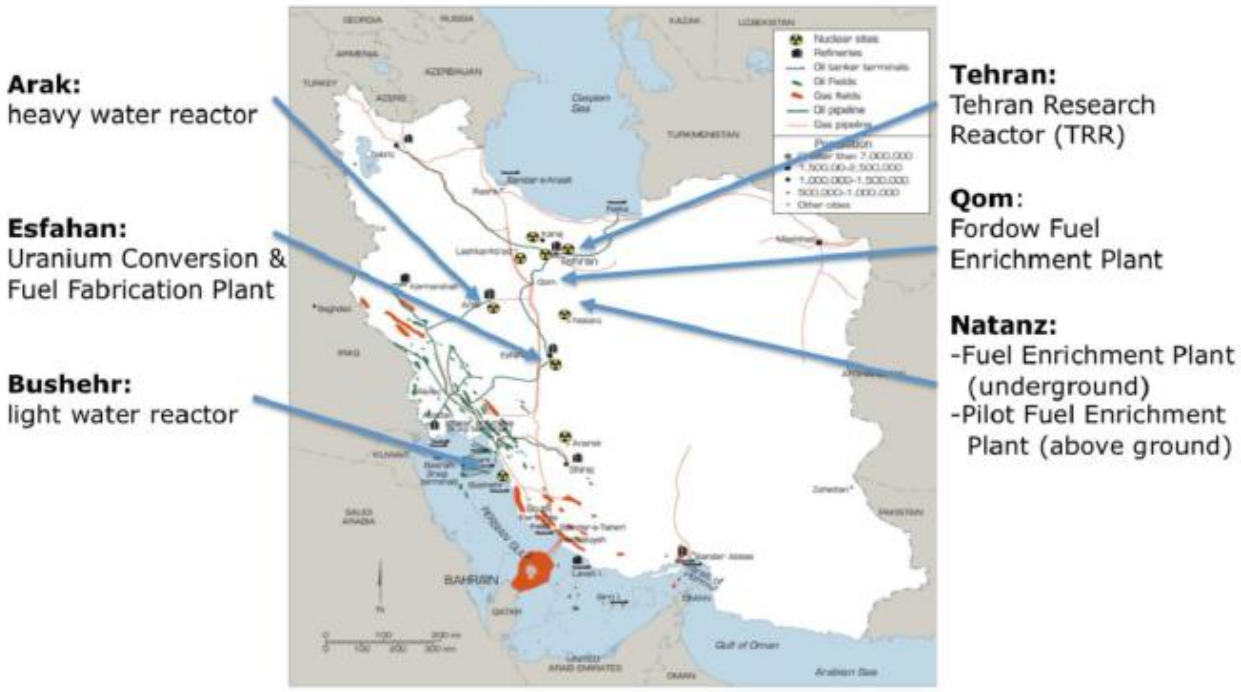
Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.34: Growth of Iran's 3.5% Enriched Uranium Stockpile



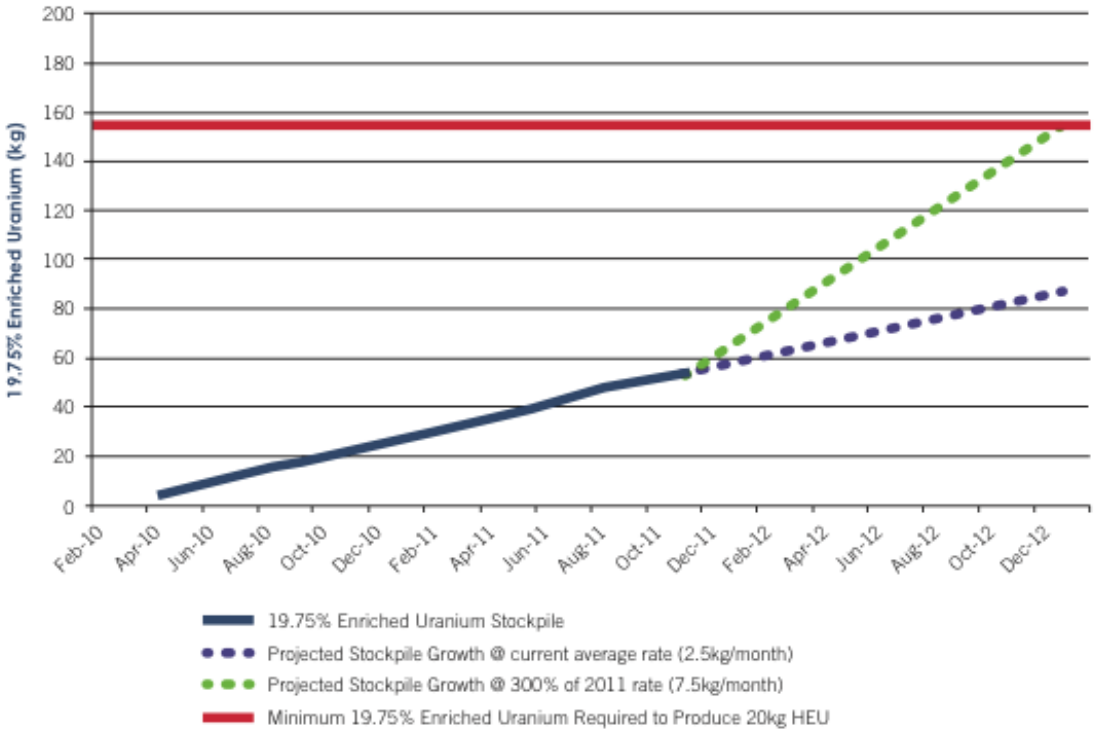
Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.35: Iran's Main Nuclear Facilities



Source: Bipartisan Policy Center. "Iran's Nuclear Program: Status and Breakout Timing." September 12, 2011. http://www.bipartisanpolicy.org/sites/default/files/Iran%20Nuclear%20Program.pdf

Figure IV.36: Projected Growth of Iran's 19.75% Enriched Uranium



Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.37: Time to Produce 20 kg of HEU at Natanz (assuming 5,184 centrifuges and .87 SWU/machine year)

CYCLE	FEEDSTOCK ENRICHMENT	FEEDSTOCK QUANTITY	PRODUCT ENRICHMENT	PRODUCT QUANTITY	TIME
First	3.5%	1,415 kg	19.7%	119.9 kg	46 days
Second	19.8%	153.2 kg (119.9 kg from 1st cycle + 38.3 kg from stockpile)	90%	20 kg	12 days
Total					62 days

- If Iran used (a) 3.5% enriched uranium feedstock for the first round of the batch recycling process and then added in its existing 19.8% enriched uranium stockpile, with (b) the efficiency of its centrifuges currently remaining at 0.87 Separative Work Units (SWU) per machine year and (c) using all 5,184 centrifuges currently enriching uranium at the FEP, Iran could produce 20 kg of HEU in 62 days.

- If Iran used (a) only 19.8% enriched uranium feedstock, which it does not currently possess but could have by the end of 2012, at the (b) the current efficiency and if it used (c) 5,184 centrifuges, it could produce 20 kg HEU in 12 days.

- If Iran used (a) only 3.5% enriched uranium feedstock, at (b) the current efficiency, it could breakout in between 43 and 105 days, depending on the number of centrifuges used.

- If Iran used (a) 3.5% enriched uranium feedstock and its (b) centrifuges' efficiency remained at the previous level of 0.5 SWU per machine year, it could break out in between 73 and 181 days, depending on the number of centrifuges used.

Source: Bipartisan Policy Center. "Iran's Nuclear Program: Status and Breakout Timing." September 12, 2011. http://www.bipartisanpolicy.org/sites/default/files/Iran%20Nuclear%20Program.pdf

Figure IV.38: Time to Produce 20 kg of HEU at Natanz (with variable stockpile enrichment levels, centrifuge efficiency and number)

CENTRIFUGES USED:	STOCKPILE ENRICHMENT LEVEL:	CENTRIFUGE EFFICIENCY (IN SWU/MACHINE YEARS):	REQUIRED STOCKPILE:	TIME TO PRODUCE:
3,772	3.5%	0.5	1,960 kg	181 days
	3.5%	0.87	1,860 kg	105 days
	19.75%	0.87	157 kg	19 days
8,528	3.5%	0.5	1,920 kg	84 days
	3.5%	0.87	1,920 kg	50 days
	19.75%	0.87	162 kg	10 days
10,004	3.5%	0.5	1,930 kg	73 days
	3.5%	0.87	1,930 kg	43 days
	19.75%	0.87	163 kg	8 days

Source: Bipartisan Policy Center. "Iran's Nuclear Program: Status and Breakout Timing." September 12, 2011. http://www.bipartisanpolicy.org/sites/default/files/Iran%20Nuclear%20Program.pdf

Figure IV.39: Time to Produce 20 kg of HEU at Natanz Using a Two-Step Batch Recycling Process (assuming 4,300 SWU/year)

Time to Produce 20 kg HEU at Natanz Using Two-Step Batch Recycling (assuming 4,300 SWU/ year)					
Cycle	Feedstock Enrichment	Feedstock Quantity	Product Enrichment	Product Quantity	Time
First	3.5%	1,415 kg	19.7%	119.9 kg	46 days
Second	19.7%	153.2 kg (119.9 kg from 1st cycle + 38.3 kg from stockpile)	90%	20 kg	12 days
Total					**62 days**

Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.40: Time to Produce 20 kg of HEU at Natanz Using a Three-Step Batch Recycling Process (assuming 4,300 SWU/year)

Time to Produce 20 kg HEU at Natanz Using Three-Step Batch Recycling (assuming 4,300 SWU/ year)					
Cycle	Feedstock Enrichment	Feedstock Quantity	Product Enrichment	Product Quantity	Time
First	3.5%	4,220 kg	19.8%	358 kg	146 days
Second	19.8%	407 kg (358 kg from 1st cycle + 54 kg from stockpile)	55.4%	71.4 kg	22 days
Third	55.4%	71.4 kg	86.3%	21 kg	7 days
Total					**181 days**

Source: Bipartisan Policy Center. "Meeting the Challenge: Stopping the Clock." February 2012. http://www.bipartisanpolicy.org/sites/default/files/BPC%20Iran%20Report.pdf

Figure IV.41: Differences Between BPC and IISS estimates of Iranian Nuclear Breakout

	ESTIMATE OF WHAT?	ENRICHMENT PROCESS	AMOUNT OF HEU	NUMBER OF CENTRIFUGES	TIME
BPC	HEU production	Batch recycling	20kg	5,184	62 days
IISS	HEU production	"Pakistan" method	37.5kg	3,936	1 year, 7 months
	HEU production	Batch recycling	37.5kg	3,936	Six months
	Metal core production				Six months

Source: Bipartisan Policy Center. "Iran's Nuclear Program: Status and Breakout Timing." September 12, 2011. http://www.bipartisanpolicy.org/sites/default/files/Iran%20Nuclear%20Program.pdf

Figure IV.42: Amount of Fissile Material Need to Build a Basic Fission (Non-Boosted) Weapon

Highly Enriched Uranium
HEU (90% U-235)

Simple gun-type weapon	**90-110 lbs./40-50 kg**
Simple implosion weapon	**33lbs/15 kg**
Sophisticated implosion weapon	**20-26lbs/9-12kg**

Weapons Grade Plutonium

Simple implosion weapon	**14lbs/6 kg**
Sophisticated implosion weapon	**4.5-9lbs/2-4 kg**

Extract from the unclassified estimates in Union of Concerned Scientists, "Preventing Nuclear Terrorism Fact Sheet," April 2004, and work by Abdullah Toukan

Figure IV.43: February 25, 2011 IAEA Report

Iran's total LEU production at the Natanz fuel enrichment plant (FEP): To date is 3606 kg of low enriched uranium, including 471 kg estimated by Iran to have been produced from October 18, 2010 to February 5, 2011. The average monthly has remained at approximately 120 kg per month

Activity at the Pilot Fuel Enrichment Plant: Since February 2010, approximately 43.6 kg of UF6 enriched up to 20% U-235 has been produced.

Continued R&D of advanced centrifuges: In the R&D area between November 20, 2010 and February 11, 2011, a total of 169 of natural UF6 was fed into centrifuges, but no low enriched uranium was withdrawn. In an updated design information questionnaire (DIQ) submitted to the Agency on January 19, 2011, Iran indicated that it would install two new 164-centrifuge cascades (Cascades 4 and 5) in the R&D area. These two cascades, one of which will comprise IR-4 centrifuges and the other IR-m centrifuges, will be fed with natural UF6.

No progress on IAEA requests for Fordow design information: To date, Iran has "not provided supporting information regarding the chronology of the design and construction of the Fordow Fuel Enrichment Plant (FFEP), as well as its original purpose, particularly in light of extensive information from a number of sources alleging that design work on the facility had started in 2006." The Agency has verified that construction of FFEP is ongoing. As of February 19, 2011, no centrifuges had been introduced into the facility. On February 21, 2011, Iran stated that it planned to begin feeding nuclear material in to the cascades "by this summer."

Diminishing cooperation on centrifuge production, uranium enrichment R&D, and the locations thereof: "Since early 2008, Iran has not responded to Agency quests for access to addition locations, inter alia, to the manufacturing of centrifuges, and to R&D on uranium enrichment. As a result, the Agency's knowledge about Iran's enrichment activities continues to diminish."

Other enrichment activities: "The Agency is still awaiting a substantive response from Iran to Agency requests for further information in relation to announcements made by Iran concerning the construction of ten new uranium enrichment facilities, the sites for five of which, according to Iran, have been decided, and the construction of which will begin by the end of the current Iranian year (March 20, 2011) or the start of the next year." Additionally, Iran has provided further information regarding its possession of laser enrichment technology or its development of third generation centrifuges.

Heavy water production: To date, the Agency has not been given access to the Heavy Water Production Plant, the Uranium Conversion Facility, or "any other location in Iran where projects related to heavy water are being carried out" in spite of UN Security Council resolution 1737 (2006) that stipulates Iran do so. Iran has objected to the Agency's requests on the basis that they go beyond the Safeguards Agreement and because Iran has already stated that it has not suspended its heavy water related projects.

No progress on weaponization issues: No progress made on resolving what the IAEA terms "possible military dimensions" to Iran's nuclear program. Iran continues to refuse IAEA requests to discuss such issues and insists that the documentation on which such allegations are based are forgeries. The IAEA's Director General "have detailed the outstanding issues related to possible military dimensions to Iran's nuclear program and the actions required of Iran necessary to resolve these. Since August 2008, Iran has declined to discuss these outstanding issues with the Agency, or to provide any further information, or access to locations or persons necessary to address the Agency's concerns." Additionally, "the Agency remains concerned about the possible existence in Iran of pat or current undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile.

Bushehr Nuclear Power Plant: "On 15-16 February 2011, the Agency conducted an inspection at the Bushehr Nuclear Power Plant (BNPP) and has verified the nuclear material present in the facility. On 23 February 2011, Iran informed the Agency that it would have to unload fuel assemblies from the core, and the Agency and Iran have agreed on the necessary safeguards measures."

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, February 25, 2011
http://www.iaea.org/Publications/Documents/Board/2011/gov2011-7.pdf

Figure IV.44: Lack of Iranian Cooperation with the IAEA as of February 25, 2011

Areas where Iran is not meeting its obligations, as indicated in this report and previous reports of the Director General Iran has not suspended its enrichment related activities as follows:

- Production of UF6 at UCF as feed material for enrichment
- Manufacturing centrifuge components, and assembling and testing centrifuges
- Conducting enrichment related research and development
- Conducting operations, installation work and the production of LEU up to 3.5% U-235 at the Fuel Enrichment Plant (FEP)
- Conducting operations, installation work and the production of LEU up to 20% U-235 at the Pilot Fuel Enrichment Plant (PFEP)
- Conducting construction work at the Fordow Fuel Enrichment Plant (FFEP)

Iran is not providing supporting information regarding the chronology of the design and construction, as well as the original purpose, of FFEP Iran has not suspended work on heavy water related projects as follows:

- Continuing the construction of the IR-40 Reactor
- Production of heavy water at the Heavy Water Production Plant (HWPP)
- Preparing for conversion activities for the production of natural UO2 for IR-40 Reactor fuel
- Manufactured a fuel assembly, fuel rods and fuel pellets for the IR-40 Reactor

Iran has not permitted the Agency to verify suspension of its heavy water related projects by:

- Not permitting the Agency to take samples of the heavy water stored at UCF
- Not providing access to HWPP

Iran is not cooperating with the Agency regarding the outstanding issues which give rise to concern about possible military dimensions to Iran's nuclear program:

- Iran is not providing access to relevant locations, equipment, persons or documentation related to possible military dimensions to Iran's nuclear program; nor has Iran responded to the many questions the Agency has raised with Iran regarding procurement of nuclear related items
- Iran is not engaging with the Agency in substance on issues concerning the allegation that Iran is developing a nuclear payload for its missile program. These issues refer to activities in Iran dealing with, inter alia:
  - neutron generation and associated diagnostics
  - uranium conversion and metallurgy
  - high explosives manufacturing and testing
  - exploding bridgewire detonator studies, particularly involving applications necessitating high simultaneity
  - multipoint explosive initiation and hemispherical detonation studies involving highly instrumented experiments
  - high voltage firing equipment and instrumentation for explosives testing over long distances and possibly underground
  - missile re-entry vehicle redesign activities for a new payload assessed as being nuclear in nature

Iran is not providing the requisite design information in accordance with the modified Code 3.1 in connection with:

- The IR-40 Reactor
- The announced new enrichment facilities

• The announced new reactor similar to TRR

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, February 25, 2011
http://www.iaea.org/Publications/Documents/Board/2011/gov2011-7.pdf

Figure IV.45: IAEA on Possible Military Dimensions as of May 24, 2011

Previous reports by the Director General have listed the outstanding issues related to possible military dimensions to Iran's nuclear program and the actions required of Iran necessary to resolve these.

On 6 May 2011, in light of Iran not having engaged with the Agency on the substance of these issues since August 2008, the Director General sent a letter to H.E. Mr. Fereydoun Abbasi, Vice President of Iran and Head of the Atomic Energy Organization of Iran (AEOI), reiterating the Agency's concerns about the existence of possible military dimensions to Iran's nuclear program and expressing the importance of Iran clarifying these issues. In the same letter, the Director General also requested that Iran provide prompt access to relevant locations, equipment, documentation and persons, and noted that, with Iran's substantive and proactive engagement, the Agency would be able to make progress in its verification of the correctness and completeness of Iran's declarations.

Based on the Agency's continued study of information which the Agency has acquired from many Member States and through its own efforts, the Agency remains concerned about the possible existence in Iran of past or current undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile.

Since the last report of the Director General on 25 February 2011, the Agency has received further information related to such possible undisclosed nuclear related activities, which is currently being assessed by the Agency. As previously reported by the Director General, there are indications that certain of these activities may have continued beyond 2004.

The following points refer to examples of activities for which clarifications remain necessary in seven particular areas of concern:

- Neutron generator and associated diagnostics: experiments involving the explosive compression of uranium deuteride to produce a short burst of neutrons.
- Uranium conversion and metallurgy: producing uranium metal from fluoride compounds and its manufacture into components relevant to a nuclear device.
- High explosives manufacture and testing: developing, manufacturing and testing of explosive components suitable for the initiation of high explosives in a converging spherical geometry.
- Exploding bridgewire (EBW) detonator studies, particularly involving applications necessitating high simultaneity: possible nuclear significance of the use of EBW detonators.
- Multipoint explosive initiation and hemispherical detonation studies involving highly instrumented experiments: integrating EBW detonators in the development of a system to initiate hemispherical high explosive charges and conducting full scale experiments, work which may have benefitted from the assistance of foreign expertise.
- High voltage firing equipment and instrumentation for explosives testing over long distances and possibly underground: conducting tests to confirm that high voltage firing equipment is suitable for the reliable firing of EBW detonators over long distances.
- Missile re-entry vehicle redesign activities for a new payload assessed as being nuclear in nature: conducting design work and modeling studies involving the removal of the conventional high explosive payload from the warhead of the Shahab-3 missile and replacing it with a spherical nuclear payload.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, May 24, 2011.

Figure IV.46: IAEA on Natanz, May 24, 2011

Fuel Enrichment Plant (FEP): There are two cascade halls at FEP: Production Hall A and Production Hall B. According to the design information submitted by Iran, eight units are planned for Production Hall A, with 18 cascades in each unit. No detailed design information has yet been provided for Production Hall B.

On 14 May 2011, 53 cascades were installed in three of the eight units in Production Hall A, 35 of which were being fed with UF6. Initially, each installed cascade comprised 164 centrifuges. Iran has modified 12 of the cascades to contain 174 centrifuges each. To date, all the centrifuges installed are IR-1machines. As of 14 May 2011, installation work in the remaining five units was ongoing, but no centrifuges had been installed. There had been no installation work in Production Hall B.

Following a physical inventory verification (PIV) at FEP, the Agency confirmed that, as of 17 October 2010, 34 737 kg of natural UF6 had been fed into the cascades since the start of operations in February 2007, and a total of 3135 kg of low enriched UF6 had been produced.

Iran has estimated that, between 18 October 2010 and 13 May 2011, it produced an additional 970 kg of low enriched UF6, which would result in a total production of 4105 kg of low enriched UF6 since

February 2007. The nuclear material at FEP (including the feed, product and tails), as well as all installed cascades and the feed and withdrawal stations, are subject to Agency containment and surveillance. In a letter dated 4 April 2011, Iran informed the Agency that a metal seal in the feed and withdrawal area of FEP had been accidentally broken by the operator. The consequences for safeguards of this seal breakage will be evaluated by the Agency upon completion of the next PIV.

Pilot Fuel Enrichment Plant (PFEP): PFEP is a research and development (R&D) facility and a pilot, low enriched uranium (LEU) production facility, which was first brought into operation in October 2003. It has a cascade hall that can accommodate six cascades, and is divided between an area designated for the production of LEU enriched up to 20% U-235 and an area designated for R&D.

In the production area, Iran first began feeding low enriched UF6 into Cascade 1 on 9 February 2010, for the stated purpose of producing UF6 enriched up to 20% U-235 for use in the manufacture of fuel for the Tehran Research Reactor (TRR). Since 13 July 2010, Iran has been feeding low enriched UF6 into two interconnected cascades (Cascades 1 and 6), each of which consists of 164 centrifuges.

Iran has estimated that, between 19 September 2010 and 21 May 2011, a total of 222.1 kg of UF6 enriched at FEP was fed into the two interconnected cascades and that approximately 31.6 kg of UF6 enriched up to 20% U-235 was produced. This would result in a total of approximately 56.7 kg of UF6 enriched up to 20% U-235 having been produced since the process began in February 2010.

In the R&D area, between 12 February 2011 and 21 May 2011, a total of approximately 331 kg of natural UF6 was fed into centrifuges, but no LEU was withdrawn as the product and the tails of this R&D activity are recombined at the end of the process

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, May 24, 2011.

Figure IV.47: 20% Enrichment and Weapons Production

May 31 IAEA safeguards report on Iran is the first to contain any data on the production of 19.75 percent enriched uranium in IR-1 centrifuges at the Natanz Pilot Fuel Enrichment Plant (PFEP.

The Natanz PFEP is configured to hold six 164-centrifuge cascades in total. Iran uses one of these cascade bays to test several more advanced types of centrifuges configured in 10, 20 and single unit cascades for R&D purposes. When Iran started making 19.75 percent enriched uranium, the PFEP held only one 164-centrifuge cascade, called cascade 1. It has now reinstalled a second cascade, called cascade 6, also designated for production of LEU enriched up to 20 percent. As of late May, cascade 6 had been prepared for enrichment but was not enriching pending the application of more sophisticated safeguards arrangements.

Between 18 and 29 September 2010, the Agency conducted a PIV at PFEP and verified that, as of 18 September 2010, 352 kg of low enriched UF6 had been fed into the cascade(s) since 9 February 2010, and that a total of 25.1 kg of UF6 enriched up to 20% U-235 had been produced. Iran declared that the enrichment level of the UF6 product was 19.89%. The Agency is continuing with its assessment of the PIV.9

Iran has estimated that, between 19 September 2010 and 19 November 2010, a total of 62.5 kg of UF6 enriched at FEP was fed into the two interconnected cascades and that approximately 7.8 kg of UF6 enriched up to 20% U-235 was produced. This would result in a total of approximately 33 kg of UF6 enriched up to 20% U-235 having been produced since the process began in February 2010.

How quickly Iran might produce 19.75 percent enriched uranium will depend on whether it uses only one cascade or decides to use more cascades at the PFEP. Although Iran has said that it will expand the enrichment effort beyond a single cascade, it has not revealed the enrichment level of the product of the second cascade.

...if Iran installs more cascades at the PFEP, it can speed up its production of 19.75 percent LEU. Nonetheless, one or two cascades would require several years to have enough 19.75 percent LEU to then further enrich and have sufficient weapon-grade uranium for a nuclear weapon. If Iran deploys five cascades it would produce this material in 0.5-1.7 years.

Iran has not stated how much 19.75 percent LEU it plans to produce or, for that matter, how many cascades it will ultimately devote to the production of this material. .

.As long as Iran maintains its centrifuge capability, it can incrementally strengthen its nuclear weapons capabilities under the guise of “peaceful” declarations, and shorten the time needed to make enough weapon-grade uranium for a nuclear weapon.

Source: ISIS Report: *Moving 20 Percent Enrichment to Fordow: Slow Motion Breakout Continues?* David Albright, Paul Brannan and Andrea Stricker. June 8, 2011, http://isis-online.org/isis-reports/detail/moving-20-percent-enrichment-to-fordow-slow-motion-breakout-continues/8

Figure IV.48: IAEA on Qom (Fordow) as of May 24, 2011

In September 2009, Iran informed the Agency that it was constructing the Fordow Fuel Enrichment Plant (FFEP), located near the city of Qom. In its DIQ of 10 October 2009, Iran stated that the purpose of the facility was the production of UF6 enriched up to 5.0% U-235, and that the facility was being built to contain 16 cascades, with a total of approximately 3000 centrifuges. In September 2010, Iran provided the Agency with a revised DIQ in which it stated that the purpose of FFEP was now to include R&D as well as the production of UF6 enriched up to 5.0% U-235.

While the Agency continues to verify that FFEP is being constructed according to the latest DIQ provided by Iran, it is still not in a position to confirm the chronology of the design and construction of FFEP or its original purpose. Iran has stated that there is no legal basis upon which the Agency may request information on the chronology and purpose of FFEP, and that the Agency is not mandated to raise questions that are beyond its Safeguards Agreement. The Agency considers that the questions it has raised are within the terms of the Safeguards Agreement, in that the information requested is essential for the Agency to confirm that the declarations of Iran are correct and complete.

As stated in the Director General's previous report, on 21 February 2011, Iran informed the Agency that it planned to begin feeding nuclear material into cascades "by this summer". As of 21 May 2011, no centrifuges had been introduced into the facility. The results of the analysis of the environmental samples taken at FFEP up to February 2010 did not indicate the presence of enriched uranium.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, May 24, 2011.

Figure IV.49: Enrichment to 20% at Fordow

On June 8, Iran's vice president and head of the Atomic Energy Organization of Iran (AEOI), Fereydoun Abbasi, announced that Iran would install164-machine cascades of advanced centrifuges at the previously hidden Fordow enrichment plant and triple its enrichment output of 19.75 percent low enriched uranium (LEU) by the end of the year. By moving its 19.75 percent LEU production to Fordow and tripling its output of 19.75 percent LEU, Iran positions itself to stockpile a large amount of 19.75 percent LEU more quickly in a facility better protected against military strikes. A year after starting, Iran would have enough 19.75 percent LEU to more quickly break out and produce enough weapon-grade uranium for a nuclear weapon, if it chose to do so.

Iran's announcement indicates that as few as one centrifuge cascade of advanced centrifuges could produce the 19.75 percent LEU at Fordow. ISIS is interpreting that the threefold increase in this case refers to the greater enrichment output of the advanced centrifuges compared to the IR-1 centrifuges at Natanz.

Based on its output at the pilot enrichment plant at Natanz, Iran's monthly output of this LEU would increase threefold to almost 12 kilograms per month. Iran has already produced about 60 kilograms of 19.75 percent LEU at its pilot plant at Natanz. With increased production, Iran could accumulate about 200 kilograms of LEU one year after starting the cascade at Fordow, assuming the cascade at Natanz stops producing this material, as Iran has indicated will happen. Two hundred kilograms of 19.75 percent LEU are enough material, if further enriched, to make sufficient weapon-grade uranium for one nuclear weapon.

All of this supports a possible on-going effort by Iran to slowly acclimatize the international community to conditions that would make a breakout to nuclear weapons more feasible. Although Iran claims that it needs 19.75 percent LEU to operate its Tehran research reactor and additional ones it plans to build, it does not yet have the capability to build these new reactors and it has produced several years' worth of enriched uranium for the Tehran research reactor. If Iran proceeds with its plan, it will accumulate a large stockpile of 19.75 percent LEU at Fordow, and this stock and the centrifuges producing it would be heavily fortified inside the Fordow mountain facility and rendered less vulnerable to aerial strikes. Iran could quickly move its stock of 19.75 percent LEU elsewhere for enrichment to weapon-grade in a small, easily hidden centrifuge facility or kick out IAEA inspectors and quickly enrich to weapon-grade, though it may risk a ground strike.

Source: ISIS Report: *Moving 20 Percent Enrichment to Fordow: Slow Motion Breakout Continues?* David Albright, Paul Brannan and Andrea Stricker. June 8, 2011, http://isis-online.org/isis-reports/detail/moving-20-percent-enrichment-to-fordow-slow-motion-breakout-continues/8

Figure IV.50: IAEA on Plutonium/ Heavy Water Facilities as of May 24, 2011

Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran has not suspended work on all heavy water related projects, including the construction of the heavy water moderated research reactor, the IR-40 Reactor, which is under Agency safeguards.

As indicated in the Director General's previous reports, in light of the request by the Security Council to report to it on whether Iran has established full and sustained suspension of, inter alia, all heavy water related projects,30 the Agency has requested that Iran make the necessary arrangements to provide the
Agency, at the earliest possible date, with access to: the Heavy Water Production Plant (HWPP); the heavy water stored at the Uranium Conversion Facility (UCF) in order to take samples; and any other location in Iran where projects related to heavy water are being carried out. Iran has objected to the Agency's requests on the basis that they go beyond the Safeguards Agreement and because Iran has already stated that it has not suspended its heavy water related projects. The Security Council has decided that Iran shall provide such access and cooperation as the Agency requests to be able to verify the suspension of its heavy water related projects. To date, Iran has not provided the requested access.

While Iran has made statements to the effect that it has not suspended work on all its heavy water related projects, without full access to the heavy water at UCF, to HWPP, and any other heavy water related projects there may be in Iran, the Agency is unable to verify such statements and therefore to report fully on this matter.

On 10 May 2011, the Agency carried out a DIV at the IR-40 Reactor at Arak and observed that construction of the facility was ongoing and that the moderator heat exchangers had been delivered to the site. According to Iran, the operation of the IR-40 Reactor is planned to commence by the end of 2013.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, May 24, 2011
http://www.iaea.org/Publications/Documents/Board/2011/gov2011-29.pdf

Figure IV.51: IAEA Concerns as of June 2011

The head of the IAEA, Yukiya Amano, disclosed on June 3, 2011 that the IAEA had received "further information related to possible past or current undisclosed nuclear-related activities that seem to point to the existence of possible military dimensions to Iran's nuclear program…The activities in Iran related to the possible military dimension seem to have been continued until quite recently."

Amano said he had written last month to the head of Iran's Atomic Energy Organization, Fereydoun Abbasi-Davani, "reiterating the agency's concerns about the existence of possible military dimensions." He had asked for Iran to "provide prompt access" to locations, equipment, documentation and officials to help resolve the agency's queries, and had sent a new letter to Abbasi-Davani on June 3 "in which I reiterated the agency's requests to Iran."

In his May 26 letter to Amano, Abbasi-Davani reiterated Iran's position that the allegations were fabricated, and said U.N. sanctions resolutions against the country were "illegal and unacceptable."

Amano stated that, Iran was "not providing the necessary cooperation to enable the agency to provide credible assurance about the absence of undeclared nuclear material and activities in Iran… I urge Iran to take steps toward the full implementation of all relevant obligations in order to establish international confidence in the exclusively peaceful nature of its nuclear program."

On June 8, 2011 Reuters reported that Iran had announced major new underground enrichment activity to start at Fordow, a mountain bunker near the clerical city of Qom. This facility was secret until September 2009, when Western intelligence revealed its existence and it and said it was evidence of covert nuclear work.

"This year, under the supervision of the (International Atomic Energy) Agency, we will transfer 20 percent enrichment from the Natanz site to the Fordow site and we will increase the production capacity by three times," (Iranian state broadcaster IRIB, quoting Fereydoun Abbasi-Davani, head of Iran's atomic energy agency, in briefing after a cabinet meeting.)

EU issued a statement at IAEA meeting stating: "We note with particular concern the announcement made only today by Iran that it will increase its capacity to enrich (uranium) to 20 percent, thereby further exacerbating its defiance of the United Nations Security Council." It also calls on IAEA chief Yukiya Amano to submit "at the earliest possible date a comprehensive analysis of the possible military dimensions of Iran's nuclear program" to the IAEA governing board.

Source: IAEA, "June Board of Governors Meeting Convenes." June 6, 2011 http://www.iaea.org/newscenter/news/2011/bog060611.html

Figure IV.52: September 2, 2011 IAEA Reporting on Natanz: LEU Production and Centrifuge Levels at the Fuel Enrichment Plant (FEP)

Iran's total LEU production at the FEP through August 13, 2011 is reported to be 4,543 kg of low enriched uranium hexafluoride, including 438 kg estimated by Iran to have been produced since May 14, 2011. This amount of low enriched uranium if further enriched to weapon grade is almost enough to make four nuclear weapons. The FEP is Iran's primary enrichment facility, where the majority of its IR-1 centrifuges are installed.

The average production of LEU at the FEP reached 148 kg per month of LEU hexafluoride (for the last reporting period ISIS noted it was 156 kg per month of LEU hexafluoride). This monthly rate is only slightly lower than Iran's rate from the previous reporting period. The current average represents about a five percent decrease, compared to the last reporting period.

As of August 28, 2011, Iran was enriching in 35 cascades containing a total of 5,860 IR-1 centrifuges. The IAEA noted that some of these centrifuges "were possibly not being fed" with uranium hexafluoride. At the end of the last reporting period, Iran was enriching in the same number of cascades containing the same number of centrifuges. Iran has also not installed any new centrifuges since the last reporting period. According to the report, the total number of centrifuges installed is about 8,000 centrifuges, the same as in the last report. Uranium hexafluoride feed rates are not given.

This situation can also be understood by using an equivalent method that is easier to compare to historical enrichment output at the FEP, namely the output measured in separative work units (swu). ISIS derives this value from the declared LEU production. In the most recent reporting period, the LEU value is used with an assumption that the material is 3.5 percent enriched and the waste has a tails assay of 0.4 percent.

The IAEA did not provide updated numbers in this report, but these older numbers can be used. Using standard enrichment calculators, 438 kg LEU translates to 1,077 kg of separative work units (swu), or 11.84 kg swu/day. On an annualized basis, this is about 4,320 swu per year. The number of centrifuges declared as enriching was 5,860 at both the end and the beginning of the reporting period, so the swu per centrifuge remains constant at 0.74 during this time. For most of 2010, this value was about 0.9 kg U swu per year per centrifuge. These numbers imply that not all of Iran's centrifuges in cascades fed with uranium are actually enriching, or that these centrifuges are enriching less efficiently.

Source: ISIS Report. *IAEA Iran Safeguards Report, September 2, 2011*. David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. September 2, 2011, http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_2Sept2011.pdf

Figure IV.53: September 2, 2011 IAEA Reporting on Natanz: Deployment of Advanced Centrifuges at the Pilot Fuel Enrichment Plant (PFEP), 20 Percent Enrichment Continues

Iran has started installing two cascades of advanced centrifuges at the PFEP as it said it would. As of August 28, 2011, Iran had installed 136 IR-2m centrifuges in cascade 5 and 27 IR-4 centrifuges in cascade 4. Iran started feeding 54 of the 136 IR-2m centrifuges with natural uranium hexafluoride. The purpose of operating these cascades is likely to demonstrate performance prior to installation of such cascades at Natanz, Fordow, or other enrichment sites.

Iran has designated two cascades at the smaller, above-ground pilot fuel enrichment plant for the production of LEU enriched to nearly 20 percent uranium-235 for the Tehran Research Reactor (TRR). One of these cascades enriches from 3.5 percent LEU to almost 20 percent LEU, while the second one takes the tails from the first one and outputs about 10 percent LEU and a tails of natural uranium. The ten percent material is fed into the first cascade in addition to 3.5 percent LEU. This process allows Iran to more efficiently use its 3.5 percent LEU stock.

Between May 22, 2011 and August 20, 2011, 98.4 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades, an 8 percent increase in the feed rate. Iran withdrew a total of 14.1 kg of nearly 20 percent LEU hexafluoride. During the reporting period, Iran produced 19.75 percent enriched uranium at a rate of 4.80 kg/month, a 23 percent increase from the average rate of 3.91 kg per month in the last reporting period. In total, Iran has fed 672.5 kg of 3.5% LEU to produce 70.8 kg 19.75% uranium since the beginning of operations in February 2010. The relatively small number of centrifuges in these cascades likely allows Iran to pay greater attention to improving their performance, accounting for the marked improvement of the IR-1 centrifuges at the PFEP in comparison to the decline in performance of IR-1 machines installed at the FEP.

Source: ISIS Report. *IAEA Iran Safeguards Report, September 2, 2011.* David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. September 2, 2011, http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_2Sept2011.pdf

Figure IV.54: September 2, 2011 IAEA Report: Heavy Water Production

Iran told the IAEA during an August 9 visit to the Arak IR-40 Reactor that the start of the operation of the reactor is planned for the end of 2013. During the visit, the IAEA observed the reactor's construction was ongoing. Moderator heat exchangers had been installed and coolant heat exchangers had been delivered to the site.

On August 17, the IAEA visited the Arak Heavy Water Production Plant (HWPP) for the first time since 2005. Iran told the IAEA that the plant was operational and it had produced a total of 60 tons of heavy water to date. Iran continues to refuse the IAEA access to the heavy water stored at the Uranium Conversion Facility (UCF) for sampling.

Source: ISIS Report. *IAEA Iran Safeguards Report, September 2, 2011.* David Albright, Paul Brannan, Andrea Stricker, and Christina Walrond. September 2, 2011, http://www.isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_ISIS_analysis_2Sept2011.pdf

The Data in the IAEA Report of November 8, 2011

The data in some of these figures may seem technical and abstract, but the IAEA's report on Iran's programs of November 8, 2011 provided the first detailed military annex the IAEA had ever issued on Iran's programs, and one that included new indicators that Iran was weaponizing its program, which have been shown from **Figure IV.55** through **Figure IV.72**.

Figure IV.55 through **Figure IV.72** indicate that Iran has engaged in substantial R&D activities to develop technology that is critical to developing a functional nuclear weapons program. These include the research into and experimentation with detonator technology, multipoint initiators, neutron initiators, exploding bridgewire (EBW), and other technology that has little, if any, use outside of military applications.

Moreover, as **Figure IV.68** indicates, Iran has "experimentation which would be useful were Iran to carry out a test of a nuclear explosive device." While it is impossible to know Iran's true intentions regarding its nuclear program, these indicators taken with Iran's refusal to engage the IAEA or the international community substantively on these matters indicate a probable military dimension to the country's program.

Figure IV.69 and **Figure IV.70** show that Iran has taken steps to integrate a spherical payload into the existing payload chamber on the re-entry vehicle of the Shahab-3 missile, as well as developed fusing, arming, and firing systems that would give re-entry vehicles an airburst capability, or explode on impact with the Earth's surface. Lastly, **Figure IV.72** reflects the IAEA's analysis of the likely payload of an Iranian ballistic missile given the developments in the country's nuclear and ballistic missile programs. While the diagram indicates that an Iranian missile could carry a range of payloads, a nuclear payload is most likely. Although by no means certain, these indicators reflect that Iran likely intends to arm its missiles with nuclear warheads, or achieve the capability to do so.

The key focus of each Figure may be summarized as follows:

- **Figure IV.55** describes Iran's lack of cooperation with the IAEA regarding heavy water at the Iran Nuclear Research Reactor (IR-40) at Arak. Although the Agency was allowed access to the site on October 17, 2011, it has not been permitted access since then. According to Iran, operation of the IR-40 reactor is due to commence by the end of 2013. Although the Agency has not been permitted access to the Heavy Water Production Plant (HWPP) since August 17, 2011, satellite imagery has indicated that the HWPP appears to be in operation. Lastly, to date Iran has not allowed the Agency access to the heavy water stored at the Uranium Conversion Facility (UCF) to take samples.
- **Figure IV.56** provides a description of the IAEA's knowledge of the Uranium Conversion Facility (UCF) as of October 18, 2011. It reflects that Iran is continuing enrichment and heavy water production at the site in contravention of international demands and regulations. It indicates that as of October 18, 2011, the Agency observed the ongoing installation of the process equipment for the conversion of UF6 (uranium hexafluoride) enriched to 20% into U3O8 (triuranium octoxide).
- **Figure IV.57** provides an introduction and summary of the possible military dimensions of Iran's nuclear program. Importantly, it indicates that Iran has not engaged the IAEA substantively regarding the military dimensions of its program since August 2008, and it stresses the following:
    I. Efforts, some successful, to procure nuclear related and dual-use equipment and materials by military-related individuals and entities.
    II. Efforts to develop undeclared pathways for the production of nuclear material.

III. The acquisition of nuclear weapons development information and the documentation from a clandestine nuclear supply network.

IV. Work on the development of indigenous nuclear weapon design, including the testing of components.

In all, this section of the report states that the Agency has "serious concerns regarding possible military dimensions to Iran's nuclear program."

- **Figure IV.58** provides a historical overview of the possible military dimensions of Iran's nuclear program. It reveals that the IAEA discovered that the Iran's program has roots going back nearly 40 years, and that it has had ongoing undeclared R&D into nuclear testing, experimentation, uranium conversion, enrichment, fabrication, and irradiation activities, including the separation of plutonium. Moreover, it reports that Iran admitted to engaging in undeclared activities at clandestine locations, and procured nuclear material via a clandestine supply network.

  Iran has further acknowledged that it received a package of information related to centrifuge enrichment technology that also included a 15-page document which describes processes for the conversion of uranium fluoride compounds into uranium metal and the production of hemispherical enriched uranium metallic components, which are integral in the construction of a rudimentary fission device.

  This portion of the report also indicates that between 2007 and 2010, Iran continued to conceal nuclear activities by not informing the Agency in a timely manner of the decision to construct or to authorize construction of a new nuclear power plant at Darkhovin, as well as a third enrichment facility near Qom (known throughout this text as the Fordow Fuel Enrichment Plant, or FFEP).

- **Figure IV.59** reflects what the IAEA believes to be the structure of Iran's nuclear production, which is thought to involve the participation of a number of research centers, government bodies, universities, and committees, all of which operate under the Ministry of Defense Armed Forces Logistics (MODAFL). Moreover, it indicates that the program's nuclear activity was consolidated under the AMAD Plan in the late 1990s and early 2000s, although it was halted in 2003.

  The report further indicates that some activities previously carried out under the AMAD Plan were resumed later, and that Mohsen Fakhrizadeh, the former Executive Officer of the AMAD Plan, retained the principal organizational role. He served in this capacity under a new organization known as the Section for Advanced Development Applications and Technologies (SADAT), which continued to report to MODAFL, and later, in mid-2008, as the head of the Malek Ashtar University of Technology (MUT) in Tehran. Fakhrizadeh now leads the Organization of Defensive Innovation and Research. Lastly, the Agency stresses that some his "activities undertaken after 2003 would be highly relevant to a nuclear weapon program."

- **Figure IV.60** provides the IAEA's knowledge of Iran's nuclear procurement activities relevant to nuclear weapons production, many of which were allegedly undertaken by private front companies. For instance, Kimia Maadan, a private Iranian company, was a company for chemical engineering operations under the AMAD Plan, while also being used to help with procurement for the Atomic Energy Organization of Iran (AEOI).

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

- **Figure IV.61** describes the IAEA's knowledge of Iran's attempts to acquire nuclear material relevant to nuclear weapons production, and states that "Iran was working on a project to secure a source of uranium suitable for use in an undisclosed enrichment program, the product of which would be converted into metal for use in the new warhead which was the subject of missile re-entry studies."

  It also emphasizes that Iran only declared a number of facilities once the IAEA was made aware of their existence by sources other than Iran. Taken with Iran's additional past efforts to conceal nuclear activity,

this reality creates more concern about the possible existence of further undeclared nuclear facilities, material, and activities in Iran.

- **Figure IV.62** provides the IAEA's analysis of Iran's alleged ongoing efforts to acquire nuclear components for use in an explosive device. It reiterates that Iran received documents that describe the processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components, which are integral in the production of a rudimentary fission device.

  Furthermore, it goes on to state that the "uranium metal document is known to have been available to the clandestine nuclear supply network that provided Iran with assistance in developing its centrifuge enrichment capability, and is also known to be part of a larger package of information which includes elements of a nuclear explosive design. A similar package of information, which surfaced in 2003, was provided by the same network to Libya. The information in the Libyan package, which was first reviewed by Agency experts in January 2004, included details on the design and construction of, and the manufacture of components for, a nuclear device." Such a document would likely provide Iran with the technical guidance necessary to build a nuclear weapon.

  Additionally, the Agency indicates that during a 2007 interview with a member of Iran's clandestine supply network, it was told that Iran had been provided with nuclear explosive design information. Lastly, this portion of the report stresses that the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004.

- **Figure IV.63** discusses the IAEA's knowledge of Iran's R&D into and acquisition of "safe, fast-acting detonators, and equipment suitable for firing the detonators," an integral component to constructing an implosion type nuclear device. It indicates that the Agency discovered that Iran had developed fast-functioning detonators known as "exploding bridgewire detonators" (EBWs) during the period 2002-2003 as safe alternatives to previous detonator technology it had developed.

  Moreover, in 2008, Iran told the Agency that before the period 2002-2004, it had already achieved EBW technology. It also provided the Agency with a short, undated document in Persian, which was understood to be the specifications for a detonator development program, and a document from a foreign source that showed the example of a civilian application in which detonators fired simultaneously. Iran, however, has not explained its own need or application for such detonators.

- **Figure IV.64** describes development of a multipoint initiation system, which is used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density. As such, it is a vital component of a fission weapon. According to the Agency, Iran has had access to information on the design concept of a multipoint initiation system that can be used to initiate a high explosive charge over its surface effectively and simultaneously. This information was reportedly supplied to the IAEA by a Member State.

  According to the Agency, "information provided to the Agency by the same Member State referred to in the previous paragraph describes the multipoint initiation concept referred to above as being used by Iran in at least one large scale experiment in 2003 to initiate a high explosive charge in the form of a hemispherical shell. According to that information, during that experiment, the internal hemispherical curved surface of the high explosive charge was monitored using a large number of optical fiber cables, and the light output of the explosive upon detonation was recorded with a high speed streak camera. It should be noted that the dimensions of the initiation system and the explosives used with it were consistent with the dimensions for the new payload which, according to the alleged studies documentation, were given to the engineers who were studying how to integrate the new payload into the chamber of the Shahab 3 missile re-entry vehicle (Project 111) (see Section C.11 below). Further information provided to the Agency by the same Member State indicates that the large scale high explosive experiments were conducted by Iran in the region of Marivan.

  The Agency has strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin. The Agency has reviewed publications by this foreign expert

and has met with him. The Agency has been able to verify through three separate routes, including the expert himself, that this person was in Iran from about 1996 to about 2002, ostensibly to assist Iran in the development of a facility and techniques for making ultra-dispersed diamonds ("UDDs" or "nanodiamonds"), where he also lectured on explosion physics and its applications."

Lastly, this portion of the report states that Iran has engaged in experimental research involving a scaled down version of the hemispherical initiation system and high explosive charged used to detonate an implosion type nuclear weapon. This technology is critical to the construction of a functioning implosion type device. Iran has not been willing to engage the Agency regarding this activity.

- **Figure IV.65** discusses Iran's efforts to evaluate the theoretical design of an implosion device using computer simulations, as well as high explosive tests referred to as "hydrodynamic experiments" in which fissile and nuclear components may be replaced with surrogate materials.

  According to information provided to the IAEA by Member States, some of which the Agency has been able to examine directly, indicates that Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten." Such experiments have also been linked to experiments involving the use of high-speed diagnostic equipment, including flash X-ray, to monitor the symmetry of the compressive shock of the simulated core of an explosive device. Such experiments would have little, if any, civilian application, and represent a serious source of concern regarding the potential weaponization of Iran's nuclear program.

- **Figure IV.66** provides an overview of the IAEA's knowledge of Iran's studies that focus on the "modelling of spherical geometries, consisting of components of the core of a HEU nuclear device subjected to shock compression, for their neutronic behavior at high density, and a determination of the subsequent nuclear explosive yield." Moreover, the Agency has acquired information that indicates Iran has conducted studies and done calculations relating to the state of criticality of a solid sphere of uranium being compressed by high explosives. Such efforts provide an additional indication of the potential weaponization of Iran's nuclear program.

- **Figure IV.67** discusses Iran's research and development into neutron initiators, which, "if placed in the center of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction." Iran has yet to explain its objectives and capabilities in this field.

- **Figure IV.68** discusses what the IAEA perceives as Iran's efforts to "have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device." It also indicates that these efforts directly reflect those undertaken by declared nuclear-weapon states. These indicators could perhaps point to a potential Iranian nuclear weapons test in the future.

- **Figure IV.69** reflects what the IAEA perceives as a structured Iranian program to carry out "engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile." Such explorations into warhead development provide a key indicator that Iran's program is military in nature.

- **Figure IV.70** describes Iran's efforts at developing "a prototype firing system that would enable the payload [a nuclear warhead on a Shahab 3 missile] to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground." It presents further indication that Iran is at least considering the possibility of installing nuclear warheads on its existing arsenal of Shahab 3 missiles.

- **Figure IV.71** provides an overview of the different bodies and projects that constitute the Iranian nuclear program (according to the IAEA).

- **Figure IV.72** provides an analysis of the likely payload of an Iranian missile, given the above indicators. It shows that Iran's R&D into its ballistic missile and nuclear programs reflect a probable effort to develop both nuclear warheads and an effective delivery vehicle thereof.

The IAEA report provides some insight into the foreign sources that supplied Iran with nuclear equipment and technical know-how. One of these sources is referred to in the document as a

"clandestine nuclear supply network," purported to be the now-disbanded A.Q. Khan network. According to the report, Iran admittedly had contact with the network in the late 1980s and early 1990s. The document also asserts that this network supplied Iran with technical know-how regarding the production of neutron initiators and spherical hemispherical enriched uranium metallic component, neither of which have any real civilian application.

According to the IAEA, Iran admitted to having received a 15-page document that provided detailed instructions for the construction of components critical to building a nuclear device. This document, known as the "uranium metal document" was also provided to Libya, and is known to have been part of a larger package of information that includes elements of a nuclear explosive design.[35] Given the circumstances surrounding Iran's acquisition of the document as well as the well-known role the A.Q. Khan network played in jump-starting nuclear weapons programs in Pakistan, Libya, and North Korea, it remains doubtful that Iran's program is purely peaceful.

The IAEA's report of November 8, 2011 also states that there are "strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin."[36]

The ISIS identifies this individual as former Soviet weapons engineer Vyacheslav Danilenko. According to the IAEA, Danilenko worked in Iran from 1996 to 2002, returning to Russia in 2002.[37] Moreover, given the small size and sophistication of a multipoint initiation system the IAEA observed in Iran in 2004, it was likely to have been developed using Danilenko's expertise as a springboard.[38] Iran's strides in detonator technology are, in all likelihood, the result of Danilenko's technical expertise.

This report provides the most detailed and convincing evidence of the probable weaponization of Iran's nuclear program to date; Iran's R&D into detonator technology, multipoint initiation systems, neutron initiators, and the construction of what appears to be a nuclear missile warhead leave little room for doubt. Although it is impossible to know Iran's intentions with certainty, these indicators, Iran's efforts to accelerate its production of HEU, and its lack of cooperation

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[35] Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[36] Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[37] ISIS Report. "Iran's Work and Foreign Assistance on a Multipoint Initiation System for a Nuclear Weapon." David Albright, Paul Brannan, Mark Gorwitz, and Andrea Strick. November 13, 2011. http://isis-online.org/uploads/isis-reports/documents/Foreign_Assistance_Multipoint_Initiation_System_14Nov2011.pdf

[38] ISIS Report. "Iran's Work and Foreign Assistance on a Multipoint Initiation System for a Nuclear Weapon." David Albright, Paul Brannan, Mark Gorwitz, and Andrea Strick. November 13, 2011. http://isis-online.org/uploads/isis-reports/documents/Foreign_Assistance_Multipoint_Initiation_System_14Nov2011.pdf

with the international community regarding said matters provide strong evidence that Iran either seeks to build a nuclear explosive device, or achieve the ability to do so.

Figure IV.55: IAEA Report of November 8, 2011 – Heavy Water Production

Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran has not suspended work on all heavy water related projects, including the construction of the heavy water moderated research reactor, the Iran Nuclear Research Reactor (IR-40 Reactor), which is subject to Agency safeguards.

On 17 October 2011, the Agency carried out a DIV at the IR-40 Reactor at Arak and observed that construction of the facility was ongoing and the coolant heat exchangers had been installed. According to Iran, the operation of the IR-40 Reactor is planned to commence by the end of 2013.

Since its visit to the Heavy Water Production Plant (HWPP) on 17 August 2011, the Agency, in a letter to Iran dated 20 October 2011, requested further access to HWPP. The Agency has yet to receive a reply to that letter, and is again relying on satellite imagery to monitor the status of HWPP. Based on recent images, the HWPP appears to be in operation. To date, Iran has not provided the Agency access to the heavy water stored at the Uranium Conversion Facility (UCF) in order to take samples.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.56: IAEA Report of November 8, 2011 – Uranium Conversion Facility

Although it is obliged to suspend all enrichment related activities and heavy water related projects, Iran is conducting a number of activities at UCF and the Fuel Manufacturing Plant (FMP) at Esfahan that, as described below, are in contravention of those obligations, although both facilities are under Agency safeguards.

Uranium Conversion Facility: On 18 October 2011, the Agency carried out a DIV at UCF during which the Agency observed the ongoing installation of the process equipment for the conversion of UF6 enriched up to 20% U-235 into U3O8. During the DIV, Iran informed the Agency that the initial tests of this conversion line, originally scheduled to start on 6 September 2011, had been postponed and would not involve the use of nuclear material.

As previously reported, Iran informed the Agency in July 2011 that it would start R&D activities at UCF for the conversion of UF6 enriched up to 5% U-235 into UO2. During the aforementioned DIV, Iran informed the Agency that 6.8 kg of DU in the form of UF6 had been processed and that Iran had produced 113 g of uranium in the form of UO2 that met its specifications. According to Iran, this UO2 has been sent to FMP to produce test pellets. Iran has also started using UF6 enriched to 3.34% U-235 to produce UO2. During the DIV, Iran further informed the Agency that this UO2 would also be sent to FMP to produce fuel pellets, which would then be sent to TRR for "performance test studies".

In a letter dated 4 October 2011, Iran informed the Agency of the postponement of the production of natural UF6, involving the use of uranium ore concentrate (UOC) produced at the Bandar Abbas Uranium Production Plant, originally scheduled to restart on 23 October 2011. In a letter dated 11 October 2011, Iran informed the Agency that, from 11 November 2011, it intended to use UOC produced at the Bandar Abbas Uranium Production Plant for the production of natural uranium in the form of UO2. During the DIV on 18 October 2011, the Agency took a sample of this UOC.

During the same DIV, Iran informed the Agency that, since 23 July 2011, it had fed into the process 958.7 kg of uranium in the form of UOC31 and produced about 185.6 kg of natural uranium in the form of UO2, and further indicated that some of the product had been fed back into the process. In a letter dated 8 October 2011, Iran informed the Agency that it had transferred about 1 kg of this UO2 to the R&D section of FMP in order to "conduct research activities and pellet fabrication."

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.57: IAEA Report of November 8, 2011 – Possible Military Dimensions

Previous reports by the Director General have identified outstanding issues related to possible military dimensions to Iran's nuclear program and actions required of Iran to resolve these. Since 2002, the Agency has become increasingly concerned about the possible existence in Iran of undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile, about which the Agency has regularly received new information.
In resolution 1929 (2010), the Security Council reaffirmed Iran's obligations to take the steps required by the Board of Governors in its resolutions GOV/2006/14 and GOV/2009/82, and to cooperate fully with the Agency on all outstanding issues, particularly those which give rise to concerns about the possible military dimensions to Iran's nuclear program, including by providing access without delay to all sites, equipment, persons and documents requested by the Agency. Since August 2008, Iran has not engaged with the Agency in any substantive way on this matter.

The Director General, in his opening remarks to the Board of Governors on 12 September 2011, stated that in the near future he hoped to set out in greater detail the basis for the Agency's concerns so that all Member States would be kept fully informed. In line with that statement, the Annex to this report provides a detailed analysis of the information available to the Agency to date which has given rise to concerns about possible military dimensions to Iran's nuclear program.

The analysis itself is based on a structured and systematic approach to information analysis which the Agency uses in its evaluation of safeguards implementation in all States with comprehensive safeguards agreements in force. This approach involves, inter alia, the identification of indicators of the existence or development of the processes associated with nuclear-related activities, including weaponization.

The information that serves as the basis for the Agency's analysis and concerns, as identified in the Annex, is assessed by the Agency to be, overall, credible. The information comes from a wide variety of independent sources, including from a number of Member States, from the Agency's own efforts and from information provided by Iran itself. It is consistent in terms of technical content, individuals and organizations involved, and time frames.

The information indicates that Iran has carried out the following activities that are relevant to the development of a nuclear explosive device:

- Efforts, some successful, to procure nuclear related and dual use equipment and materials by military related individuals and entities (Annex, Sections C.1 and C.2);
- Efforts to develop undeclared pathways for the production of nuclear material (Annex, Section C.3);
- The acquisition of nuclear weapons development information and documentation from a clandestine nuclear supply network (Annex, Section C.4); and
- Work on the development of an indigenous design of a nuclear weapon including the testing of components (Annex, Sections C.5–C.12).

Summary of Concerns: While the Agency continues to verify the non-diversion of declared nuclear material at the nuclear facilities and LOFs declared by Iran under its Safeguards Agreement, as Iran is not providing the necessary cooperation, including by not implementing its Additional Protocol, the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.
The Agency has serious concerns regarding possible military dimensions to Iran's nuclear
program. After assessing carefully and critically the extensive information available to it, the Agency finds the information to be, overall, credible. The information indicates that Iran has carried out activities relevant to the development of a nuclear explosive device. The information also indicates that prior to the end of 2003, these activities took place under a structured program, and that some activities may still be ongoing.

Given the concerns identified above, Iran is requested to engage substantively with the Agency without delay for the purpose of providing clarifications regarding possible military dimensions to Iran's nuclear program as identified in the Annex to this report.

The Agency is working with Iran with a view to resolving the discrepancy identified during the recent PIV at JHL.

The Director General urges Iran, as required in the binding resolutions of the Board of Governors and mandatory Security Council resolutions, to take steps towards the full implementation of its Safeguards Agreement and its other obligations, including: implementation of the provisions of its Additional Protocol; implementation of the modified Code 3.1 of the Subsidiary Arrangements General Part to its Safeguards Agreement; suspension of enrichment related activities; suspension of heavy water related activities; and, as referred to above, addressing the Agency's serious concerns about possible military dimensions to Iran's nuclear program, in order to establish international confidence in the exclusively peaceful nature of Iran's nuclear program.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.58: IAEA Report of November 8, 2011 – Historical Overview of the Possible Military Dimensions of Iran's Nuclear Program

Since late 2002, the Director General has reported to the Board of Governors on the Agency's concerns about the nature of Iran's nuclear program. Such concerns coincided with the appearance in open sources of information that indicated that Iran was building a large underground nuclear related facility at Natanz and a heavy water production plant at Arak.

Between 2003 and 2004, the Agency confirmed a number of significant failures on the part of Iran to meet its obligations under its Safeguards Agreement with respect to the reporting of nuclear material, the processing and use of undeclared nuclear material and the failure to declare facilities where the nuclear material had been received, stored and processed.

Specifically, it was discovered that, as early as the late 1970s and early 1980s, and continuing into the 1990s and 2000s, Iran had used undeclared nuclear material for testing and experimentation in several uranium conversion, enrichment, fabrication and irradiation activities, including the separation of plutonium, at undeclared locations and facilities.

In October 2003, Iran informed the Director General that it had adopted a policy of full disclosure and had decided to provide the Agency with a full picture of its nuclear activities. Following that announcement, Iran granted the Agency access to locations the Agency requested to visit, provided information and clarifications in relation to the origin of imported equipment and components and made individuals available for interviews. It also continued to implement the modified Code 3.1 of the Subsidiary Arrangements General Part, to which it agreed in February 2003, which provides for the submission of design information on new nuclear facilities as soon as the decision to construct or to authorize construction of such a facility is taken. In November 2003, Iran announced its intention to sign an Additional Protocol to its Safeguards Agreement (which it did in December 2003 following Board approval of the text), and that, prior to its entry into force, Iran would act in accordance with the provisions of that Protocol.

Between 2003 and early 2006, Iran submitted inventory change reports, provided design information with respect to facilities where the undeclared activities had taken place and made nuclear material available for Agency verification. Iran also acknowledged that it had utilized entities with links to the Ministry of Defence in some of its previously undeclared activities.

Iran acknowledged that it had had contacts with intermediaries of a clandestine nuclear supply network in 1987 and the early 1990s, and that, in 1987, it had received a handwritten one page document offering assistance with the development of uranium centrifuge enrichment technology, in which reference was also made to a reconversion unit with casting equipment. Iran further acknowledged that it had received a package of information related to centrifuge enrichment technology that also included a 15 page document (hereafter referred to as the "uranium metal document") which Iran said it did not ask for and which describes, inter alia, processes for the conversion of uranium fluoride compounds into uranium metal and the production of hemispherical enriched uranium metallic components.

The Agency continued to seek clarification of issues with respect to the scope and nature of Iran's nuclear program, particularly in light of Iran's admissions concerning its contacts with the clandestine nuclear supply network, information provided by participants in that network and information which had been provided to the Agency by a Member State. This last information, collectively referred to as the "alleged studies documentation", which was made known to the Agency in 2005, indicated that Iran had been engaged in activities involving studies on a so-called green salt project, high explosives testing and the re-engineering of a missile re-entry vehicle to accommodate a new payload. All of this information, taken together, gave rise to concerns about possible military dimensions to Iran's nuclear program.

In August 2007, Iran and the Agency agreed on "Understandings of the Islamic Republic of Iran and the IAEA on the Modalities of Resolution of the Outstanding Issues" (generally referred to as the "work plan") (INFCIRC/711). By February 2008, the four items identified in the work plan as "past outstanding issues", and the two items identified as "other outstanding issues", had been determined by the Agency to be either closed, completed or no longer outstanding. The remaining issues which needed to be clarified by Iran related to the alleged studies, together with other matters which had arisen in the course of resolving the six other issues and which needed to be addressed in connection with the alleged studies, specifically: the circumstances of Iran's acquisition of the uranium metal document, procurement and research and development (R&D) activities of military related institutes and companies that could be nuclear related; and the production of nuclear equipment and components by companies belonging to defense industries.

Between February and May 2008, pursuant to the work plan, the Agency shared with Iran information (including documentation) on the alleged studies, and sought clarifications from Iran. In May 2008, Iran submitted to the Agency a 117 page assessment of that information. While Iran confirmed the veracity of some of the information that the Agency had shared with it (such as acknowledgement of names of people, places and organizations), Iran's assessment was focused on deficiencies in form and format, and dismissed the allegations as having been based on "forged" documents and "fabricated" data.

The Agency continued to receive additional information from Member States and acquired new information as a result of its own efforts. The Agency tried without success to engage Iran in discussions about the information, and finally wrote to Iran in October 2010 to inform it about this additional information.

Between 2007 and 2010, Iran continued to conceal nuclear activities, by not informing the Agency in a timely manner of the decision to construct or to authorize construction of a new nuclear power plant at Darkhovin and a third enrichment facility near Qom (the Fordow Fuel Enrichment Plant). The Agency is still awaiting substantive responses from Iran to Agency requests for further information about its announcements, in 2009 and 2010 respectively, that it had decided to construct ten additional enrichment facilities (the locations for five of which had already been identified) and that it possessed laser enrichment technology.

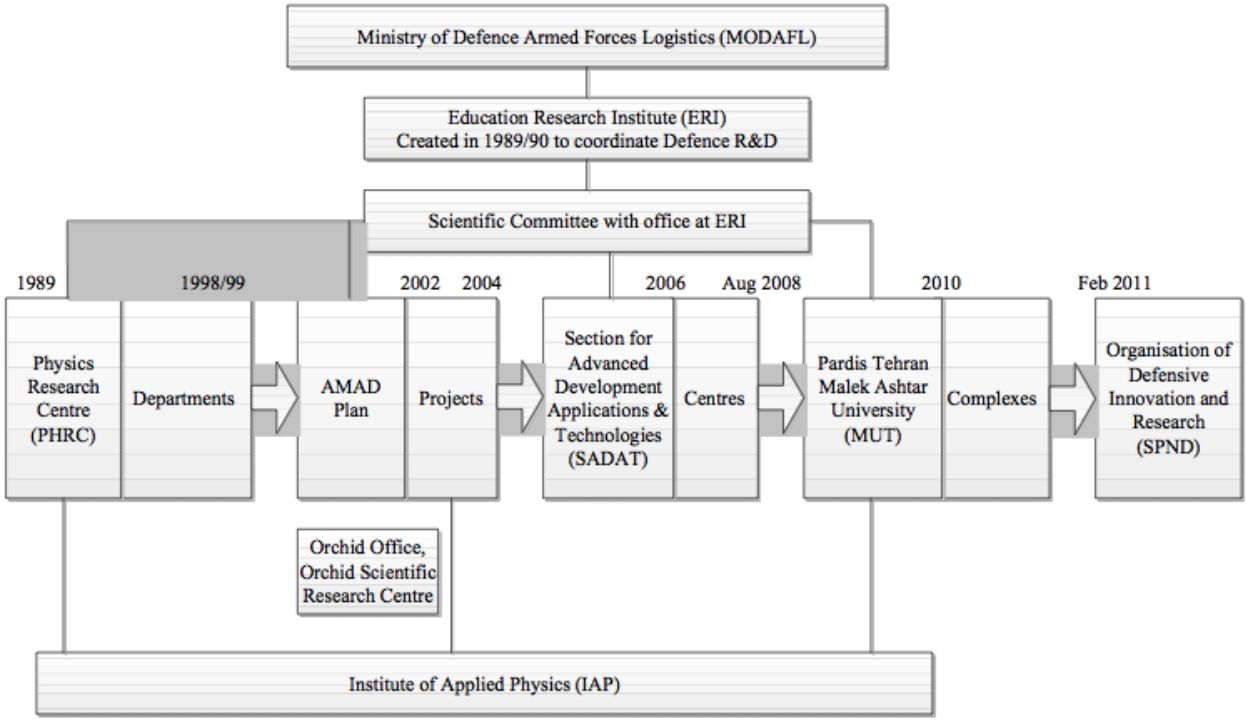
The Agency has continued to receive, collect and evaluate information relevant to possible military dimensions to Iran's nuclear program. As additional information has become available to the Agency, the Agency has been able, notwithstanding Iran's lack of engagement, to refine its analysis of possible military dimensions to Iran's nuclear program.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.59: IAEA Report of November 8, 2011 – Program Management Structure

The Agency has been provided with information by Member States which indicates that the activities referred to in Sections C.2 to C.12 were, at least for some significant period of time, managed through a program structure, assisted by advisory bodies, and that, owing to the importance of these efforts, senior Iranian figures featured within this command structure. From analysis of this information and information provided by Iran, and through its own endeavors, the Agency has been able to construct what it believes to be a good understanding of activities undertaken by Iran prior to the end of 2003. **The Agency's ability to construct an equally good understanding of activities in Iran after the end of 2003 is reduced, due to the more limited information available to the Agency.** For ease of reference, the figure below depicts, in summary form, what the Agency understands of the program structure, and administrative changes in that structure over the years. Attachment 1 to this Annex provides further details, derived from that information, about the organizational arrangements and projects within that program structure.



The Agency received information from Member States which indicates that, sometime after the commencement by Iran in the late 1980s of covert procurement activities, organizational structures and administrative arrangements for an undeclared nuclear program were established and managed through the Physics Research Centre (PHRC), and were overseen, through a Scientific Committee, by the Defence Industries Education Research Institute (ERI), established to coordinate defense R&D for the Ministry of Defence Armed Forces Logistics (MODAFL). Iran has confirmed that the PHRC was established in 1989 at Lavisan-Shian, in Tehran. Iran has stated that the PHRC was created with the purpose of "preparedness to combat and neutralization of casualties due to nuclear attacks and accidents (nuclear defense) and also support and provide scientific advice and services to the Ministry of Defence". Iran has stated further that those activities were stopped in 1998. In late 2003/early 2004, Iran completely cleared the site.

According to information provided by Member States, by the late 1990s or early 2000s, the PHRC activities were consolidated under the "AMAD Plan". Mohsen Fakhrizadeh (Mahabadi) was the Executive Officer of the AMAD Plan, the executive affairs of which were performed by the "Orchid Office". Most of the activities carried out under the AMAD Plan appear to have been conducted during 2002 and 2003.

The majority of the details of the work said to have been conducted under the AMAD Plan come from the alleged studies documentation which, as indicated in paragraph 6 above, refer to studies conducted in three technical areas: the green salt project; high explosives (including the development of exploding bridgewire detonators); and re-engineering of the payload chamber of the Shahab 3 missile re-entry vehicle.

According to the Agency's assessment of the information contained in that documentation, the green salt project (identified as Project 5.13) was part of a larger project (identified as Project 5) to provide a source of uranium suitable for use in an undisclosed enrichment program. The product of this program would be converted into metal for use in the new warhead which was the subject of the missile re-entry vehicle studies (identified as Project 111). As of May 2008, the Agency was not in a position to demonstrate to Iran the connection between Project 5 and Project 111. However, subsequently, the Agency was shown documents which established a connection between Project 5 and Project 111, and hence a link between nuclear material and a new payload development program.

Information the Agency has received from Member States indicates that, owing to growing concerns about the international security situation in Iraq and neighboring countries at that time, work on the AMAD Plan was stopped rather abruptly pursuant to a "halt order" instruction issued in late 2003 by senior Iranian officials. According to that information, however, staff remained in place to record and document the achievements of their respective projects. Subsequently, equipment and work places were either cleaned or disposed of so that there would be little to identify the sensitive nature of the work which had been undertaken.

The Agency has other information from Member States which indicates **that some activities previously carried out under the AMAD Plan were resumed later, and that Mr. Fakhrizadeh retained the principal organizational role, first under a new organization known as the Section for Advanced Development Applications and Technologies (SADAT), which continued to report to MODAFL, and later, in mid-2008, as the head of the Malek Ashtar University of Technology (MUT) in Tehran.** The Agency has been advised by a Member State that, in February 2011, Mr. Fakhrizadeh moved his seat of operations from MUT to an adjacent location known as the Modjeh Site, and that he now leads the Organization of Defensive Innovation and Research. The Agency is concerned because some of the activities undertaken after 2003 would be highly relevant to a nuclear weapon program.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.60: IAEA Report of November 8, 2011 – Procurement Activities

Under the AMAD Plan, Iran's efforts to procure goods and services allegedly involved a number of ostensibly private companies which were able to provide cover for the real purpose of the procurements. The Agency has been informed by several Member States that, for instance, Kimia Maadan was a cover company for chemical engineering operations under the AMAD Plan while also being used to help with procurement for the Atomic Energy Organization of Iran (AEOI).

In addition, throughout the entire timeline, instances of procurement and attempted procurement by individuals associated with the AMAD Plan of equipment, materials and services which, although having other civilian applications, would be useful in the development of a nuclear explosive device, have either been uncovered by the Agency itself or been made known to it.

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

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.61: IAEA Report of November 8, 2011 – Nuclear Material Acquisition

In 2008, the Director General informed the Board that: it had no information at that time — apart from the uranium metal document — on the actual design or manufacture by Iran of nuclear material components of a nuclear weapon or of certain other key components, such as initiators, or on related nuclear physics studies, and that it had not detected the actual use of nuclear material in connection with the alleged studies.

However, as indicated in paragraph 22 above, **information contained in the alleged studies documentation suggests that Iran was working on a project to secure a source of uranium suitable for use in an undisclosed enrichment program, the product of which would be converted into metal for use in the new warhead which was the subject of the missile re-entry vehicle studies.**

Additional information provided by Member States indicates that, although uranium was not used, kilogram quantities of natural uranium metal were available to the AMAD Plan.

Information made available to the Agency by a Member State, which the Agency has been able to examine directly, indicates that Iran made progress with experimentation aimed at the recovery of uranium from fluoride compounds (using lead oxide as a surrogate material to avoid the possibility of uncontrolled contamination occurring in the workplace).

In addition, although now declared and currently under safeguards, a number of facilities dedicated to uranium enrichment (the Fuel Enrichment Plant and Pilot Fuel Enrichment Plant at Natanz and the Fordow Fuel Enrichment Plant near Qom) were covertly built by Iran and only declared once the Agency was made aware of their existence by sources other than Iran.

This, taken together with the past efforts by Iran to conceal activities involving nuclear material, create more concern about the possible existence of undeclared nuclear facilities and material in Iran.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011
http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.62: IAEA Report of November 8, 2011 – Nuclear Components for an Explosive Device

For use in a nuclear device, HEU retrieved from the enrichment process is first converted to metal. The metal is then cast and machined into suitable components for a nuclear core.

As indicated in paragraph 5 above, Iran has acknowledged that, along with the handwritten one page document offering assistance with the development of uranium centrifuge enrichment technology, in which reference is also made to a reconversion unit with casting equipment.

Iran also received the uranium metal document which describes, inter alia, processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components.

The uranium metal document is known to have been available to the clandestine nuclear supply network that provided Iran with assistance in developing its centrifuge enrichment capability, and is also known to be part of a larger package of information which includes elements of a nuclear explosive design.

A similar package of information, which surfaced in 2003, was provided by the same network to Libya. The information in the Libyan package, which was first reviewed by Agency experts in January 2004, included details on the design and construction of, and the manufacture of components for, a nuclear explosive device.

In addition, a Member State provided the Agency experts with access to a collection of electronic files from seized computers belonging to key members of the network at different locations. That collection included documents seen in Libya, along with more recent versions of those documents, including an up-dated electronic version of the uranium metal document.

In an interview in 2007 with a member of the clandestine nuclear supply network, the Agency was told that Iran had been provided with nuclear explosive design information. From information provided to the Agency during that interview, the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004 as having been provided to Libya by the nuclear supply network.

Additionally, a Member State provided information indicating that, during the AMAD Plan, preparatory work, not involving nuclear material, for the fabrication of natural and high enriched uranium metal components for a nuclear explosive device was carried out.

As the conversion of HEU compounds into metal and the fabrication of HEU metal components suitable in size and quality are steps in the development of an HEU nuclear explosive device, clarification by Iran is needed in connection with the above.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.63: IAEA Report of November 8, 2011 – Detonator Development

The development of safe, fast-acting detonators, and equipment suitable for firing the detonators, is an integral part of a program to develop an implosion type nuclear device. Included among the alleged studies documentation are a number of documents relating to the development by Iran, during the period 2002–2003, of fast functioning detonators, known as "exploding bridgewire detonators" or "EBWs" as safe alternatives to the type of detonator described for use in the nuclear device design referred to in paragraph 33 above.

In 2008, Iran told the Agency that it had developed EBWs for civil and conventional military applications and had achieved a simultaneity of about one microsecond when firing two to three detonators together, and provided the Agency with a copy of a paper relating to EBW development work presented by two Iranian researchers at a conference held in Iran in 2005.

A similar paper was published by the two researchers at an international conference later in 2005. Both papers indicate that suitable high voltage firing equipment had been acquired or developed by Iran. Also in 2008, Iran told the Agency that, before the period 2002–2004, it had already achieved EBW technology.

Iran also provided the Agency with a short undated document in Farsi, understood to be the specifications for a detonator development program, and a document from a foreign source showing an example of a civilian application in which detonators are fired simultaneously. However, Iran has not explained to the Agency its own need or application for such detonators.

The Agency recognizes that there exist non-nuclear applications, albeit few, for detonators like EBWs, and of equipment suitable for firing multiple detonators with a high level of simultaneity.

Notwithstanding, given their possible application in a nuclear explosive device, and the fact that there are limited civilian and conventional military applications for such technology, Iran's development of such detonators and equipment is a matter of concern, particularly in connection with the possible use of the multipoint initiation system referred to below.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.64: IAEA Report of November 8, 2011 – Initiation of High Explosives and Associated Experiments

Detonators provide point source initiation of explosives, generating a naturally diverging detonation wave. In an implosion type nuclear explosive device, an additional component, known as a multipoint initiation system, can be used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density.

The Agency has shared with Iran information provided by a Member State which indicates that Iran has had access to information on the design concept of a multipoint initiation system that can be used to initiate effectively and simultaneously a high explosive charge over its surface. The Agency has been able to confirm independently that such a design concept exists and the country of origin of that design concept. Furthermore, the Agency has been informed by nuclear-weapon States that the specific multipoint initiation concept is used in some known nuclear explosive devices. In its 117 page submission to the Agency in May 2008, Iran stated that the subject was not understandable to Iran and that Iran had not conducted any activities of the type referred to in the document.

Information provided to the Agency by the same Member State referred to in the previous paragraph describes the multipoint initiation concept referred to above as being used by Iran in at least one large scale experiment in 2003 to initiate a high explosive charge in the form of a hemispherical shell. According to that information, during that experiment, the internal hemispherical curved surface of the high explosive charge was monitored using a large number of optical fiber cables, and the light output of the explosive upon detonation was recorded with a high speed streak camera. It should be noted that the dimensions of the initiation system and the explosives used with it were consistent with the dimensions for the new payload which, according to the alleged studies documentation, were given to the engineers who were studying how to integrate the new payload into the chamber of the Shahab 3 missile re-entry vehicle (Project 111) (see Section C.11 below). Further information provided to the Agency by the same Member State indicates that the large scale high explosive experiments were conducted by Iran in the region of Marivan.

The Agency has strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin. The Agency has reviewed publications by this foreign expert and has met with him. The Agency has been able to verify through three separate routes, including the expert himself, that this person was in Iran from about 1996 to about 2002, ostensibly to assist Iran in the development of a facility and techniques for making ultra-dispersed diamonds ("UDDs" or "nanodiamonds"), where he also lectured on explosion physics and its applications.

Furthermore, the Agency has received information from two Member States that, after 2003, Iran engaged in experimental research involving a scaled down version of the hemispherical initiation system and high explosive charge referred to in paragraph 43 above, albeit in connection with non-nuclear applications. This work, together with other studies made known to the Agency in which the same initiation system is used in cylindrical geometry, could also be relevant to improving and optimizing the multipoint initiation design concept relevant to nuclear applications.

The Agency's concern about the activities described in this Section derives from the fact that a multipoint initiation system, such as that described above, can be used in a nuclear explosive device. However, Iran has not been willing to engage in discussion of this topic with the Agency.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.65: IAEA Report of November 8, 2011 – Hydrodynamic Experiments

One necessary step in a nuclear weapon development program is determining whether a theoretical design of an implosion device, the behavior of which can be studied through computer simulations, will work in practice. To that end, high explosive tests referred to as "hydrodynamic experiments" are conducted in which fissile and nuclear components may be replaced with surrogate materials.

Information which the Agency has been provided by Member States, some of which the Agency has been able to examine directly, indicates that Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten. These components were said to have incorporated small central cavities suitable for the insertion of capsules such as those described in Section C.9 below. The end use of such components remains unclear, although they can be linked to other information received by the Agency concerning experiments **involving the use of high speed diagnostic equipment, including flash X ray, to monitor the symmetry of the compressive shock of the simulated core of a nuclear device.**

Other information which the Agency has been provided by Member States indicates that Iran constructed a large explosives containment vessel in which to conduct hydrodynamic experiments. The explosives vessel, or chamber, is said to have been put in place at Parchin in 2000. A building was constructed at that time around a large cylindrical object at a location at the Parchin military complex. A large earth berm was subsequently constructed between the building containing the cylinder and a neighboring building, indicating the probable use of high explosives in the chamber. The Agency has obtained commercial satellite images that are consistent with this information. From independent evidence, including a publication by the foreign expert referred to in paragraph 44 above, the Agency has been able to confirm the date of construction of the cylinder and some of its design features (such as its dimensions), and that it was designed to contain the detonation of up to 70 kilograms of high explosives, which would be suitable for carrying out the type of experiments described in paragraph 43 above.

As a result of information the Agency obtained from a Member State in the early 2000s alleging that Iran was conducting high explosive testing, possibly in association with nuclear materials, at the Parchin military complex, the Agency was permitted by Iran to visit the site twice in 2005. From satellite imagery available at that time, the Agency identified a number of areas of interest, none of which, however, included the location now believed to contain the building which houses the explosives chamber mentioned above; consequently, the Agency's visits did not uncover anything of relevance.

Hydrodynamic experiments such as those described above, which involve high explosives in conjunction with nuclear material or nuclear material surrogates, are strong indicators of possible weapon development. In addition, the use of surrogate material, and/or confinement provided by a chamber of the type indicated above, could be used to prevent contamination of the site with nuclear material. It remains for Iran to explain the rationale behind these activities.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.66: IAEA Report of November 8, 2011 – Modeling and Calculations

Information provided to the Agency by two Member States relating to modeling studies alleged to have been conducted in 2008 and 2009 by Iran is of particular concern to the Agency. According to that information, the studies involved the modeling of spherical geometries, consisting of components of the core of an HEU nuclear device subjected to shock compression, for their neutronic behavior at high density, and a determination of the subsequent nuclear explosive yield.

The information also identifies models said to have been used in those studies and the results of these calculations, which the Agency has seen. The application of such studies to anything other than a nuclear explosive is unclear to the Agency. It is therefore essential that Iran engage with the Agency and provide an explanation.

The Agency obtained information in 2005 from a Member State indicating that, in 1997, representatives from Iran had met with officials from an institute in a nuclear-weapon State to request training courses in the fields of neutron cross section calculations using computer codes employing Monte Carlo methodology, and shock wave interactions with metals.

In a letter dated 14 May 2008, Iran advised the Agency that there was nothing to support this information. The Agency has also been provided with information by a Member State indicating that, in 2005, arrangements were made in Iran for setting up projects within SADAT centers (see Section C.1 and Attachment 1), inter alia, to establish a databank for "equation of state" information and a hydrodynamics calculation center.

The Agency has also been provided with information from a different Member State that, in 2005, a senior official in SADAT solicited assistance from Shahid Behesti University in connection with complex calculations relating to the state of criticality of a solid sphere of uranium being compressed by high explosives.

Research by the Agency into scientific literature published over the past decade has revealed that Iranian workers, in particular groups of researchers at Shahid Behesti University and Amir Kabir University, have published papers relating to the generation, measurement and modeling of neutron transport.

The Agency has also found, through open source research, other Iranian publications which relate to the application of detonation shock dynamics to the modelling of detonation in high explosives, and the use of hydrodynamic codes in the modelling of jet formation with shaped (hollow) charges. Such studies are commonly used in reactor physics or conventional ordnance research, but also have applications in the development of nuclear explosives.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.67: IAEA Report of November 8, 2011 – Neutron Initiator

The Agency has information from a Member State that Iran has undertaken work to manufacture small capsules suitable for use as containers of a component containing nuclear material. The Agency was also informed by a different Member State that Iran may also have experimented with such components in order to assess their performance in generating neutrons.

Such components, if placed in the center of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction.

The location where the experiments were conducted was said to have been cleaned of contamination after the experiments had taken place. The design of the capsule, and the material associated with it, are consistent with the device design information which the clandestine nuclear supply network allegedly provided to Iran.

The Agency also has information from a Member State that work in this technical area may have continued in Iran after 2004, and that Iran embarked on a four year program, from around 2006 onwards, on the further validation of the design of this neutron source, including through the use of a non- nuclear material to avoid contamination.

Given the importance of neutron generation and transport, and their effect on geometries containing fissile materials in the context of an implosion device, Iran needs to explain to the Agency its objectives and capabilities in this field.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.68: IAEA Report of November 8, 2011 – Conducting a Nuclear Test

The Agency has information provided by a Member State that Iran may have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device. In particular, the Agency has information that Iran has conducted a number of practical tests to see whether its EBW firing equipment would function satisfactorily over long distances between a firing point and a test device located down a deep shaft.

Additionally, among the alleged studies documentation provided by that Member State, is a document, in Farsi, which relates directly to the logistics and safety arrangements that would be necessary for conducting a nuclear test. The Agency has been informed by a different Member State that these arrangements directly reflect those which have been used in nuclear tests conducted by nuclear-weapon States.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.69: IAEA Report of November 8, 2011 – Integration into a Missile Delivery Vehicle

The alleged studies documentation contains extensive information regarding work which is alleged to have been conducted by Iran during the period 2002 to 2003 under what was known as Project 111. From that information, **the project appears to have consisted of a structured and comprehensive program of engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile.**

According to that documentation, using a number of commercially available computer codes, Iran conducted computer modeling studies of at least 14 **progressive design iterations of the payload chamber** and its contents to examine how they would stand up to the various stresses that would be encountered on being launched and travelling on a ballistic trajectory to a target. It should be noted that the masses and dimensions of components identified in information provided to the Agency by Member States that Iran is alleged to have been developing (see paragraphs 43 and 48 above) correspond to those assessed to have been used in Project 111 engineering studies on the new payload chamber.

During these studies, prototype components were allegedly manufactured at workshops known to exist in Iran but which Iran refused the Agency permission to visit. The six engineering groups said to have worked under Project 111 produced many technical reports, which comprise a substantial part of the alleged studies documentation. The Agency has studied these reports extensively and finds that they are both internally consistent and consistent with other supporting information related to Project 111.

The alleged studies documentation also shows that, as part of the activities undertaken within Project 111, consideration was being given to subjecting the prototype payload and its chamber to engineering stress tests to see how well they would stand up in practice to simulated launch and flight stresses (so-called "environmental testing"). This work would have complemented the engineering modeling simulation studies referred to in paragraph 60 above. According to the information reflected in the alleged studies documentation, within Project 111, some, albeit limited, preparations were also being undertaken to enable the assembly of manufactured components.

Iran has denied conducting the engineering studies, claiming that the documentation which the Agency has is in electronic format and so could have been manipulated, and that it would have been easy to fabricate. However, the quantity of the documentation, and the scope and contents of the work covered in the documentation, are sufficiently comprehensive and complex that, in the Agency's view, it is not likely to have been the result of forgery or fabrication. While the activities described as those of Project 111 may be relevant to the development of a non-nuclear payload, they are highly relevant to a nuclear weapon program.

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.70: IAEA Report of November 8, 2011 – Fusing, Arming, and Firing System

The alleged studies documentation indicates that, as part of the studies carried out by the engineering groups under Project 111 to integrate the new payload into the re-entry vehicle of the Shahab 3 missile, additional work was conducted on the development of a prototype firing system that would enable the payload to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground. Iran was shown this information, which, in its 117 page submission (referred to above in paragraph 8), it dismissed as being "an animation game".

The Agency, in conjunction with experts from Member States other than those which had provided the information in question, carried out an assessment of the possible nature of the new payload. As a result of that assessment, it was concluded that any payload option other than nuclear which could also be expected to have an airburst option (such as chemical weapons) could be ruled out. Iran was asked to comment on this assessment and agreed in the course of a meeting with the Agency which took place in Tehran in May 2008 that, if the information upon which it was based were true, it would constitute a program for the development of a nuclear weapon. Attachment 2 to this Annex reproduces the results of the Agency's assessment as it was presented by the Secretariat to the Member States in the technical briefing which took place in February 2008.

Source: IAEA*, Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011

http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.71: IAEA Report of November 8, 2011 – Departments, Projects, and Centers Relating to Iran's Nuclear Program

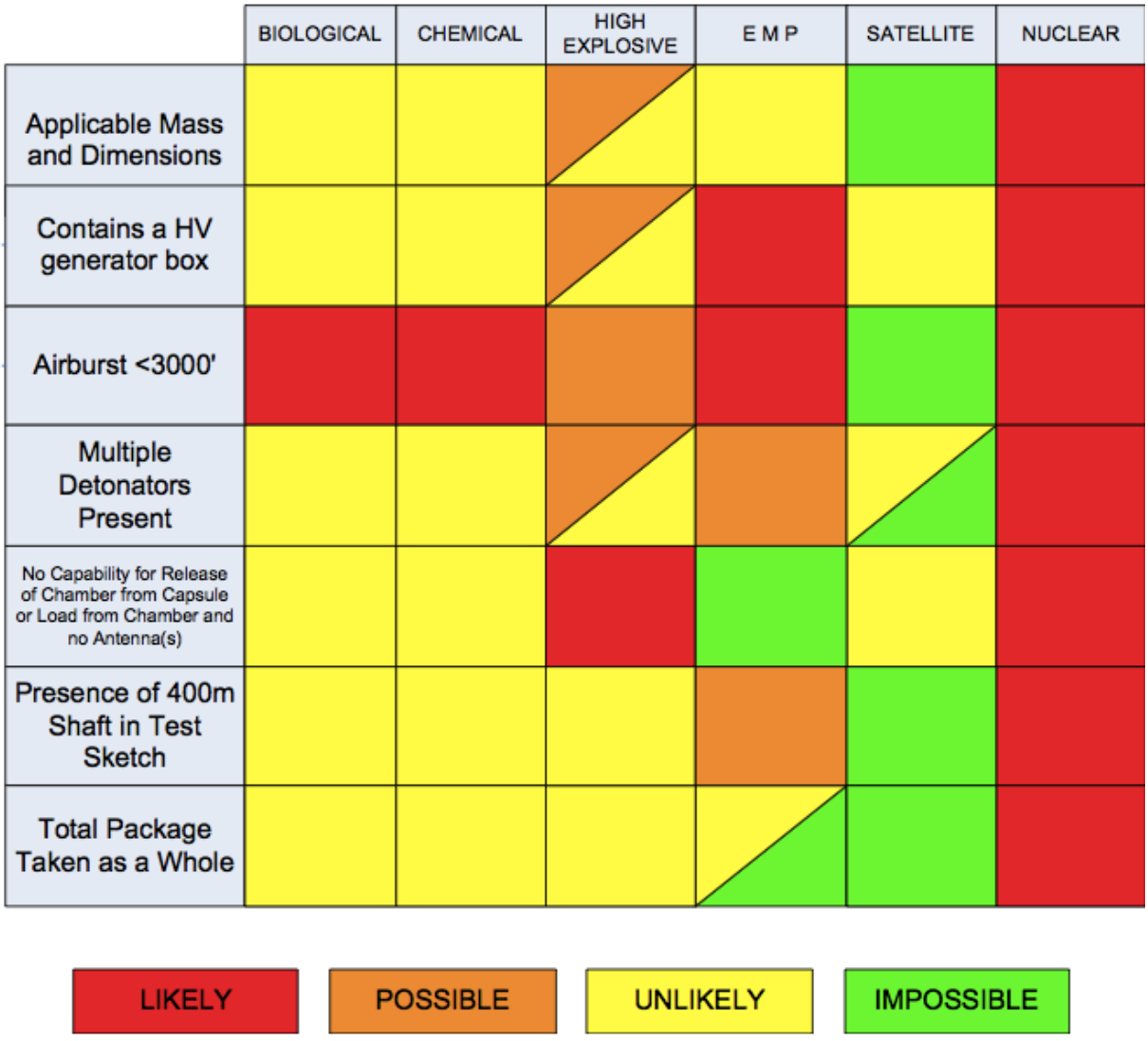
PHRC Departments	AMAD Plan Projects	SADAT Centers
Department 01: Nuclear Physics	Project 110: Payload Design	Center for Readiness & New Defense Technologies
Department 02: Centrifuge Enrichment	Project 111: Payload Integration	Center for R&D (1) of Explosion and Shock Technology
Department 03: Laser Enrichment	Project 3: Manufacture of Components 3.12: Explosives and EBW Detonator 3.14: Uranium Metallurgy	Center for Industrial Research & Construction
Department 04: Uranium Conversion	Project 4: Uranium Enrichment	Center for R&T (2) of Advanced Materials – Chemistry
Department 05: Geology	Project 5: Uranium Mining, Concentration, and Conversion 5.13: Green Salt Project 5.15: Gchine Mine Project	Center for R&T of New Aerospace Technology
Department 06: Health Physics	Projects 8, 9, and 10	Center for Laser and Phototonics Applications
Department 07: Workshop	Project Health and Safety	
Department 08: Heavy Water	Project 19: Involvement of IAP	
Department 09: Analytical Laboratory	Project/Group 117: Procurement and Supply	
Department 10: Computing		
Department 20: Analysis		

(1) R&D = Research & Development

(2) R&T = Research and Technology

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011 http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

Figure IV.72: IAEA Report of November 8, 2011 – Analysis of Payload



Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011 http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

US Official Views of Iran's Competition in Nuclear and Missile Efforts

The difficulties in measuring this aspect of US and Iranian military competition are compounded by the fact that there are serious limits to how much information US officials can disclose about official US estimates of Iran's nuclear programs, and how they affect US and Iranian military competition. The annual unclassified reports to Congress by the US Director of National Intelligence do, however, offer a cleared and coordinated overview of US perceptions – which now seems to track closely with the views of many European and Gulf officials and experts.

An unclassified March 2010 report produced by the Office of the Director of National Intelligence has been partly overtaken by the pace of Iran's rapidly developing program, but it still represents a useful unclassified national intelligence estimate of Iran's capabilities: [39]

Nuclear

We continue to assess Iran is keeping open the option to develop nuclear weapons though we do not know whether Tehran eventually will decide to produce nuclear weapons. Iran continues to develop a range of capabilities that could be applied to producing nuclear weapons, if a decision is made to do so.

During the reporting period, Iran continued to expand its nuclear infrastructure and continued uranium enrichment and activities related to its heavy water research reactor, despite multiple United Nations Security Council Resolutions since late 2006 calling for the suspension of those activities. Although Iran made progress in expanding its nuclear infrastructure during 2001, some obstacles slowed progress during this period.

• In 2009, Iran continued to make progress enriching uranium at the underground cascade halls at Natanz with first-generation centrifuges, and in testing and operating advanced centrifuges at the pilot plant there.

As of mid-November, Iran had produced about 1,800 kilograms of low-enriched uranium hexafluoride (LEUF6) gas product at Natanz, compared to 555 kilograms of LEUF6 in November 2008. Between January and November 2009, Iran increased the number of installed centrifuges from about 5,000 to about 8,700, but the number reported to be operating remains at about 3,000~100.

• In September, Iran disclosed that it was constructing a second gas-centrifuge uranium enrichment plant near the city of Qom that is designed to house approximately 3,000 centrifuges.

• Iran in 2009 continued construction of the IR-40 Heavy Water Research Reactor. Iran during National Nuclear Day inaugurated its fuel manufacturing plant and claimed to have manufactured a fuel assembly for the IR-40.

Iran in 2009 continued to make progress on completing its Bushehr Nuclear Power Plant but did not load fuel in the reactor. Iran currently plans to load fuel in the reactor in 2010.

[39] ODDNI, Report to Congress on Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, March 2010, http://www.dni.gov/reports/2009_721_Report.pdf

> Iran's Uranium Conversion Facility (UCF) at Esfahan shut down for maintenance in August and had not resumed UF6 production as of late October. International Atomic Energy Agency reports indicate Iran has almost exhausted its imported stockpile of yellowcake that may have contributed to its decision to extend the shutdown of the UCF.
>
> **Missiles**
>
> Iran has continued to develop its ballistic missile program that it views as its primary deterrent. Iran is fielding increased numbers of short- and medium-range ballistic missiles (SRBMs, MRBMs) and we judge that producing more capable MRBMs remains one of its highest priorities. Iran's ballistic missile inventory is one of the largest in the Middle East.
>
> In late November 2007, Iran's defense minister claimed Iran had developed a new 2,000 km-range missile called the Ashura. Iranian officials on 12 November 2008 claimed to have launched a two stage, solid propellant missile called the Sajjil with a range of 2,000 km. In 2009, Iran conducted three flight tests of this missile.
>
> As early as 2005, Iran stated its intentions to send its own satellites into orbit. As of January 2008, Tehran reportedly had allocated $250 million to build and purchase satellites. Iran announced it would launch four more satellites by 2010 to improve land and mobile telephone communications.
>
> Iran's President Ahmadinejad also announced Tehran would launch a "home- produced" satellite into orbit in 2008, and several Iranian news websites released photos of a new rocket called "Safic."
>
> In mid-August 2008, Iran first launched its Safir space launch vehicle, carrying the Omid satellite. Iran claimed the launch a success; however US officials believed the vehicle did not successfully complete its mission. Iran successfully launched the Omid satellite aboard the Safir 2 SLV in early February 2009 according to press reports.
>
> Russian entities at least in the past, have helped Iran move toward self-sufficiency in the production of ballistic missiles. Iran still remains dependent on foreign suppliers for some key missile components, however. Iran also has marketed for export at trade shows guidance components suitable for ballistic missiles.
>
> **Chemical and Biological**
>
> We assess that Iran maintains the capability to produce chemical warfare (CW) agents and conducts research that may have offensive applications. Tehran continues to seek dual-use technologies that could advance its capability to produce CW agents. We judge that Iran is capable of weaponizing CW agents in a variety of delivery systems.
>
> Iran probably has the capability to produce some biological warfare (BW) agents for offensive purposes, if it made the decision to do so. We assess that Iran has previously conducted offensive BW agent research and development. Iran continues to seek dual- use technologies that could be used for BW.

Clapper gave a less detailed statement to Congress on March 3, 2011, but noted that the US estimate of operating centrifuges had now risen to 4,100 in late 2010, and Iran had used them to produce over 3,000 kilograms of low enriched uranium. He also stated that the US intelligence community assessed that,[40]

> Iran is keeping open the option to develop nuclear weapons in part by developing various nuclear capabilities that better position it to produce such weapons, should it choose do so. We do not know, however, if Iran will eventually decide to build nuclear weapons…Iran is technically capable of producing enough highly enriched uranium for a weapon in the next few years, if it chooses to do so.

[40] James R. Clapper, "Statement for the Record on the Worldwide Threat Assessment of the US Intelligence Community for the Senate Committee on Armed Services, March 10, 2011.

> …We judge Iran would likely choose missile delivery as its preferred method of delivering a nuclear weapon. Iran already has the largest inventory of ballistic missiles in the Middle East. It continues to expand the scale, research, and sophistication of its ballistic missile forces, many of which are inherently capable of carrying a nuclear payload…Iran's growing inventory of ballistic missiles and its acquisition and indigenous production of anti-ship cruise missiles provide capabilities to enhance its power projection. Tehran views its conventionally armed missiles as an integral part of its strategy to deter – and if necessary retaliate against—forces in the region, including those of the US. Its ballistic missiles are inherently capable of delivering WMD, and if so armed, would fit into this same strategy.

Clapper's testimony to the Congress on January 31, 2012 provided another update of the official US position and for the first time suggested that Iran might strike at targets in the US:[41]

> We assess **Iran** is keeping open the option to develop nuclear weapons, in part by developing various nuclear capabilities that better position it to produce such weapons, should it choose to do so. We do not know, however, if Iran will eventually decide to build nuclear weapons.
>
> Iran nevertheless is expanding its uranium enrichment capabilities, which can be used for either civil or weapons purposes. As reported by the International Atomic Energy Agency, to date, Iran in late October 2011 had about 4,150 kg of 3.5 percent LEUF6 and about 80 kg of 20-percent enriched UF6 produced at Natanz. Iran confirmed on 9 January that it has started enriching uranium for the first time at its second enrichment plant, near Qom.
>
> Iran's technical advancement, particularly in uranium enrichment, strengthens our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons, making the central issue its political will to do so. These advancements contribute to our judgment that Iran is technically capable of producing enough highly enriched uranium for a weapon, if it so chooses.
>
> We judge Iran would likely choose missile delivery as its preferred method of delivering a nuclear weapon. Iran already has the largest inventory of ballistic missiles in the Middle East, and it is expanding the scale, reach, and sophistication of its ballistic missile forces, many of which are inherently capable of carrying a nuclear payload.
>
> We judge Iran's nuclear decision making is guided by a cost-benefit approach, which offers the international community opportunities to influence Tehran. Iranian leaders undoubtedly consider Iran's security, prestige, and influence, as well as the international political and security environment, when making decisions about its nuclear program.
>
> Iran's growing inventory of ballistic missiles and its acquisition and indigenous production of anti-ship cruise missiles (ASCM) provide capabilities to enhance its power projection. Tehran views its conventionally armed missiles as an integral part of its strategy to deter—and if necessary retaliate against—forces in the region, including US forces. Its ballistic missiles are inherently capable of delivering WMD, and, if so armed, would fit into this strategy.
>
> … The 2011 plot to assassinate the Saudi Ambassador to the United States shows that some Iranian officials—probably including Supreme Leader Ali Khamenei—have changed their calculus and are now more willing to conduct an attack in the United States in response to real or perceived US actions that threaten the regime. We are also concerned about Iranian plotting against US or allied interests overseas.
>
> Iran's willingness to sponsor future attacks in the United States or against our interests abroad probably will be shaped by Tehran's evaluation of the costs it bears for the plot against the Ambassador as well as Iranian leaders" perceptions of US threats against the regime.

[41] James R. Clapper, Director of National Intelligence, "Unclassified Statement for the Record on the Worldwide Threat Assessment of the US Intelligence Community for the Senate Select Committee on Intelligence," ODDNI, Washington, January 31, 2012

Timing Iran's Bomb

As for official US statements on the current estimate of the timing of Iran's programs, US officials no longer talk in terms of a two to three year delay before Iran could get some form of nuclear explosive device. US experts have highlighted Iran's recent activity in enriching uranium to the 20% level, although they had previously acknowledged that Iran's known enrichment programs had run into trouble in 2010, that its overt centrifuge program has had serious problems in the past, and Iran is still several years away from the point where it has enough weapons grade fissile material for a single device (It is unclear what role, if any, Israeli and U.S. actions played in the reported cyber-attacks on Iran's centrifuge program; and it seems likely that the U.S. did not play any role in attacks on Iranian nuclear scientists, although Israel may have played such a role).

US Secretary of Defense Panetta stated in January 2012 that US analysts believed that Iran could develop a nuclear weapon within about one year if Tehran decided to do so. Panetta was speaking on the CBS television program, "60 Minutes," in a broadcast on January 29, 2012.

Panetta was careful, to note, however, that it would probably take Iran another two to three years to produce a missile or other vehicle that could deliver the weapon to a target.[42] There are some levels of uncertainty that can only be fully resolved if Iran actually tests a nuclear weapon and begins to deploy nuclear-armed forces.

Is There a Formal Iranian Nuclear Weapons Program?

According to press sources, US intelligence still believes that Iran has not reconstituted the formal nuclear weapons program it seems to have disbanded in 2003. According to reporting in the *Los Angeles Times*,[43]

> A highly classified U.S. intelligence assessment circulated to policymakers early last year largely affirms that view, originally made in 2007. Both reports, known as national intelligence estimates, conclude that Tehran halted efforts to develop and build a nuclear warhead in 2003.
>
> The most recent report, which represents the consensus of 16 U.S. intelligence agencies, indicates that Iran is pursuing research that could put it in a position to build a weapon, but that it has not sought to do so.
>
> Although Iran continues to enrich uranium at low levels, U.S. officials say they have not seen evidence that has caused them to significantly revise that judgment. Senior U.S. officials say Israel does not dispute the basic intelligence or analysis

There are US and Israeli experts who dispute these conclusions, but even if the US National Intelligence Estimates issued in 2007 and 2011 do agree that Iran does not have a formal program as such, it is unclear what this means. Iran can – as the IAEA report cited earlier makes all too clear – pursue every major aspect of weapons design and production in parallel without having a formal centralized program. The actual design and testing of a weapon before it is

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[42] Radio Free Europe/Radio Liberty, "Panetta Says Iran Could Develop Nuclear Weapon Within A Year," 30.01.2012 09:19, http://www.rferl.org/content/panetta_iran_nuclear_weapon_year_awire/24467286.html.

[43] Ken Dilanian, "U.S. does not believe Iran is trying to build nuclear bomb: The latest U.S. intelligence report indicates Iran is pursuing research that could enable it to build a nuclear weapon, but that it has not sought to do so," Los Angeles Times, February 23, 2012, 6:11 PM PST,

tested in an actual nuclear explosion can be restricted to a very small group in a cell outside a formal program, and it would take almost total transparency as to Iran's action and intentions to know whether such activity took place.

Moreover, if Iran is seeking nuclear weapons, it makes little sense to provoke more sanctions or preventive strikes as long as it can continue to enrich more uranium to at least 20%, stockpile more material it can quickly enrich to weapons grade, build and deploy more centrifuges, create more sheltered facilities like Fordow, and develop and deploy more longer range missiles.

Accordingly, the debate over the ultimate nature of Iran's nuclear program and intentions can really only be resolved in one of two ways: First, Iran fully complies with the NNPT and IAEA, or second it builds its first weapon and conducts a test. The debate over the structure of its current program and possible intentions is not meaningless, but it also is not particularly meaningful as long as Iran steadily moves forward towards developing the capability to deploy nuclear weapons.

Focusing On Proliferation Rather than Force

Most US, European, and Arab assessments focus on Iran's progress in nuclear and missile programs rather than the force it may intend to build and its strategic goals in doing so. As yet, US officials have not issued any unclassified estimate of the possible size and character of Iranian nuclear-armed forces. They also have never address how Iran might weaponized a fissile weapon, or move on to boosted and thermonuclear weapons.

So far, most of the analysis of Iran's nuclear program concentrates on the risk of proliferation – Iran's first bomb – rather than what Iran might do to arm and deploy a nuclear force it could use in warfighting. There are no meaningful unclassified data on the size and nature of Iran's plans to deploy a nuclear-armed force, what role aircraft and various types of missiles will play, how such a force will be based, and what kinds of command, control, computer, communications, and intelligence (C4I) systems Iran intends to deploy.

As noted earlier, any effort to correct this situation is complicated by the fact that Iran is constantly testing variants of its existing missiles, claiming it is producing new types, and possibly using its satellite program as a vehicle for research and development into longer-range ballistic missile technology. At the same time, Iran may be shifting from liquid-fueled missiles to solid-fuel types, and keeps changing warhead configurations.

Nevertheless, most regional governments and experts now feel that Iran's nuclear and missile programs are directed towards giving Iran a force of land-based, nuclear-armed missiles. Where they differ is largely over how quickly Iran can move forward, over the extent Iran is committed to deploying nuclear forces, and how serious the resulting threat may become.

There is also a difference between countries in perceived urgency regarding this issue. Israel's senior leadership -- specifically Prime Minister Benyamin Netanyahu and Defense Minister Ehud Barak -- already see Iran as on the edge of having a nuclear force strong enough to pose an "existential" threat to Israel.[44] However, as will be highlighted later, even within Israel there is

[44] Aviad Glickman. "Netanyahu Links Holocaust to Iranian Threat." Ynetnews.com. April 18, 2012. http://www.ynetnews.com/articles/0,7340,L-4217989,00.html and Harriet Sherwood. "Ehud Barak Restates

not a consensus perception of the urgency of the threat. There are few indications that Americans, Europeans, Turks, and the Gulf states see the potential Iranian nuclear threat as "existential," or assign anything approaching the same sense of urgency as Israel's leaders. Americans, Europeans, and the Gulf states see Iranian efforts to acquire nuclear weapons more as a way Iran can increase its strategic leverage and influence, increase its ability to intimidate and exert political pressure, and deter any military action against Iran in the face of a confrontation or crisis. While there is no consensus among them, many are more likely than their Israeli counterparts to believe that Iran is containable and deterrable through a mix of steps like missile defenses and regional extended deterrence.

The Chemical and Biological Dimension

The Deputy Director of National Intelligence's (DDNI) and other senior US intelligence officers have repeatedly called attention to Iran's Chemical and Biological Weapons (CBW) efforts. Iran is a signatory to the Chemical Weapons Convention, a declared chemical weapons power, is known to have produced mustard and nerve gas in the past, and has had access to Russian chemical cluster munitions technology along with Syria. It is not clear, however, how large a force it still maintains and what level of delivery capability it possesses.

Similarly, Iran has all of the technology needed to produce genetically engineered and other sophisticated biological weapons, but the status of its program – if any – is unknown.

The subject gets little more than passing mention in Gulf and other Arab sources. According to the U.S. DDNI, however, Iran maintains the capability to produce chemical warfare agents, and probably has the capability to produce some biological warfare agents for offensive purposes.

The Impact of Iranian Nuclear Weapons on US and Iranian Competition

Iran's possible search for nuclear weapons is already having a major impact on US and Iranian competition and military capabilities in spite of the fact that Iran does not yet possess a nuclear weapon, has never conducted a nuclear test, and has never announced plans for developing given types and yields of weapons, deploying them on delivery systems, and using them to gain influence, to deter, or to use as instruments of war. Similarly, Israel took the decision at the time of the Iran-Iraq War to extend its missile forces to cover targets in both countries, and has long had the capability to target Iran with nuclear weapons. The Iranian-Israeli nuclear arms race is already underway.

Any assessment of the net effects of an Iranian nuclear weapon must be theoretical and somewhat problematic. Nevertheless, the maturity and likely weaponization of Iran's nuclear program necessitate an evaluation of the potential net effects such a scenario would engender.

Case for Military Strike On Iran's Nuclear Programme." The Guardian. April 30, 2012. http://www.guardian.co.uk/world/2012/apr/30/ehud-barak-iran-nuclear-programme

Iran's Use of Nuclear Weapons Once It Possesses Them

Much will depend on how Iran exploits its nuclear programs if it acquires and deploys such weapons. Iran has already reached the point where it is so close to a nuclear weapons break-out capability that the US, its neighbors, and the world must take this into account. Every new step in technology, missile development, enrichment, and the dispersal and sheltering of Iran's capabilities reinforces this leverage, even if Iran never formally revives a nuclear weapons program. The question now is whether Iran will persist to the point where it is undeniably a threshold state, go on to test a device, or actually deploy.

The Threshold State and "Wars of Intimidation"

Iran is already using its nuclear and missile programs to conduct what might be called "wars of intimidation," and it can exploit each further step in acquiring the capability to deploy nuclear weapons. Releasing enough data to show that Iran has actually reached even weapons grade material to build a device or weapons would be another major step – both increasing Iran's leverage and the risk of a US/Gulf or Israeli military response. An actual Iranian test would remove all ambiguity about Iran's intentions and capability. Activity indicating Iran was about to deploy nuclear warheads and bombs would be another major signal. The actual deployment of a nuclear-armed missile force, and tacit or overt threats to use weapons, would be the penultimate steps before use.

Each step will give Iran more potential leverage, but will do more to provoke a response in kind from the US and Iran's neighbors, and accelerate the ongoing nuclear arms race with Israel. Each step will produce new US, Arab, European and Turkish diplomatic reactions and probably sanctions – as well as new reactions from other states. Each step will increase tension throughout the region, the risks of unplanned escalation, and the risk of US or Israeli preventive attacks.

The Transition Stage: Launch on Warning? Launch Under Attack?

It should be stressed that Iran can shape the pace with which it acts and rush forwards, back off for a period of years, limit its activity to dispersed efforts that move it forward without being a nuclear weapons program per se, or carry out a slow and systematic program while using its past tactics of denial and negotiation.

No one can calculate the level of Iranian risk-taking if Iran does take each of the major steps left in acquiring and deploying nuclear-armed forces and go on to create a nuclear-armed force – although the past actions of Iran's leaders have been far more cautious than their most extreme rhetoric. Iran's leaders have to realize that it is one thing to threaten and intimidate and seek political leverage, and quite another to move towards an exchange that could involve the vastly superior nuclear forces of the US, push neighbors into creating their own nuclear retaliatory forces, or lead to nuclear strikes on Iran by Israel. If Iran does create nuclear forces, they will only benefit Iran if they are never actually used.

It is possible, however, that Iran's actions might push it to be most risk prone between the point where it actually has at least a few nuclear weapons and the time it creates a force that cannot be preempted and is large enough to deter conventional or nuclear attack because it could survive and retaliate.

Given the fact that Iran's strike aircraft and bombers have aged considerably – and are nearly obsolescent in comparison with their US, Israeli, and Gulf equivalents – Iran would probably select another means for delivering a nuclear weapon, including nuclear-tipped ballistic or cruise missiles.

Such assets would, however, be detectable and partly targetable by US radar and satellite systems, and could provoke a retaliatory strike. Long before Iran had anything approaching a survivable second strike capability, it could seek to deter by creating a force designed to be used through launch on warning (LOW) or launch under attack (LUA) after Iran received the first strike. This is a high-risk posture compared to waiting out the risk or reality of an enemy first strike, characterizing the result, and acting cautiously and in proportion to a known event. It also, however, is a posture that almost all emerging nuclear powers have had to consider or take at some point in deploying a nuclear force since the first US use of nuclear weapons in World War II.

It is also possible that Iran would consider delivering a nuclear weapon covertly if it felt it faced an almost inevitable attack from the outside, using any one of its regional proxies or its Al Quds Force. Using a covert means of nuclear delivery, Iran would possess a degree of deniability, and minimize the chances of US nuclear retaliation.

In one worst-case scenario, Iranian proxies might smuggle in a nuclear device or detonate it in the water off of a city like Haifa or Tel Aviv, or a key city or petroleum export facility in the Southern Gulf. The public focus on nuclear weapons ignores the fact that Iran has previously been declared a chemical weapons state, and Israel has been caught importing the precursors for chemical weapons. Both Iran and Israel are suspected to have advanced biological weapons programs, and both present a possible risk in that they could use conventionally armed precision-guided weapons to attack key power, water, refinery, and other critical targets – turning such weapons into "weapons of mass effectiveness."

Decision makers, military planners, and intelligence experts cannot ignore these possibilities and options. In fact, the same senior U.S. intelligence officers who were quoted earlier in regard to the risk in Iran's nuclear programs have repeatedly warned in public that Iran has chemical and suspected biological weapon programs. There are however, no Israeli or U.S. official statements that go beyond this level of detail to provide a meaningful picture of how either country really perceives such threats.

Iranian Efforts to Use a Survivable or "Mature" Nuclear Force

If Iran does successfully go on to create a dispersed or protected force large enough to pose a major threat even in a retaliatory strike or "ride out" mode, such a "mature" force would almost certainly take long enough to create that it would provoke the US, Iran's Arab neighbors, and Israel to target Iran to the point where it would lose every major population center in a major exchange. This point is often lost in focusing solely on Iran's options rather than a nuclear arms race that has already begun. It is not a point that either Israel or US planners have lost, and US and Iranian competition would be competition in nuclear forces just as Israel already targets Iran.

Iran could, however, seek to exploit its leverage and the extent to which the US and its neighbors would make concession to reduce nuclear tension – a game of "nuclear chicken" that could range from prudent cautious Iranian demands to levels of tension that could lead to critical

miscalculations by the nations involved. The Cold War consisted largely of a cautious version of the game, with the exception of the Cuban missile crisis. North Korea has been a cautious player. So have India and Pakistan with the exception of at least one point where Pakistan considered deploying active weapons. There are no guarantees, however, that cautious intentions succeed. The Napoleonic Wars, the Crimean War, WW I, and WW II all illustrate the extent to which caution can fail and sometimes do so suddenly and in totally unpredictable ways.

Iran can also seek to leverage any nuclear forces against the conventional superiority of the US and its southern Gulf neighbors. In addition to US forces and installations in the Gulf, Iran could seek to use the risk of nuclear escalation to gain freedom from conventional attack if Iranian asymmetric forces threaten or attack the Southern Gulf states, move into Iraq, support a proxy war by force like Hezbollah against Israel, or attack Gulf shipping and oil export capabilities. A mature Iranian nuclear force might even attempt to use a limited or demonstrative strike to reinforce the threat while being so limited in nature so as not to garner massive nuclear retaliation. The problem for Iran is that every potential mix of opponents could counter escalate in proportion – but again history scarcely consists of actions based on the wise use of game theory.

Regardless of its means of delivery, the mere existence of an Iranian nuclear arsenal would also provide Iran with some ability to deter and neutralize the US conventional superiority in the region to a degree. Iran would consequently be enabled to pursue a more aggressive foreign policy than it would otherwise, and use its nuclear capability to leverage other regional actors and competitors.

US Responses to Iran's Nuclear and Missile Efforts

The US response to Iran's existing and potential actions has scarcely been passive. As is described in the next chapter, the US continues to use sanctions and diplomacy as its primary *current* means of limiting Iran's nuclear efforts, and other diplomatic and negotiating initiatives. US officials have consistently stated that military options are still under consideration, but the US has joined its P5+1 (US, France, UK, China, Russia, and Germany) allies at the negotiating table with Iran each year since 2008, and most recently March 2012, with another round of negotiations expected in June.

The need to keep many key aspects of US threat perceptions classified means that there is no clear way to determine how top level US decision makers view the broader trade-offs between negotiation, preventive and preemptive military options, and deterrence/containment. The US has taken enough overt actions, however, so that it is clear that the US is treating Iran's missile and nuclear programs as a key aspect of US and Iranian military competition, and one where current US perceptions will almost certainly change if Iran clearly moves to the point of a nuclear break out capability, tests a device, and begins to deploy some mix of nuclear armed forces.

Direct Negotiations

The US first participated in direct talks with the Islamic Republic over its nuclear program in a 2008 P5+1 negotiation in Geneva. Those talks stalled due to the perceived inability of the

Iranians to adequately confront the nuclear issue.[45] Following other unsuccessful attempts, direct negotiations were re-launched in January 2011 between the P5+1 and Iran, which also ended without agreement as the Iranian delegation was determined to push for preconditions, stressing its desire for relief from international sanctions and its resolve to continue enrichment.[46]

In the spring of 2012, Catherine Ashton announced on behalf of the P5+1 countries that direct negotiations would continue as the Iranian government committed itself to discussing its nuclear program.[47] The first meeting in this new round of negotiations was held in Istanbul on April 15, with a commitment to hold a second meeting on May 23 in Baghdad.

While many of the specific details of the exact content of the Istanbul meeting have yet to be disclosed, some of the steps taken by each sides suggest that some progress was made. Although it was initially reported that the US would pursue a somewhat rigid positional negotiating strategy in these talks, indications later surfaced after the meeting that the US was possibly beginning to alter its negotiating stance on Iran's uranium enrichment.

Just days before the meeting in Istanbul, sources in the US and European diplomatic communities suggested that the US would take the position that Iran must close and dismantle the facility at Fordo, stop generating near-weaponizable uranium fuel, and cease exporting such uranium fuel.[48] However, 12 days after the meeting, officials within the Obama Administration suggested that the US might be willing to allow Iran to enrich uranium at levels below what would be needed to create a weapon, with the caveat that Iran give inspectors unfettered access to their nuclear program.[49]

Some experts feel there have been indications that Iran's approach to the negotiations are perhaps more genuine than in past sessions. For one, while Iran has made it a point in the past to steer negotiations away from the nuclear issue, the Iranian delegate gave his assurances that the issue will be central to these new negotiations.[50]

Additionally, whereas factions within the Iranian government have hindered negotiations in the past, there is a direct line of authority from Iran's delegate at the talks, Saeed Jalili, to Ayatollah Khamenei, the Supreme Leader of the Islamic Republic. This has brought "unprecedented legitimacy" to the current negotiations, according to one report, while at the same time creating

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[45] Arms Control Association. "History of Official Proposals on the Iranian Nuclear Issue." April, 2012. http://www.armscontrol.org/factsheets/Iran_Nuclear_Proposals

[46] Julia Damianova. "Nuclear Negotiations With Iran End in Failure." Los Angeles Times. January 23, 2011. http://articles.latimes.com/2011/jan/23/world/la-fg-iran-nuclear-20110123

[47] Nicholas Kulish and James Kanter. "World Powers Agree to Resume Nuclear Talks With Iran." New York Times. March 6, 2012. http://www.nytimes.com/2012/03/07/world/middleeast/iran-agrees-to-inspection-of-secret-military-site-report-says.html

[48] David E. Sanger and Steven Erlanger. "U.S. Defines Its Demands for New Rounds of Talks With Iran." The New York Times. April 7, 2012. http://www.nytimes.com/2012/04/08/world/middleeast/us-defines-its-demands-for-new-round-of-talks-with-iran.html?pagewanted=all

[49] Paul Richter. "U.S. Signals Major Shift on Iran Nuclear Program." Los Angeles Times. April 27, 2012. http://articles.latimes.com/2012/apr/27/world/la-fg-iran-nuclear-20120428

[50] Nicholas Kulish and James Kanter. "World Powers Agree to Resume Nuclear Talks With Iran."

concerns that the Ayatollah may push a firmer stance at the discussions. During the 2009 negotiations in Geneva, President Ahmadinejad backed a deal with the P5+1 on a fuel-swap arrangement – a deal which was vetoed by Ayatollah Khamenei.[51] Moreover, according to US government sources, in the wake of the Istanbul meeting the Iranian government has framed the talks in a positive light for their constituents, suggesting that, "the Iranian government is preparing the public for a deal with the West that could be portrayed as a win for Iran."[52]

Yet, any positive indications coming out of the negotiations could simply reflect a variation on what some call Iran's "negotiate and stall" tactics and need to deal with growing outside pressure. Iran's struggles with the impact of economic sanctions that have grown increasingly tighter in the past several months, the development of Sunni Arab Gulf militaries in its vicinity, technological issues with its nuclear infrastructure, and the threat of airstrikes from Israel.

The Obama Administration faces major traders such as China and India who continue to import Iranian oil, and the fact that failed negotiations could further precipitate the threat of an Israeli airstrike, which would complicate US security interests in the region. Moreover, the collapse of negotiations could be perceived as a failure in President Obama's diplomatic solution to the Iran nuclear problem during an election year.

Neither the US nor Iran have particularly palatable fallback positions in the event that negotiations fail, although the US and its negotiating partners will still likely fare better from a collapse of talks than Iran, whose national security can be directly at stake. However, the risks of adopting rigid positions could complicate negotiations by making it difficult for the Iranian government to save face. In addition to the comments made by US and European government sources before the talks regarding a rigid stance on Fordo and inspectors, the EU has demanded that Iran stop uranium enrichment, seemingly at all levels.[53] These stances, coupled with the potential for the Ayatollah to assert his own rigidity on the negotiations, create a serious risk that the current negotiations can share the same fruitless fate as previous rounds.

Missile Defense

As has already been noted, the US has made it clear that it will rely on a combination missile defense and deterrence even if Iran does deploy nuclear-armed aircraft and missiles. As noted earlier, the U.S. has continued to work with its allies to create missile defense forces in the Gulf, has supported Israel's missile defense programs, has laid the ground for missile defense in Europe, and has begun to deploy advanced missile defense destroyers. The new US strategy

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[51] Roshanak Taghavi. "Ayatollah Khamenei Gives Iran Nuclear Talks Unprecedented Legitimacy." Christian Science Monitor. May 4, 2012. http://www.csmonitor.com/World/Middle-East/2012/0504/Ayatollah-Khamenei-gives-Iran-nuclear-talks-unprecedented-legitimacy and Steven Erlanger. "At Nuclear Talks, Hopes That A New Iranian Attitude Will Reduce Tensions." The New York Times. April 12, 2012. http://www.nytimes.com/2012/04/13/world/middleeast/us-hopes-iran-nuclear-talks-will-reduce-tensions.html?_r=1&pagewanted=all

[52] James Risen. "Experts Believe Iran Conflict Is Less Likely." New York Times. April 30, 2012. http://www.nytimes.com/2012/04/30/world/middleeast/chances-of-iran-strike-receding-us-officials-say.html

[53] Fredrik Dahl and Justyna Pawlak. "EU Tells Defiant Iran It "Must" Suspend Atom Activity." Reuters. May 7, 2012. http://uk.reuters.com/article/2012/05/07/uk-nuclear-iran-usa-idUKBRE8460Q320120507

announced in January 2012 calls for four advanced guided missile defense destroyers – with wide area ballistic missile defense coverage -- to be based in Rota, Spain that can be used to defend Europe and Israel.

Other key missile defense assets in the region include US Navy Aegis anti-ballistic missile cruisers stationed in the Gulf, and advanced versions of the MIM-104 Patriot surface-to-air missile system that Bahrain, Egypt, Israel, Jordan, Kuwait, and Saudi Arabia have acquired from the US. Lastly, in September, 2011 the US and Turkey reached an agreement whereby a missile defense radar site will be constructed only 435 miles from the Turkey-Iran border.[54] While Iran's missiles have not been stated as the exclusive target of the system, it will greatly enable the US' ability to detect and intercept an Iranian missile launch.

This radar station is an element of the US' larger European Phased Adaptive Approach to missile defense, which is comprised of four phases:[55]

- Phase one: the construction of the aforementioned radar system in Turkey as well as the stationing of three Aegis anti-ballistic missile cruisers in the eastern Mediterranean.
- Phase two: the deployment of a ballistic missile defense interceptor site at Deveselu Air Base in Romania scheduled for 2015.
- Phase three: the installation of a land-based interceptor site in Poland and the deployment of a more advanced Standard Missile-3 (SM-3) interceptor scheduled for 2018.
- Phase four: the deployment of more advanced SM-3 interceptors in 2020 to enhance the ability to counter MRBMs and potential future ICBMs missile threats to the US from the Middle East through the deployment of more advanced SM-3 interceptors.

As **Figure IV.73** shows, the US has continued to push for missile defense forces in the Gulf, to support Israel's missile defense programs, and lay the ground for missile defense in Europe.

"Extended Deterrence"

The US has also made it clear that deterrence and containment of Iran will not be defensive. In response to the Iranian threat, the US has offered its allies "extended regional deterrence," although it has left the character of such a capability ambiguous and indicated such a deterrent might use conventional weapons, rather than the theater nuclear forces the U.S. once used to provide extended deterrence for its NATO European allies.

Secretary of State Hillary Clinton put the U.S. view forward as follows in June 2009, "We want Iran to calculate what I think is a fair assessment that if the United States extends a defense umbrella over the region, if we do even more to support the military capacity of those in the

[54] Shanker, Thom. "U.S. Hails Deal With Turkey on Missile Shield." New York Times. September 15, 2011, http://www.nytimes.com/2011/09/16/world/europe/turkey-accepts-missile-radar-for-nato-defense-against-iran.html

[55] "U.S.-Romania Missile Defense Comes Into Force." VOA. January 3, 2012. http://www.voanews.com/policy/editorials/europe/US---Romania-Missile-Defense-Comes-Into-Force-136698993.html

Gulf, it's unlikely that Iran will be any stronger or safer because they won't be able to intimidate and dominate as they apparently believe they can once they have a nuclear weapon."[56]

The U.S. went further in its April 2010 Nuclear Posture Review.[57] The review discussed arms control options, and efforts to eventually end U.S. reliance on nuclear weapons, but also stated that,

> Security architectures in key regions will retain a nuclear dimension as long as nuclear threats to U.S. allies and partners remain. U.S. nuclear weapons have played an essential role in extending deterrence to U.S. allies and partners against nuclear attacks or nuclear-backed coercion by states in their region that possess or are seeking nuclear weapons. A credible U.S. "nuclear umbrella" has been provided by a combination of means – the strategic forces of the U.S. Triad, non-strategic nuclear weapons deployed forward in key regions, and U.S.-based nuclear weapons that could be deployed forward quickly to meet regional contingencies.
>
> In Asia and the Middle East – where there are no multilateral alliance structures analogous to NATO – the United States has mainly extended deterrence through bilateral alliances and security relationships and through its forward military presence and security guarantees. When the Cold War ended, the United States withdrew its forward-deployed nuclear weapons from the Pacific region, including removing nuclear weapons from naval surface vessels and general-purpose submarines. Since then, it has relied on its central strategic forces and the capacity to re-deploy non-strategic nuclear systems in East Asia, if needed, in times of crisis.
>
> The Administration is pursuing strategic dialogues with its allies and partners in East Asia and the Middle East to determine how best to cooperatively strengthen regional security architectures to enhance peace and security, and reassure them that U.S. extended deterrence is credible and effective.

US Preventive Strike Options

The need to keep many key aspects of US plans and intelligence classified means that there is no clear way to determine exactly how top level US decision makers view the trade-offs between negotiation, preventive and preemptive military options, and deterrence/containment.

Moreover, current US perceptions will almost certainly change with each state of Iran's progress if Iran clearly moves to the point of a nuclear break out capability, then tests a device, an then begins to deploy some mix of nuclear armed forces. Given the timing of Iran's actions, a different set of key actors are almost certain to be in office before Iran has significant nuclear capabilities, and possibly a different Administration. Iran may define its goals in ways that raise or lower US perceptions of threat, and the 5+1, Gulf, and other regional states may change their perceptions as well.

The Diplomacy and Politics of Preventive Strikes

The same problems occur in trying to guess at US plans and perceptions of preventive and preemptive strike options. It is clear that the US has strike assets that are far larger and more capable than those of Israel. At the same time, there is no practical way to determine how U.S. senior policymakers and military leaders perceive U.S. abilities to identify, target and destroy Iran's current nuclear and other strike capabilities, or assess the degree to which this would

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[56] Mike Schuster, "Iran Prompts Debate Over Mideast Defense Umbrella," *NPR,* August 26, 2009. Available at http://www.npr.org/templates/story/story.php?storyId=112222260

[57] "Nuclear Posture Review Report," *Department of Defense,* April 2010. Available at http://www.defense.gov/npr/docs/2010%20Nuclear%20Posture%20Review%20Report.pdf

provide security over time vs. provoking Iran into some massive new effort to acquire nuclear weapons.

It is clear that the U.S. has conducted serious military contingency plans for years, has exercised and tested some elements of such trikes, and has improved its intelligence and targeting coverage. It is also clear from media sources that the US has focused on developing better ordnance to kill underground and hard targets, has developed regional missile defense options, is seeking to improve regional air defenses, and retains stealth and cruise missiles – options where Israel has far more limited capabilities – as important potential assets.

What is not clear is exactly how the U.S. would approach such strikes, and how much acceptance or support it feels it needs, or can count on, from the Gulf and other neighboring states. The US does have major *potential* advantages over Israel. It may be possible to get the overt or covert support of Gulf States. It may be able to launch and base from bases in the Gulf area and carriers. It has sufficient forces to strike with near simultaneous strikes at key Iranian nuclear, missile, air defense, and leadership targets.

Depending on its access to forward bases in or near the Gulf, the US can carry out a limited to massive wave of initial air and cruise missile strikes against Iran's nuclear facilities or a much wider range of Iranian targets and then take the time to assess battle damage, and carry out restrikes over a period of days, weeks, months, or years.

Much depends on whether the US would be able to get regional support for a US presence and overwatch that would allow it to continue to strike Iran – if Iran attempted to reconstitute its nuclear and missile programs. This would give the US an indefinite ability to restrike, suppress Iran, and attack other types of Iranian targets if a covert Iranian program was suspected and Iran did reveal its actions.

This would give the US a very different kind of credibility in preventive operations from Israel. Israel may only be able to carry out one major wave of strikes – which would be far more limited than those the U.S. can conduct – before Israel faced political constraints it cannot ignore, and must consider threats in terms of non-state actors with ties to Iran.

It is important to note, however, that US success would depend heavily on partnership with key southern Gulf and other Arab states and the extent to which they felt Iran's nuclear and missile programs threatened their vital interests. The US confronts the problem that a limited Israeli strike might create conditions where only the US could effectively finish the job, but where Arab states would either not feel threatened enough to support such a strike or would not support any follow on action to Israel.

Any current judgment about Gulf perceptions has to be speculative. Neither the public statements of Gulf leaders, nor the kind of material available from sources like WikiLeaks, provide a clear indication of the links between U.S. and Gulf perceptions of the Iranian threat at the official level, or their willingness to act. Moreover, current Gulf perceptions are certain to change over time just as Israeli and U.S. perceptions will evolve as the Iranian threat alters and becomes more tangible. It is far from clear that today's threat perceptions provide a clear picture for the future.

Moreover, the U.S. must deal with the legacy of its invasion of Iraq after totally mischaracterizing the Iraqi WMD threat, and would have to deal with the negative political consequences of the military aftermath of any US preventive strike. Unless it's Arab, major

Western European, and other allies saw that it had exhausted diplomatic options, it could face serious problems with its closest friends.

The US must also seek to minimize the cost it will have to pay in terms of reactions from states that do not support its policies on sanctions -- which include major powers like Russia and China, and important regional allies like Turkey. The US must consider the impact strikes will have on the US role in Iraq, Afghanistan, and the war on terror. The US must also balance the need for restraint in attacking Iran against whether limited US action would provoke Iran into a massive new covert effort; and how Iran might react in using its other forces to attack energy exports in the Gulf, Israel, and other US interests in the region.

It is also important to point out that whatever US contingency plans and military capabilities exist today will change steadily over time. Given the timing of Iran's actions, these are also areas where a different set of key actors in the US, Iran, and the Gulf may be in office by the time Iran has significant nuclear capabilities. Iran may also define its goals in ways that raise or lower US perceptions of threat, and the P5+1, Gulf, and other regional states may change their perceptions as well.

US Strike Options Against Iran

US senior officials and officers have regularly made it clear that the US has developed serious military contingency plans to carry out preventive strikes on Iran, and has improved its intelligence and targeting coverage. It is also clear from media sources that the US is steadily developing better ordnance to kill underground and hard targets, has developed regional missile defense options, is seeking to improve regional air defenses, and retains stealth and cruise missiles.

There is no practical way to use unclassified sources to determine how US senior policymakers and military leaders perceive the US ability to identify, target, and destroy Iran's current nuclear and other strike capabilities, or assess the degree to which this would provide security over time vs. provoking Iran into some massive new effort to acquire nuclear weapons.

What is clear is that the US has strike assets that are far larger and more capable than those of Israel, and that no Southern Gulf state has the capability to conduct such an attack. A power as large as the US can strike at possible targets as well as confirmed targets. In fact, the problem for Iran in conducting the equivalent of a nuclear shell game is that Iran then provokes strikes at all the possible shells. US officials have never described US options for preventive and preemptive strikes, but the US can draw upon a number of assets that Iran would find difficult to counter and which are listed in **Figure IV.74.**

The US also could strike at a wide range of critical Iranian military facilities of the kind shown in **Figure IV.75**, including its missile production facilities. Most are soft targets, and would be extremely costly to Iran. Even if many of Iran's nuclear facilities did survive US strikes, Iran would be faced with either complying with the EU3 and UN terms or taking much broader military losses – losses its aging and limited forces can ill afford.

It is important to note, however, that Iran's total target base could include a far wider range of targets than the major facilities that are listed on most maps. Iran has a very wide range of facilities that could be used for nuclear, missile, biological, and chemical weapons programs as well as deployed and sometimes mobile missile forces. There is no way to know how broadly

distributed these facilities are, but the NTI has put together lists of possible research facilities that at least illustrate how broad the target base could be, and how deep US (or Israeli) strikes would have to go into Iran. These facilities are shown in **Figure IV.76.**

Many are primarily civil facilities in populated areas, and many are almost certainly innocent of any military purpose. It would take exceptional intelligence to know what target points to hit and still minimize civilian casualties and collateral damage. Moreover, long as the list in **Figure IV. 76** is, it does not include any covert military facilities, deployed forces, and most of Iran's chemical weapons facilities and holdings.

Presumably, US and Israeli intelligence have very different lists that narrow the suspect civilian facilities and add covert and military ones. Any comparison of **Figure IV.75** and **Figure IV.76** show, however, just how difficult a total effort to suppress Iran's programs would be, and how much more complex the targeting and strike planning activities would be than a simple focus on the major facilities that have gotten so much attention in the press because Iran has declared them to the IAEA under the terms of the NNPT.

Military operations against Iran's nuclear, missile, and other WMD facilities and forces would be challenging for the US, but Iran would find it difficult to defend against US forces. It would face a complex and unpredictable mix of attacks from cruise missiles, stealth aircraft, and stand-off precision weapons. It would also face a US opponent equipped with a mix of vastly superior air combat assets and the IS&R assets necessary to strike and restrike Iranian targets in near real time.

For example, the US could use a range of regular and special purpose cruise missiles, including submarines and surface ship launched Tomahawk BGM-109s. While these only have 1,000lb warheads, and cannot be used to hit deep hardened targets, they can deliver extremely precise strikes even in relatively crowded urban areas and potentially destroy Iran's nuclear, missile, and other critical military production and research centers even within cities with limited collateral damage. Iran's only credible defense system would be the Tor-M, and it is available only in limited numbers and has never been tested in combat. It also offers the US the ability to carry out a massive suppressive strike against suspect as well as known facilities with limited collateral damage and innocent civilian casualties.

The US could use a mix of regular strike aircraft, anti-radiation missiles, electronic warfare aircraft, cruise missiles, UAVs/UCAVs, and other systems to systematically suppress Iran's aging land-based surface-to-air missiles and destroy any fighter it sent into air-to-air combat. Once it did so, it could attack virtually all Iranian land targets with stand-off precision guided munitions that would keep its fighters from being vulnerable to Iran's surviving short-range air defenses. These strikes could hit a full range of targets including critical missile and other military production sites and facilities, crippling Iran's overall military capabilities in the process of destroying its nuclear facilities. Knocking out key corridors in Iran's land-based air defenses would also allow the US to restrike at will and confront Iran with a lack of options to reconstitute its capabilities.

This would not be a minor air war. One analyst has privately estimated that strikes against some 400 targets would be necessary to totally dismantle Iran's nuclear, missile, and related critical facilities. According to other reports, the US Department of Defense is considering both conventional strikes at Iran's other WMD facilities, missiles and missile production facilities,

and create an entry corridor by destroying part of Iran's air defense system. This could easily require 800-1,200 sorties and cruise missile strikes.

The US would almost certainly use stealth as well as non-stealth aircraft, although it is just as possible that it might conduct a more limited mix of strikes only using cruise missiles and stealth aircraft. Each US B-2A Spirit stealth bomber can carry eight 4,500-pound enhanced BLU-28 satellite-guided bunker-busting bombs or their more modern precision-guided equivalents – potentially enough to take out one hardened Iranian site per sortie. Such bombers could operate flying from Al Udeid air base in Qatar, Diego Garcia in the Indian Ocean, RAF Fairford in Gloucestershire, United Kingdom, and Whiteman US Air Force (USAF) Base in Missouri.

At the same time, the B-2 could be used to deliver large numbers of precision-guided 250 and 500-pound bombs, or two MOPs against dispersed surface targets. Likewise, it could carry a mix of light and heavy precision-guided weapons. Submarines and surface ships could deliver cruise missiles for such strikes, and conventional strike aircraft and bombers could deliver standoff weapons against most suspect Iranian facilities without suffering a high risk of serious attrition. The challenge would be to properly determine what targets and aim points were actually valuable, not to inflict high levels of damage.

At present, a large-scale US attack might include B-2A bombers carrying 2 GBU-57 MOP bombs, escorted by F/A-18s from the 5th fleet stationed in the Gulf area, or F-15E's, F-16C's, or F-22's from forward operating bases.

- In July 2009, verification of equipment required to integrate the MOP on the B-2 was complete - the hardware that holds the MOP inside the weapons bay.
- The MOP is a GPS-guided weapon containing more than 5,300 pounds of conventional explosives inside a 20.5 ft long bomb body of hardened steel. It is designed to penetrate dirt, rock and reinforced concrete to reach enemy bunker or tunnel installations. The B-2 will be capable of carrying two MOPs, one in each weapons bay.
- The B-2 currently carries up to 40,000 pounds of conventional ordnance. For example, it can deliver 80 independently targeted 500-lb class bombs from its smart bomb rack assembly; or up to 16 2,000-lb class weapons from its rotary launcher.
- Integration of the MOP on the B-2 is the latest in a series of modernization programs that Northrop Grumman and its subcontractors have undertaken with the Air Force to ensure that the aircraft remains fully capable against evolving threats.

While the success rate of any attack on Iran's nuclear facilities would depend on its duration and the number of strikes carried out, a high success rate would be possible if the attack were sustained for a couple of days. The US could cripple Iran's economy at the same time by striking at major domestic gas production and distribution facilities, refineries, and electric power generations. There are no rules that would preclude the US from immediate restrikes or restrikes over time. If the US chose to strike at the necessary level of intensity, it could use conventional weapons to cripple Iran's ability to function as a nation in a matter of days with attacks limited to several hundred aim points.

US capabilities to use stealth in a general, large-scale strike or a more limited stealth and cruise missile-only strike will also be able to use a steadily expanding number of other stealth systems. US stealth UCAVs are known to exist, but their capabilities are classified.

While the F-22 is generally treated as an air defense aircraft, it too is a sophisticated stealth strike aircraft with internal weapons bays that preserve stealth while allowing the F-22 to fly demanding high-speed, low altitude missions carrying a payload of precision guided weapons in two internal bomb racks that can each hold a 1,000lb JDAM bomb or four to eight small diameter bombs. It has very sophisticated attack avionics that are being upgraded. As the F-35 deploys, the US will also acquire a land-based, carrier-based, and VSTOL stealth attack aircraft that can carry two 2,000 pound precision guided munitions or eight small diameter bombs.[58]

Killing Hardened and Deeply Buried targets

The greatest physical challenges in a U.S. campaign would be the risk that important unknown facilities and other targets would survive, and the ability to fully destroy deeply buried hardened targets, like Iran's centrifuge facility at Natanz and its deeply buried new mountain centrifuge site at Fordow – just north of Qom. It should be noted, however, that these challenges largely occur *only* if the US is limited to one set of strikes. Missing some sites would be unimportant if the US could go back and restrike sites that had not been detected or destroyed the first time, or keep destroying the entrances to deeply sheltered strikes. If anything, the constant risk and or reality of such restrikes would then become a way of showing Iran it had no alternative other than to negotiate.

The US also has a wide range of hard target killers, many of which are in development or classified – although none could necessarily destroy an underground site as large and as well compartmented as Natanz or a deep mountain site like Fordow. Systems that are *known* to be deployed include the BLU-109 Have Void "bunker busters," a "dumb bomb" with a maximum penetration capability of four to six feet of reinforced concrete. An aircraft must overfly the target and launch the weapon with great precision to achieve serious penetration capability. It can be fitted with precision guidance and converted to a guided glide bomb.

The Joint Direct Attack Munition (JDAM) GBU-31 version has a nominal range of 15 kilometers with a CEP of 13 meters in the GPS-aided Inertial Navigation System (INS) modes of operation and 30 meters in the INS-only modes of operation.

More advanced systems that have been discussed in the unclassified literature include the BLU-116 Advanced Unitary Penetrator (AUP), the GBU-24 C/B (USAF), or the GBU-24 D/B (US Navy), which has about three times the penetration capability of the BLU-109. The US is investing in other weapons that are supposed to destroy targets that are buried under more than 20 meters of dirt and concrete.

It is not clear whether the United States has fully deployed the AGM-130C with an advanced earth penetrating/hard target kill system. The AGM-130 Surface Attack Guided Munition was developed to be integrated into the F-15E, so it could carry two such missiles, one on each inboard store station. It is a retargetable, precision-guided standoff weapon using inertial navigation aided by GPS satellites and has a 15-40-NM range.

[58] http://www.afa.org/professionaldevelopment/issuebriefs/F-22_v_F-35_Comparison.pdf

The US does, however, have a number of other new systems that are known to be in the developmental stage and can probably deploy systems capable of roughly twice the depth of penetration with twice the effectiveness of the systems known from their attacks on Iraq in 1991.

The nature and characteristics of such systems are classified. The newest, most advanced weapons in US service are the 5,000-pound BLU-122 and the 30,000-pound Massive Ordnance Penetrator (MOP). The MOP weighs almost 30,000 pounds and is able to carry 5,300 pounds of explosives. According to some estimates optimum penetrating distance for the MOP is up to 200 feet. Possible alternatives to these weapons are directed-energy and high-power microwave (HPM) weapons, none of which are currently beyond testing phase.

Again, it must be stressed that it is not clear whether such weapons could destroy all of Iran's most hardened underground sites, although it seems likely that they could do serious damage at a minimum. Much depends on the accuracy of reports that Iran has undertaken a massive tunneling project with some 10,000 square meters of underground halls and tunnels branching off for hundreds of meters from each hall.

Iran is reported to be drawing on North Korean expertise and to have created a separate corporation (Shahid Rajaei Company) for such tunneling and hardening efforts under the IRGC, with extensive activity already under way in Natanz and Isfahan, and possibly within the 3,000 centrifuge site inside the mountain complex at Fordow. The facilities are said to make extensive use of blast-proof doors, extensive divider walls, hardened ceilings, 20-centimeter-thick concrete walls, and double concrete ceilings with earth filled between layers to defeat earth penetrates. Such passive defenses could have a major impact, but reports of such activity are often premature, exaggerated, or report far higher construction standards than are actually executed.

Unlike Israeli, the US could also deploy enough forces with heavy hard-target and earth penetrating weapons to do serious damage to any Iranian site even if it were buried. It the US adopt a strike-assess-restrike approach it could use hard target killers like the GBU-28 and its precision guided equivalent to strike decisively at the more vulnerable hard or buried targets, and close the entrances and destroy the above ground service facilities for even the hardest targets. In a prolonged overwatch and restrike scenario, it could keep them shut or unusable indefinitely – effectively turning the hardening or burial of a facility into a trap – in not the equivalent of a tomb.

Even so, the problem is all too real. Regardless of these tactical options -- resources and the R&D the US is investing in creating an effective asset for destroying hardened underground objectives -- Iran’s nuclear sites remain challenging, and sites like Fordow are tough targets for any kind of strike. Despite the size and power of the MOP, reports surfaced in January of 2012 that it would not be capable of destroying some of Iran’s nuclear facilities because of their depth and new fortifications.[59]

According to the government officials who briefed the *Wall Street Journal*, the Pentagon is seeking to invest $82 million to make the bomb more effective against hardened, deeply-buried

[59] Entous, Adam and Barnes, Julian E. “Pentagon Seeks Mightier Bomb vs. Iran.” The Wall Street Journal. January 28, 2012. http://online.wsj.com/article/SB10001424052970203363504577187420287098692.html

structures such as Iran's nuclear sites.[60] In an interview with the Wall Street Journal, however, US Secretary of Defense acknowledged that the MOP could still do significant damage to Iran's sites in its current configuration, but not destroy them outright.[61]

Given the depth of the Fordow facility and its location inside of a mountain, one unnamed senior defense official even stated that conventional weaponry would not be effective in destroying the site, and that a tactical nuclear weapon may be the only military option to destroy it.[62] As such, the likelihood that Iran's nuclear facilities would be completely destroyed in a conventional attack seems uncertain.

US and allied decisionmakers, military planners, and intelligence experts cannot ignore these possibilities and options in deciding how to compete with Iran. Senior US intelligence officers have repeatedly warned in public that Iran has chemical and suspected biological weapon programs. Accordingly, options like missile defense, preemptive strikes, and extended regional deterrence must look beyond competition on a nuclear level.

The Aftermath of A US Preventive Attack

If the US ever did exercise a preventive attack option, it would face far less serious threats of Iranian retaliation than Israel in the form of non-state actors with ties to Iran like Hezbollah. The US could also take the time to assess battle damage, and carry out restrikes – while Israel might only be able to carry out one major strike before it faced political constraints it cannot ignore. The US might also be able to get regional support for a US presence and overwatch that would continue to strike Iran – if Iran attempts to reconstitute its nuclear and missile programs.

At the same time, the US would have to deal with the negative political consequences of the military aftermath of any strike, and the cost it will have to pay in terms of reactions from other states. Moreover, it must consider the impact strikes will have on the US conflicts in Iraq, Afghanistan, and the war on terror; whether US actions will provoke Iran into a massive new covert effort; and how Iran might react in attacking energy exports in the Gulf, Israel, and other US interests in the region.

As analyzed in Chapter III, Iran would also still have a wide range of surviving asymmetric warfare capabilities that it could use to strike at its neighbors or US targets. It could conduct some kind of spasmodic effort to close the Gulf – either having already lost many key conventional assets or being willing to accept further losses. It could conduct a long war of attrition using its asymmetric assets against non-US and/or US targets over time at levels that did not justify a major US retaliatory attack but kept up constant visible pressure.

Iran has a wide range of other options. It could use its long-range missiles and rockets to make politically symbolic or "terror" attacks on targets in the Gulf. It could seek to work with Syria, Hamas, and Hezbollah to attack Israel – attacking the US indirectly in the process. It could seek to attack a US ship or embassy outside the region, or to conduct another attack like the strike on the Marine Corps barracks in Lebanon or the USAF barracks at Al Khobar. It could try to

[60] Ibid.

[61] Ibid.

[62] Ibid.

sabotage a major oil exporting facility in Saudi Arabia or the rest of the Gulf to strike at the US economy, It could try the use the UN and World Court to charge aggression and discredit the US. And/or, it could use the opportunity to try to gain more direct influence or control in Iraq by force.

Once again, much would depend on the extent to which the leaders of friendly Gulf states were actually willing to back the US in such a post-preventive strike campaign, but any judgment about Gulf perceptions has to be speculative.

Neither the public statements of Gulf leaders, nor the kind of material available from sources like WikiLeaks, provides a clear indication of the links between US and Gulf perceptions of the Iranian threat at the official level, or their willingness to act. Moreover, current Gulf perceptions are certain to change over time just as Israeli and US perceptions will evolve as the Iranian threat alters and becomes more tangible, and perceptions in peacetime will be very different from perceptions once a conflict has begun – particularly if a US preventive strike is followed by some form of Iranian-initiative asymmetric attack or war in the Gulf .

It is far from clear that today's threat perceptions provide a clear picture for the future, and – as is outlined in depth in Chapter III – there are no rules or clear probabilities affecting Iran's choices or those of neighboring states. Iran can escalate in many different ways over very different periods of time, and do so even if the US is prepared to maintain a major air and sea overwatch and restrike capability and has the support of Arab Gulf states and other neighboring states in doing so.

Figure IV.73: Gulf Integrated Missile Defenses

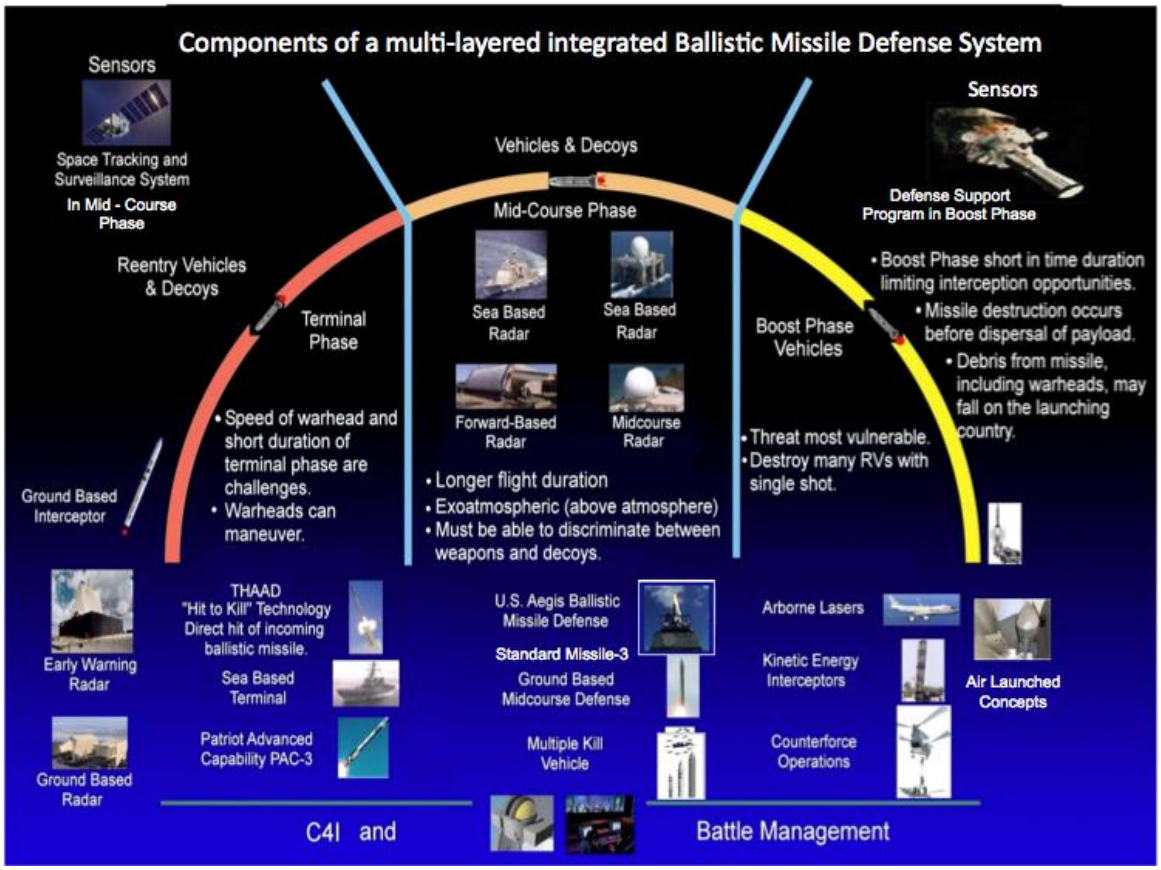

Figure IV.74: Key Assets for a US Strike on Iran

- **B-2A Spirit Bomber**

Primary Function	Multi role heavy bomber
Engines:	Four GE F-118-GE-100 engines, each with a thrust of 17,300 pounds (7,847kg)
Speed, Cruise:	High Subsonic
Ceiling:	50,000 ft (15,000 meters)
Weight Takeoff, (typical):	335,500 – 350,000 pounds (152,600 – 159,000kg)
Weight, Empty (typical):	125,000 – 160,000 pounds
Range:	6,000 nmi (9,600 km), unrefueled range for a Hi-Lo mission with nuclear free-fall bombs. 10,000 nmi with one aerial refueling.
Payload:	40,000 pounds (18,000kg)
Crew:	2 pilots
Current Armament:	**Nuclear:** 16 B61, 16 B83 **Conventional:** 80 MK82 (500lb), 16 MK84 (2000lb), 34-36 CBU-87, 34-36 CBU-89, 34-36 CBU-97 **Precision:** 216 GBU-39 SDB (250lb), 80 GBU-30 JDAM (500lb), 16 GBU-32 JDAM (2000lb), GBU-27, GBU-28, GBU-36, GBU-37, AGM-154 HSOW, 8-16 AGM-137 TSSAM, 2 MOP/DSHTW/Big BLU

- **GBU-57 Massive Ordnance Penetrator (MOP)**

GBU-57A/B Massive Ordnance Penetrator (MOP)	**Specifications**
Weight, total:	13,600kg (slightly less than 30,000 pounds)
Weight, explosive:	2,700kg (6,000lb)
Length:	6m/20.5 feet
Diameter:	31.5 in
Penetration:	60 meters (200ft) through 5,000 psi reinforced concrete. 40 meters (125ft) through moderately hard rock. 8 meters (25ft) through 10,000 psi reinforced

	concrete.
Control:	Short-span wings and trellis-type tail
Contractors:	Boeing, Northrop Grumman
Platforms:	B-52, B2
Guidance	GPS aided Inertial Navigation System

Figure IV.75: Potential US Strike on Iran's Key Known Nuclear Facilities

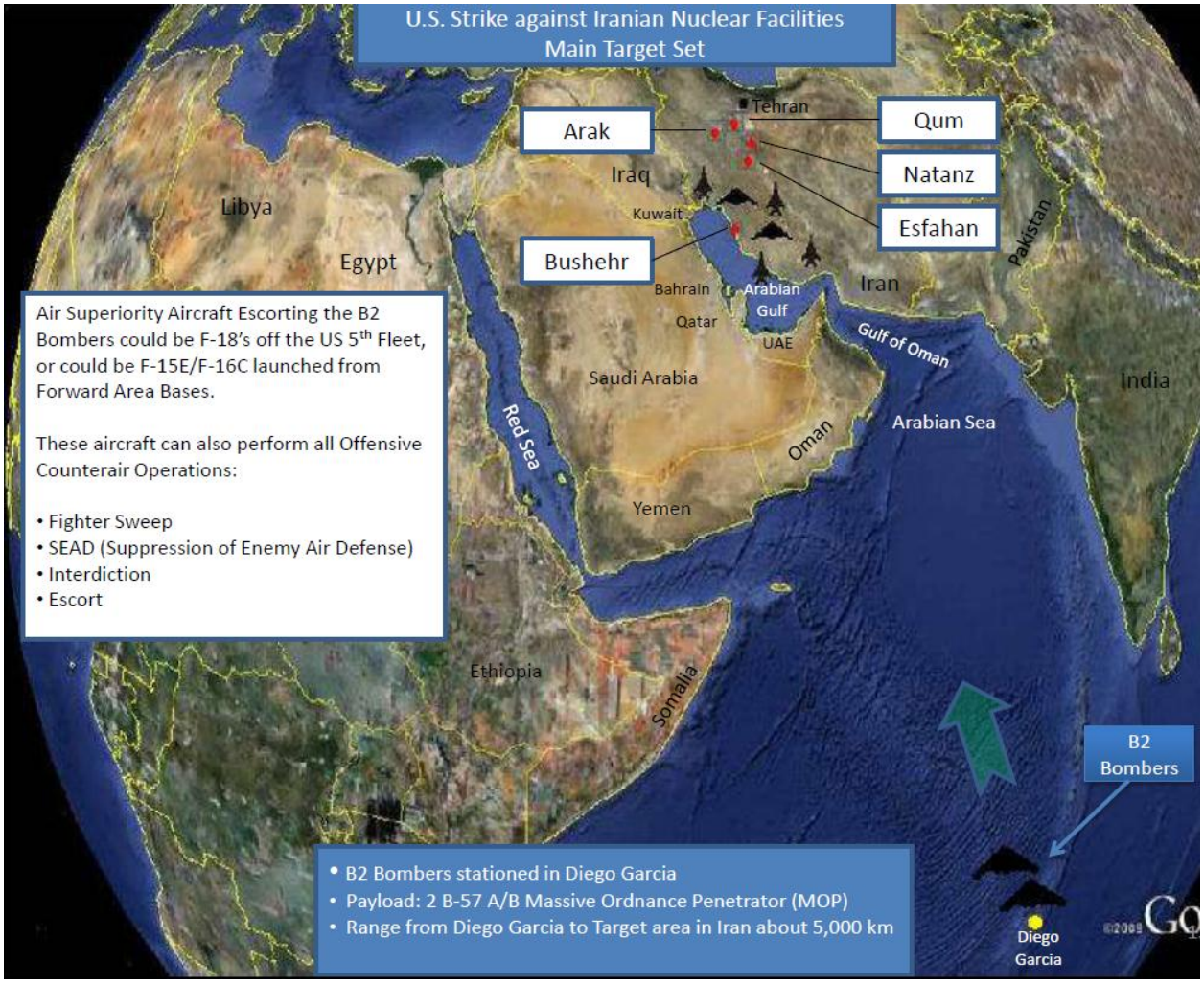

Figure IV.76: NTI List of Suspect Nuclear, Missile, and Biological Facilities

NUCLEAR

Nuclear-Conversion

- Jabr Ibn Hayan Mulitpurpose Laboratories (JHL)
- Rudan Conversion Facility
- Uranium Conversion Facility (UCF)

Nuclear-Education and Training

- Amir Kabir University of Technology
- Imam Hussein University (IHU)
- Institute for Studies in Theoretical Physics and Mathematics (IPM)
- Malek Ashtar University (MAU)
- Sharif University of Technology (SUT)
- University of Tehran (UT)

Nuclear-Enrichment

- 7th of Tir Industries
- Defense Industries Organization (DIO)
- Farayand Technique
- Fordow Fuel Enrichment Plant
- Fuel Enrichment Plant (FEP)
- Kalaye Electric Company
- Kaveh Cutting Tools Company/Abzar Boresh Kaveh Co
- Lashkar Ab'ad
- Natanz Enrichment Complex
- Pars Trash
- Pilot Fuel Enrichment Plant (PFEP)
- Tehran Nuclear Research Center (TNRC)

Nuclear-Fuel Fabrication

- Fuel Fabrication Laboratory (FFL)
- Fuel Manufacturing Plant (FMP)
- Zirconium Production Plant (ZPP)

Nuclear-Heavy Water Production

- Heavy Water Production Plant (HWPP)

Nuclear-Mining and Milling

- Ardakan Yellowcake Production Plant
- Bandar Abbas Uranium Production Plant (BUP)
- Saghand

Nuclear-Power Reactors

- Bushehr Nuclear Power Plant (BNPP)
- Darkhovin Nuclear Power Plant

Nuclear-Regulatory

- Atomic Energy Organization of Iran (AEOI)

Nuclear-Reprocessing

- Tehran Nuclear Research Center (TNRC)

Nuclear-Research Reactors

- IR-40
- Miniature Neutron Source Reactor (MNSR)
- Tehran Research Reactor (TRR)

Nuclear-Research and Development

- Bonab Atomic Energy Research Center
- Graphite Sub-Critical Reactor (ENTC GSCR)
- Heavy Water Zero Power Reactor (ENTC-HWZPR)
- Isfahan (Esfahan) Nuclear Fuel Research and Production Center (NFRPC)
- Isfahan (Esfahan) Nuclear Technology Center (INTC)
- Karaj Agricultural and Medical Research Center
- Light Water Sub-Critical Reactor (ENTC-LWSCR)
- Plasma Physics Research Center
- Tehran Nuclear Research Center (TNRC)
- Yazd Radiation Processing Center (YRPC)

Nuclear-Waste Management

- Anarak Waste Storage Facility
- Isafan (Esfahan) Nuclear Waste Storage Facility
- Karaj Waste Storage Facility
- Qom Waste Disposal Site

Nuclear-Weaponization

- Institute of Applied Physics (IAP)
- Kimia Maadan Company (KM)
- Parchin Military Complex
- Physics Research Center (PHRC)
- Tehran Nuclear Research Center (TNRC)

MISSILE

Missile-Education and Training

- Imam Hussein University (IHU)
- Malek Ashtar University (MAU)
- Sanam College

Missile-Missile Bases

- Abu Musa Island
- Bakhtaran Missile Base
- Bandar Abbas
- Imam Ali Missile Base
- Kuhestak Missile Battery
- Mashad Airbase
- Semnan Space and Missile Center
- Tabriz Missile Base

Missile-Production

- Bank Sepah

- Dorud
- Fajr Industrial Group
- Farhin
- Gostaresh Scientific Research Center
- Iran Aircraft Manufacturing Industries
- Isfahan Missile Complex
- Karaj Missile Development Complex
- Lavizan Technical and Engineering Complex
- Manzariyah
- Parchin Chemical Industries
- Parchin Military Complex
- Qods Aeronautics Industries
- Semnan Missile Complex
- Shahid Bakeri Industrial Group
- Shahid Hemmat Industrial Group
- Shiraz Missile Plant
- Sirjan Missile Plant
- Ya Mahdi Industries Group

Missile-Regulatory

- Aerospace Industries Organization (AIO)
- Defense Industries Organization (DIO)
- Ministry of Defense and Armed Forces Logistics (MODAFL)

Missile-Testing

- Garmsar Missile Test Range
- Shahroud Missile Test Site
- Tabas

BIOLOGICAL

Biological-Dual-Use Infrastructure

- Persian Type Culture Collection

Biological-Education and Training

- Amir Kabir University of Technology
- Sharif University of Technology Biochemical and Bioenvironmental Engineering Research Center
- Tehran University Institute for Biochemistry and Biosphysics Research (IBB)

Biological-Production

- Razi Institute for Serums and Vaccines
- Vira Laboratory

Biological-Regulatory

- Science and Technology Group

- Special Industries Organization (SIO)

Biological-Research and Development

- Biotechnology Institute of the Iranian Research Organization for Science and Technology
- Institute for Pestilence and Plant Disease Research
- Institute for Plant and Seed Modification Research
- Iranian Research Organization for Science and Technology
- National Research Center of Genetic Engineering and Biotechnology (NRCGEB)
- Pasteur Institute
- Research Center of the Construction Crusade (Jihad-e Sazandegi)

Chemical-Production

- Damghan

Source: NTI (Nuclear Threat Initiative), "Iran," Facilities, http://www.nti.org/country-profiles/iran/facilities/, updated February 2012.

Possible US War Plans: Attacking, Delaying, Waiting Out

There is no way to know how US intelligence exports, military planners, and officials currently assess US strike options, or to predict the details of how these options will evolve in the future. It is equally difficult to know what level of attacks the US would conduct, or their scale and persistence.

Much will depend on the exact nature of the intelligence available at a given time, complex calculation about the vulnerability of given targets and the effectiveness of specific munitions, the urgency the US feels in acting and its willingness to take risks in targeting and striking, allied support and international attitudes, and where Iran's programs stand at a given point in time.

If the US does choose to respond militarily, however, it could turn the broad options in its escalation ladder into the more detailed military options reflected in **Figure IV.77** through **Figure IV.82**.

It should be stressed that these are only rough outlines of such US options. They are not based on any inside knowledge of actual US war plans, and calculations.

- **Figure IV.77** reflects a potential scenario in which the US used limited "demonstrative" or "deterrent" strikes to coerce Iran into abandoning its efforts to acquire nuclear weapons without launching a full strike on Iran's nuclear facilities. It is unclear how Iran would respond to such action.
- **Figure IV.78** reflects a potential scenario in which the US used limited strikes to damage or destroy Iran's largest and most important nuclear sites.
- **Figure IV.79** reflects a potential scenario in which the US engaged in major strikes on Iran's CBRN and major missile targets.
- **Figure IV.80** reflects a potential scenario in which the US engaged in major attacks on Iran's nuclear facilities, major missile assets, as well as "dual use" assets that contribute to Iran's "technology base" such as universities.
- **Figure IV.81** reflects a potential scenario in which the US waited for Iran to provide proof of or a "smoking gun" that indicated nuclear proliferation to strike at the country's facilities.
- **Figure IV.82** reflects a potential scenario in which the US would not attack Iran's nuclear sites, but indicated nuclear targeting of Iran's military and CBRN facilities and its cities. Other potential action could include deploying anti-ballistic missile and cruise missile defense and tacitly signaling a "green light" for Israeli nuclear retaliation or preemption, among others.

Figure IV.77: US Demonstrative, Coercive, or Deterrent Strikes

- Conduct a few cruise missile or stealth strikes simply as a demonstration or warning of the seriousness of US intentions if Iran does not comply with the terms of the EU3 or UN.
- Hit at least one high value target recognized by IAEA and EU3 to show credibility to Iran, minimize international criticism.
- Might strike at new sites and activities to show Iran cannot secretly proceed with, or expand its efforts, by ignoring the UN or EU3.
- Could be carrier-based; would not need territory of Gulf ally.
- International reaction would be a problem regardless of the level of US action.
- Might trigger Iranian counteraction in Iraq, Afghanistan, and dealing with Hezbollah.

Figure IV.78: Limited US Attacks

- Limited strike would probably take 16-20 cruise missile and strike sorties. (Total sorties in Gulf and area would probably have to total 100 or more including escorts, enablers, and refuelers).
- Might be able to combine B-2s and carrier-based aircraft and sea-launched cruise missiles. Might well need land base(s) in Gulf for staging, refueling, and recovery.
- Goal would be at least 2-3 of most costly and major facilities critically damaged or destroyed.
- Hit at high value targets recognized by IAEA and EU3 to show credibility to Iran, minimize international criticism.
- Might strike at new sites and activities to show Iran cannot secretly proceed with, or expand its efforts, by ignoring the UN or EU3.
- Might slow down Iran if used stealth aircraft to strike at hard and underground targets, - but impact over time would probably still be more demonstrative than crippling.
- Hitting hard and underground targets could easily require multiple strikes during mission, and follow-on restrikes to be effective.
- Battle damage would be a significant problem, particularly for large buildings and underground facilities.
- Size and effectiveness would depend very heavily on the quality of US intelligence, and suitability of given ordnance, as well as the time the US sought to inflict a given effect.
- Iran's technology base would survive; the same would be true of much of equipment even in facilities hit with strikes. Little impact, if any, on pool of scientists and experts.
- Iranian response in terms of proliferation could vary sharply and unpredictably: Deter and delay vs. mobilize and provoke.
- Likely to produce cosmetic Iranian change in behavior at best. Would probably make Iran disperse program even more, and drive it to deep underground facilities. Might provoke to implement (more) active biological warfare program.
- Any oil embargo likely to be demonstrative.
- Would probably trigger Iranian counteraction in Iraq, Afghanistan, and dealing with Hezbollah.
- International reaction could be a serious problem; US might well face same level of political problems as if it had launched a comprehensive strike on Iranian facilities.

Figure IV.79: Major US Attacks on Iranian CBRN and Major Missile Targets

- 200-600 cruise missiles and strike sorties; would have to be at least a matching number of escorts, enablers, and refuelers. Period of attacks could extend from 3 to 10 days.
- Hit all suspect facilities for nuclear, missile, BW, and related C4IBM.
- Knock out key surface-to-air missile sites and radars for future freedom of action.
- Would need to combine B-2s, carrier-based aircraft and sea-launched cruise missiles, and use of land base(s) in Gulf for staging, refueling, and recovery.
- Threaten to strike extensively at Iranian capabilities for asymmetric warfare and to threaten tanker traffic, facilities in the Gulf, and neighboring states.
- At least 7-10 days to fully execute and validate.
- Goal would be at least 70-80% of most costly and major facilities critically damaged or destroyed.
- Hit at all high value targets recognized by IAEA and EU3 to show credibility to Iran, minimize international criticism, but also possible sites as well.
- Strike at all known new sites and activities to show Iran cannot secretly proceed with, or expand its efforts, unless hold back some targets as hostages to the future.
- Impact over time would probably be crippling, but Iran might still covertly assemble some nuclear device and could not halt Iranian biological weapons effort.
- Hitting hard and underground targets could easily require multiple strikes during mission, and follow-on restrikes to be effective.
- Battle damage would be a significant problem, particularly for large buildings and underground facilities.
- Size and effectiveness would depend very heavily on the quality of US intelligence and suitability of given ordnance, as well as the time the US sought to inflict a given effect.
- Much of Iran's technology base would still survive; the same would be true of many equipment items, even in facilities hit with strikes. Some impact, if any, on pool of scientists and experts.
- Iranian response in terms of proliferation could vary sharply and unpredictably: Deter and delay vs. mobilize and provoke.
- A truly serious strike may be enough of a deterrent to change Iranian behavior, particularly if coupled to the threat of follow on strikes in the future. It still, however, could as easily produce only a cosmetic Iranian change in behavior at best. Iran might still disperse its program even more, and shift to multiple, small, deep underground facilities.
- Might well provoke Iran to implement (more) active biological warfare program.
- An oil embargo might be serious.
- Iranian government could probably not prevent some elements in Iranian forces and intelligence from seeking to use Iraq, Afghanistan, support of terrorism, and Hezbollah to hit back at the US and its allies if it tried; it probably would not try.
- International reaction would be a serious problem, but the US might well face same level of political problems as if it had launched a small strike on Iranian facilities.

Figure IV.80: Major US Attacks on Military and Civilian Targets

- 1,000-2,500 cruise missiles and air strike sorties.
- Hit all suspect facilities for nuclear, missile, BW, and C4IBM, and potentially "technology base" targets including universities, dual use facilities.
- Either strike extensively at Iranian capabilities for asymmetric warfare and to threaten tanker traffic, facilities in the Gulf, and neighboring states or threaten to do so if Iran should deploy for such action.
- Would require a major portion of total US global assets. Need to combine B-2s, other bombers, and carrier-based aircraft and sea-launched cruise missiles. Would need land base(s) in Gulf for staging, refueling, and recovery. Staging out of Diego Garcia would be highly desirable.
- Would probably take several weeks to two months to fully execute and validate.
- Goal would be 70-80%-plus of most costly and major CBRN, missile and other delivery systems, key conventional air and naval strike assets, and major military production facilities critically damaged or destroyed.
- Hit at all high value targets recognized by IAEA and EU3 to show credibility to Iran, minimize international criticism, but also possible sites as well.
- Strike at all known new sites and activities to show Iran cannot secretly proceed with, or expand its efforts, unless hold back some targets as hostages to the future.
- Hitting hard and underground targets could easily require multiple strikes during mission, and follow-on restrikes to be effective.
- Impact over time would probably be crippling, but Iran might still covertly assemble some nuclear device and could not halt Iranian biological weapons effort.
- Battle damage would be a significant problem, particularly for large buildings and underground facilities.
- Size and effectiveness would depend very heavily on the quality of US intelligence and suitability of given ordnance, as well as the time the US sought to inflict a given effect.
- Much of Iran's technology base would still survive; the same would be true of many equipment items, even in facilities hit with strikes. Some impact, if any, on pool of scientists and experts.
- Iranian response in terms of proliferation could vary sharply and unpredictably: Deter and delay vs. mobilize and provoke.
- Such a series of strikes might be enough of a deterrent to change Iranian behavior, particularly if coupled to the threat of follow on strikes in the future. It still, however, could as easily produce only a cosmetic Iranian change in behavior at best. Iran might still disperse its program even more, and shift to multiple, small, deep underground facilities.
- Might well provoke Iran to implement (more) active biological warfare program.
- An oil embargo might be serious.
- Iranian government could probably not prevent some elements in Iranian forces and intelligence from seeking to use Iraq, Afghanistan, support of terrorism, and Hezbollah to hit back at the US and its allies if it tried; it probably would not try.
- International reaction would be a serious problem, and far greater than strikes that could be clearly associated with Iran's efforts to proliferate.

Figure IV.81: Delay and Then Strike

- The US could execute any of the above options, and wait until after Iran provided proof was proliferating. Such a "smoking gun" would create a much higher chance of allied support, and international tolerance or consensus.
- Iran will have committed major resources, and created much higher value targets.
- The counter-risk is an unanticipated Iranian break out; some form of Iranian launch on warning (LOW), launch under attack (LUA), or survivable "ride out" capability.
- Iranian dispersal and sheltering may be much better.
- Iran might have biological weapons as a counter.
- Allied and regional reactions would be uncertain. Time tends to breed tolerance of proliferation.

Figure IV.82: Ride Out Iranian Proliferation

- Announce or quietly demonstrate US nuclear targeting of Iran's military and CBRN facilities and cities.
- Tacitly signal US “green light” for Israeli nuclear retaliation or preemption.
- Deploy anti-ballistic and cruise missile defenses, and sell to Gulf and neighboring states.
- Signal US conventional option to cripple Iran by destroying its power generation, gas, and refinery facilities.
- Provide US guarantees of extended deterrence to Gulf states.
- Tacitly accept Saudi acquisition of nuclear weapons.
- Maintain preventive/preemptive option at constant combat readiness. Act without warning.
- Encourage Israel to openly declare its strike options as a deterrent.
- Announce doctrine that any Iranian use of biological weapons will lead to nuclear retaliation against Iran.

The Impact of Israeli-Iranian Nuclear Arms Race on US and Iranian Competition

The US cannot ignore the fact that Israel also has military options and that Israeli action might reshape the game board in this aspect of the competition between the US and Iran. While Iran does not yet possess a nuclear weapon, it already possesses aircraft and missiles with the range to target Israel, and Israel has nuclear armed missiles that can reach any target in Iran. This creates a de facto nuclear arms race in the Middle East, and creates an even stronger incentive for Israel to try to suppress Iran's nuclear program and missile capabilities than exists for the US and Arab Gulf states.

Israel's Fear of An "Existential Threat"

Despite Israel's advantage in weapons technology, one nuclear detonation on Israeli territory could prove to be an "existential" threat to Israel given its size, dependence on Tel Aviv and Haifa, and the impact of such a strike on Israel's political cohesion and Israeli emigration after such a strike.

Senior Israeli officials and officers have repeatedly made it clear that they fear any Iranian success in creating effective nuclear delivery capabilities will pose an "existential" threat to Israel in the sense that even one major nuclear strike on a city like Tel Aviv might produce enough casualties and damage to threaten Israel's cohesion as a state.

Israeli officials and officers have also focused heavily on the threat posed by Iran's missile programs – which already can reach any target in Israel and still present only a relatively problematic threat to the U.S. and Europe. The coverage of this threat is illustrated in the estimates of the nominal range of Iran's current missile developments, as has been shown in **Figure IV.1** – although these estimates do not include the longer ranges of several new Iranian developments, including its first long-range solid fuel missiles.

Senior Israeli officials and officers have never publically discussed exactly what this "existential" threat consists of. Moreover, any such discussion would necessarily have to be speculative. There is no magic number of casualties that determines the point at which a state cannot survive or so radically changes its character that its values change beyond recognition. There is no way to know what level of attack would lead an unsupportable number of survivors to emigrate, make economic recovery too difficult, or critically weaken the ability to defend Israel against outside threats.

Would it take one weapon? Three? Thirty? Will the prospect of an attack undermine Israel's cohesion and raise emigration? Will Israelis unify in the event of an attack? Some Israeli leaders may not be prepared to learn the answers or take such risks. They would prefer diplomatic solutions or to have the US take military action, but at least some perceive the threat as so serious in broad terms that they are prepared to strike preventively or preemptively to deny Iran the option – *if* they feel they have no choice, and *if* the Israeli Defense Force (IDF) concludes such strikes will be effective and produce acceptable costs in terms of U.S. and other international reactions.

The CIA estimates that Israel will have a population of some 7.6 million in mid-2012. Data on ethnicity is dated, but the CIA estimates this population is 76.4% Jewish (of which Israel-born

67.1%, Europe/America-born 22.6%, Africa-born 5.9%, Asia-born 4.2%), non-Jewish 23.6% (mostly Arab) (2004). It estimates religious divisions are Jewish 75.6%, Muslim 16.9%, Christian 2%, Druze 1.7%, other 3.8% (2008 census). [63] Israeli data are more current, but involve complex debates over ethnicity and defining resident. The population is mixed in many areas, but Jerusalem (780,000) is the only potential target which has both the religious significance and a large enough Muslim Arab population so as to deter Iranian nuclear targeting on an a largely Jewish population center.

Israel is 92% urbanized. While current estimates of its population in greater urban areas are uncertain for nuclear targeting purposes, the CIA estimates that a small number of Israel's major cities contain much of its population – the best educated part and most important in terms of Israel's Jewish economy and culture. [64] Nuclear strikes on only two Israeli cities -- Tel Aviv-Yafo 3.219 million and Haifa 1.027 million – could pose a major threat to Israel's existence in anything like its current form.[65]

The psychological and political dimensions of an Iranian attack would be as important as the physical and killing impact. Horrifying as a small nuclear attack with basic fission weapons with nominal yields of around 20 kilotons each would be, much of the population in a coastal city would survive an attack by one bomb, although the long-term death rate from radiation and fall out would later be significant. The question would then be how much of Israel's Jewish population – much of which could leave the country -- would stay, the reaction of Israel's Palestinians and Arab neighbors, and how nations outside the region would treat Israel's suffering.

A larger nuclear armed Iranian missile force that was still restricted to basic fission weapons with nominal yields of around 20 kilotons each could strike at Israel's key coastal cities using a mix of air and ground bursts to both achieve maximum near-term killing capability and to contaminate the area. It could do so without producing physical damage to Jerusalem, although strikes on Tel Aviv might produce significant fall out on Jerusalem or Palestinian areas under some conditions. It is unlikely that Iranian strikes limited to basic fission weapons would produce enough prompt damage and casualties to Israel's Jewish populations to make recovery impossible – although it might kill a significant percentage and the political and psychological impact might well reach the point where a significant percentage of the remaining population would leave.

An Iranian force armed with boosted fission weapons of 100 kilotons each or more – or thermonuclear weapons in the 1 megaton or larger range – is probably 6-10 years in the future if Iran can achieve such a force. It could deliver enough damage to destroy much of Israel's coastal cities and population. The damage done to Israel's Palestinian population would depend heavily on the prevailing winds and the height of burst of the Iranian nuclear explosions. Fall out models

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[63] Data based on "Israel": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/is.html.

[64] Data based on "Israel": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html.

[65] Data based on "Israel": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html.

are extremely difficult to calculate, and far less even than most nominal unclassified estimates indicate.

It is likely, however, that this level of Iranian strike would have far more impact on the Palestinians, and might affect neighboring Arab states to a much more significant degree, and it might produce a much more significant degree of contamination in Jerusalem. It is much less likely, however, that it would produce mass prompt Palestinian and Arab casualties versus cause a significant increase in the longer-term death rate from cancer and radiation poisoning.

The Unknowns in Assessing Israel's Calculations of Its Ability to Use Missile Defense, "Extended Deterrence," and Destroy Iran's Population Using Nuclear Weapons

An Israeli preventive strike is the alternative to Israeli reliance on the threat of retaliation in the form of an existential counterstrike on Iran, reliance on some degree of US "extended deterrence," and reliance on defenses like anti-missile systems and passive civil defense.

It must be stressed that there is no unclassified basis for understanding the degree to which Israeli leaders and defense planners feel a combination of Israel's undeclared nuclear forces, missile and air defenses, and support from the US in the form of additional missile defenses and an as yet undefined US extended regional deterrent could safely contain an Iranian threat and deter nuclear and missile attacks.

There are a variety of media and think tank reports that Israel has already extended the range-payload of its missile forces to be able to conduct nuclear strikes with thermonuclear weapons on any target in Iran. Iran also has key target points like Tehran, and Israel could conduct its own existential strikes on Iran by destroying some 5-7 major Iranian cities.

Unfortunately, there is no practical way to discuss Israeli or Iranian perceptions of what already is a covert nuclear and missile arms race tied to missile defenses, air capabilities, and possible submarine and sea launch forces. Comparing perceptions of an undeclared force relative to one that does not yet exist presents obvious problems, and it is one that has a major impact on both US competition with Iran and how the Arab Gulf states and other neighboring states assess the balance of present and future risks.

As Herman Khan noted, "thinking about the unthinkable" is anything but pleasant, but it is important to note that "existential" is a relative term shaped by the character and success of a specific attack. It is also important to remember that Israel's missile defenses might significantly limit the damage Iran's forces could inflict – particularly when their numbers remained small, warhead yields were limited, and they had few or no penetration aids. It is equally important to remember that Iran has long been vulnerable to Israel, Iran has no meaningful missile defenses, Israel has a mature force that probably has thermonuclear weapons, and Israel would not face the Jerusalem and Palestinian problem in inflicting nuclear damage.

The CIA estimates that Iran will have a population of some 78.8 million in mid-2012, and that it is well over 70% urbanized. While accurate current estimates of its urban population are uncertain, the CIA estimates that a small number of Iran's major cities contained much of its

population – the best educated part and most important in terms of its economy and culture. [66] A mix of several air and ground bursts in an Israeli thermonuclear or high fission yield attack on five key cities -- Tehran (capital) 7.19 million; Mashhad 2.592 million; Esfahan 1.704 million; Karaj 1.531 million; Tabriz 1.459 million – would probably destroy Iran as a nation in anything like its current form.[67] The greater metropolitan area of Tehran alone is home to some 8-9 million people. Furthermore, 45% of large Iranian industrial firms are located in Tehran, as is 50% of all Iranian industry. As such, an Israeli nuclear strike on Tehran would have disastrous consequences for the Iranian state and Israel could target every major Iranian city.

In actual practice, Israel can already deliver an "existential" nuclear strike on Iran, and will have far more capability to damage Iran than Iran is likely to have against Israel for the next decade. Moreover, Israel has steadily improving missile defenses, and the US has offered "extended deterrence" to Israel and the Arab states. This potentially could mean US retaliation for any Iranian nuclear attack on Israel or an Arab ally of the US.

Most of Iran's major cities are also far enough inland so that Israel could strike them with large numbers of ground and air bursts while doing only limited damage to neighboring states – all of which except Turkey and Pakistan are not key political actors. Israel could use airbursts on Iran's cities near its borders and minimize the risk of major amounts of fall out crossing borders and still inflict catastrophic damage on these cities.

Moreover, Israel could selectively target Iran's Persian population to pose an existential threat using fewer weapons. While such estimates are dated and uncertain, the CIA estimates that Iran's population has the following ethnic distribution: Persian (official) 53%, Azeri Turkic and Turkic dialects 18%, Kurdish 10%, Gilaki and Mazandarani 7%, Luri 6%, Balochi 2%, Arabic 2%, other 2% (2008 est.). [68] Nuclear targeting could also include key religious cities like Qom and all of Iran's major shrine cities and those with key theological seminars – effectively destroying the structure of the Shi'ite clergy and possibly much of the support for Iranian Shi'ite practices.

It should be noted, however, that as the attack levels rise – and to some degree even during limited attacks – a significant number of the missiles launched would not hit near their target. It is doubtful that either Israel or Iran would take the design risk of trying to create fail-safe arming mechanisms in their nuclear warheads that would keep such missiles from producing nuclear strikes. Given the probable attack vectors, some Arab population centers might be struck by accident and the fall out effects from any such strikes could produce significant longer-term casualties.

The Unknowns in Assessing Israel's Preventive Attack Options

Similarly, there is no practical way to determine exactly how Israel's senior policymakers and military leaders perceive the Israeli ability to identify, target, and destroy Iran's current nuclear

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[66] Data based on "Iran": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html.

[67] Data based on "Iran": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html.

[68] Data based on "Iran": section of the CIA World Factbook, accessed February 19, 2012, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html.

and other strike capabilities, or assess the degree to which this would give Israel security over time vs. provoking Iran into some massive new effort to acquire nuclear weapons. There is no way to determine the degree to which their public statements represent real war plans and threats versus efforts to push the US and the P5+1 group into taking a harder line with Iran, pushing the country to halt its efforts, or push the US towards a focus on military options.

These uncertainties include Israeli perceptions of the extent to which an Israeli strike on Iran would force the US to deal with the military aftermath or act as a trigger force option. They include Israeli assessments of the cost Israel would have to pay in terms of reactions from the U.S. and other states, and they include Israeli perceptions of how much damage Iran might be able to inflict using Hezbollah, Hamas, and other proxies and asymmetric means to attack Israel. It is clear from Israeli media and think tank publications that Israelis recognize these issues, but it is not clear how Israel's leaders and military planners perceive them.

The US has made it repeatedly clear in recent years that it is not giving Israel any kind of "green light" in conducting an attack on Iran. Both Secretary Clinton and Secretary Gates have given Israel this message, and Secretary Panetta seems to have repeated it since he replaced Secretary Gates. Key US military leaders like Admiral Mike Mullen and General David Petraeus have made it clear in public statements that they oppose any near-term Israeli strike on Iran, and see such options as deeply destabilizing at a time when the US is still engaged in Iraq and Afghanistan in addition to dealing with a broader struggle against Islamic extremism.[69]

General Martine Dempsey, the Chairman of the Joint Chiefs, made similar points in an interview in the *National Journal* after a visit to Israel in January 2012,[70]

> "We have to acknowledge that they (the Israeli) ... see that threat differently than we do. It's existential to them… My intervention with them was not to try to persuade them to my thinking or allow them to persuade me to theirs, but rather to acknowledge the complexity and commit to seeking creative solutions, not simple solutions…We are determined to prevent them (Iran) from acquiring that weapon, but that doesn't mean dropping bombs necessarily," he said. "I personally believe that we should be in the business of deterring as the first priority. I do think the path we're on—the economic sanctions and the diplomatic pressure—does seem to me to be having an effect…I just think that it's premature to be deciding that the economic and diplomatic approach is inadequate…A conflict with Iran would be really destabilizing, and I'm not just talking from the security perspective. It would be economically destabilizing.

The Ongoing Policy Debate Within Israel Regarding a Preemptive Strike on Iran

There have been many reports that Israel is planning a preventive or preemptive strike on Iran, including leaks of official reports. Material released by Wikileaks indicates, for example, that as of 2005, [71]

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[69] "'Military strike won't stop Iran's nuclear program'," *Haaretz,* February 22, 2010. http://www.haaretz.com/news/military-strike-won-t-stop-iran-s-nuclear-program-1.266113

[70] Yitzhak, Benhorin, Dempsey: US, Israel view Iran threat very differently; US army chief says Washington determined to prevent nuclear Iran, 'but that doesn't mean dropping bombs necessarily' YNet, January 27, 2012,, http://www.ynetnews.com/articles/0,7340,L-4181550,00.html

> Senior defense officials ruled out an Israeli military attack on Iran's nuclear sites as early as five and a half years ago, telegrams sent from the U.S. embassy in Tel Aviv in 2005 and 2006 indicate. The cables, which were revealed over the weekend, are among hundreds of thousands shared exclusively with Haaretz by the Wikileaks website. In the first telegram, sent on December 2, 2005, American diplomats said their conversations with Israeli officials indicate that there is no chance of a military attack being carried out on Iran. A more detailed telegram was sent in January 2006, summing up a meeting between U.S. Congressman Gary Ackerman (a Democrat for New York) and Dr. Ariel Levite, then deputy chief of Israel's Atomic Energy Commission. "Levite said that most Israeli officials do not believe a military solution is possible," the telegram ran. "They believe Iran has learned from Israel's attack on Iraq's Osirak reactor, and has dispersed the components of its nuclear program throughout Iran, with some elements in places that Israel does not know about."

Various versions of such reports have surfaced in the form of media reports of policy debates within Israel's leadership and intelligence community regarding a possible strike on Iran's nuclear program. Meir Dagan, the former chief of Mossad, testified to the Knesset Foreign Affairs and Defense Committee on January 6, 2011 that he did not believe that Iran would have a nuclear weapons capability before "2015 approximately."[72] The Israeli newspaper *Haaretz* reported the next day that Dagan had said Iran was a long way from being able to produce nuclear weapons, following a series of failures that had set its program back by several years.[73]

Other Israeli officials – including Prime Minister Netanyahu – contradicted Dagan. On January 25, 2011, Israel's head of military intelligence, Brigadier General Aviv Kochavi, testified to the same Foreign Affairs and Defense Committee that, "The question is not when Iran will acquire the bomb, but how long until the leader decides to begin enriching (uranium) at 90 percent… Once such a decision is made, it would take 'a year or two' to produce a nuclear warhead," he said, adding that Iran would then need more time to develop an effective missile delivery system for it.[74]

Kochavi is reported to have said that it was unlikely that Iran, which then had enriched uranium to 20 percent, would start enriching it to the 90 percent level needed for a bomb because it would be in open breach of the nuclear Non-Proliferation Treaty, exposing it to harsher sanctions or even a US or Israeli military strike. He said Iran was reluctant to do this at a time when the country was going through a period of "instability" and "religious tension." "At the moment, it's not in Iran's interest to move their program ahead," he told the committee.[75] These comments

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[71] Yossi Melman, "2005 report says senior defense officials did not believe an attack similar to Israel's assault on Iraq's Osirak reactor was possible," 03:12 10.04.11, http://www.haaretz.com/print-edition/news/haaretz-wikileaks-exclusive-israel-ruled-out-military-option-on-iran-years-ago-1.355024

[72] Yossi Melman. "Outgoing Mossad chief: Iran won't have nuclear capability before 2015." Haaretz, Jan. 6, 2011 http://www.haaretz.com/print-edition/news/outgoing-mossad-chief-iran-won-t-have-nuclear-capability-before-2015-1.335656.

[73] Lis, Jonathan. "Former Mossad chief: Nuclear Iran must not be neglected like North Korea." *Haaretz*. January 17, 2011. http://www.haaretz.com/news/diplomacy-defense/former-mossad-chief-nuclear-iran-must-not-be-neglected-like-north-korea-1.337569

[74] Jonathan Lis. "New MI chief: Iran could have nukes within two years." Haaretz, Jan. 25 2010 http://www.haaretz.com/news/diplomacy-defense/new-mi-chief-iran-could-have-nukes-within-two-years-1.339137

[75] "Iran not working on bomb: Israel intelligence head." *AFP*. January 25, 2011. http://www.google.com/hostednews/afp/article/ALeqM5gShKfmWcoQ1ABBQ_DodMUUh61ckA

have come amid reports that Israel was involved in a plot to sabotage Iran's nuclear program through a destructive computer worm called Stuxnet, and might have been involved in the assassination of Iranian nuclear experts.

It is also important to note that Israeli officials and officers – like those in the US – have a long history of revising Israeli threat perceptions and changing such estimates. As *Haaretz* noted on January 6, 2011,[76]

> "The Israeli intelligence community's assessments of Iran's nuclear capability have changed during Dagan's tenure," the story noted. "In 2003, Israeli intelligence officials thought Iran would have its first bomb by 2007. In 2007, they thought it would be 2009, and a year later they put it at 2011. Now the date has moved to 2015. These adjustments were not the result of mistaken evaluations, but due to the difficulties Iran has encountered in advancing its program, largely because of the Mossad's efforts…Dagan's term centered around two main issues: the Iranian nuclear program; and the assassinations of Hezbollah and Hamas leaders and Iranian scientists, most if not all of which have been attributed to the Mossad."

This helps to explain why public and leaked statements emanating from key individuals within the Israeli government in the fall and winter of 2011 that indicated that Israel might be more active in considering a strike.

- *"It is obvious that no option should be removed from the table, and that diplomacy must be conducted intensively and urgently."* – Israeli Minister of Defense, Ehud Barak
- *"Today, as opposed to the past, the world has no doubt that the Iranian military nuclear program is steadily approaching maturity and is about to enter the zone of immunity, after which the Iranian regime will be able to complete the program without effective interruption and at a time it finds convenient.*

  The dividing line may not pass not where the Iranians decide to break out of the non-proliferation treaty and move toward a nuclear device or weapon, but at the place where the dispersal, protection, and survivability efforts will cross a point that would make a physical strike impractical.

  The assessment of many experts around the world, not only here, is that the result of avoiding action will inevitably be a nuclear Iran, and that dealing with a nuclear Iran will be more complicated, more dangerous, and more costly in blood and money than stopping it." – Israeli Minister of Defense, Ehud Barak
- *"It's clear to all that a nuclear Iran is a grave danger and the whole world, led by the United States, must make constant efforts to stop Iran from obtaining nuclear weapons. The Iranians already have more than four tons of 3-4 percent enriched uranium and 70 kgs. of 20 percent enriched uranium. It's clear to us they are continuing to make missiles. Iran's nuclearization is not only a threat to Israel but to several other Western states, and the international interest must unite here."* – Israeli Minister of Intelligence and Atomic Energy, Dan Meridor
- *"This is a complicated time and it's better not to talk about how complicated it is. This possible action is keeping me awake at night. Imagine we're [attacked] from the north, south and center. They have short-range and long-range missiles - we believe they have about 100,000 rockets and missiles."* – Israeli Interior Minister, Eli Yishai
- *"One of those regional powers is Iran, which is continuing its efforts to obtain nuclear weapons. A nuclear Iran would constitute a grave threat to the Middle East and the entire world, and of course it is a direct and grave threat on us."* – Israeli Prime Minister, Benjamin Netanyahu

[76] Melman, Yossi. "Outgoing Mossad chief: Iran won't have nuclear capability before 2015." *Haaretz*. January 7, 2011. http://www.haaretz.com/print-edition/news/outgoing-mossad-chief-iran-won-t-have-nuclear-capability-before-2015-1.335656

- *"I don't think that that is a subject for public discussion. But I can tell you that the IAEA report is, has a sobering impact on many in the world leaders, as well as the publics, and people understand that the time has come. Amano told straightly what he found, unlike Baradei, and it became a major issue that I think duly so, becomes a major issue for sanctions, for intensive diplomacy, with urgency. People understand now that Iran is determined to reach nuclear weapons. No other possible or conceivable explanation for what they have been actually doing. And that should be stopped."* – Israeli Minister of Defense, Ehud Barak

- *"As long as no such sanctions have been imposed and proven effective, we continue to recommend to our friends in the world and to ourselves, not to take any option off the table.*

  This outlandish depiction (by the media) of two people, the prime minister and the defense minister, sitting in a closed room and leading the entire country into an adventurist operation is baseless and divorced from reality.

  We haven't decided yet to embark on any operation… We don't want war.

  I tell you there won't be 100,000 casualties, and not 10,000 casualties and not 1,000 casualties… And Israel won't be destroyed." – Israeli Minister of Defense, Ehud Barak

- *"The possibility of a military strike on Iran is more likely to be realized than the diplomatic option.*

  I do not think there has already been a decision on the matter, but it appears that Iran is getting closer to obtaining nuclear weapons." – Israeli President, Shimon Peres

- *"I think that one has to use diplomatic pressure and sanctions on Iran.*

  I refuse to be intimidated, as if Iran could destroy Israel.

  Israel is the most powerful country, from Tripoli to Tehran. There is no reason to be afraid of anything." – Israeli Minister of Defense, Ehud Barak

- *"A situation could be created in the Middle East in which Israel must defend its vital interests in an independent fashion, without necessarily having to reply on other forces, regional or otherwise."* – Israeli Minister of Defense, Ehud Barak

- *"The more Iran believes that all options are on the table, the less the chance of confrontation."* – Israeli Prime Minister, Benjamin Netanyahu

- *"The war won't be against Iran, but will be a regional war. I recommend that the prime minister not decide to attack... I will express my opinion anyway. I am not prepared for it to be on my conscience that there will be a repeat of what happened in 1973."* – Former Head of the Mossad, Meir Dagan[77]

It is hard to put such statements in context. As has been touched upon earlier, Israel has every reason to make threats and develop options as a means of reinforcing US and other efforts to find a solution through sanctions and diplomacy. Israel's fractious politics almost ensure there is no unified message emanating from the Israeli leadership regarding an Israeli preemptive attack, and it is clear that those involved in the debate are divided regarding the effectiveness and potential ramifications of such a strike.

Israeli leaders have shown considerable caution. In late May of 2011, Prime Minister Netanyahu stated that "the more Iran believes that all options are on the table, the less the chance of

[77] Quotes obtained from a number of Western and Israeli news outlets, including but not limited to Ha'aretz, New York Times, the Washington Post, and others.

confrontation" in a speech to the US Congress.[78] In a speech at Tel Aviv University during the same period, Meir Dagan, the former head of the Mossad, made the following statement regarding a potential attack on Iran's nuclear facilities,

> "The war won't be against Iran, but will be a regional war. I recommend that the prime minister not decide to attack."[79]

Further referring to the possibility of such an attack, Dagan stated,

> "I will express my opinion anyway. I am not prepared for it to be on my conscience that there will be a repeat of what happened in 1973."[80]

According to Israeli media reports, Dagan reportedly stated that such a strike was "the stupidest thing I have ever heard" in a public conference.[81] Such statements made by the former director of the Mossad cannot be taken lightly.

Meir Dagan was not the only individual who expressed doubts about an Israeli strike on Iran's facilities. In early November of 2011, former Israeli Minister of Defense, Benjamin Ben-Eliezer, said he feared a "horror scenario" in which Netanyahu and Barak decide to attack Iran. He warned of a "rash act" and said he hoped "common sense will prevail."[82] Once again, statements made by Benjamin Ben-Eliezer, who, like Meir Dagan, held a top post in the Israeli defense community, must be taken seriously. While nebulous and ill-defined, they show that there is an unmistakable opposition to an Israeli strike on Iran within the Israeli defense community.

Speaking to the potential repercussions of such an attack, Israel's Interior Minister, Eli Yishai, stated in an October 31, 2011 speech to Shas activists in northern Israel that,

> "This is a complicated time and it's better not to talk about how complicated it is. This possible action is keeping me awake at night. Imagine we're [attacked] from the north, south and center. They have short-range and long-range missiles - we believe they have about 100,000 rockets and missiles."[83]

More recent statements by high-level current and former figures in the Israeli government indicate that there is no a consensus about the immediate severity of the Iranian threat and how exactly the threat should be addressed by the Israeli government. Yishai and Dagan's remarks were followed in April 2012 by those of Lieutenant-General Benny Gantz, Chief of Staff of the Israeli Defense Forces. The general stated, "I think the Iranian leadership is comprised of very rational people."

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[78] Ravid, Barak; Harel, Amos; Zrahiya, Zvi; Lis, Jonathan. "Netanyahu Trying to Persuade Cabinet to Support Attack on Iran." Ha'aretz. November 2, 2011. http://www.haaretz.com/print-edition/news/netanyahu-trying-to-persuade-cabinet-to-support-attack-on-iran-1.393214

[79] Ibid.

[80] Ibid.

[81] Buck, Tobias. "Ex-spymasters Oppose Iran Attack." Financial Times. November 11, 2011. http://www.ft.com/cms/s/0/fbbe0342-0c57-11e1-88c6-00144feabdc0.html#axzz1exldRNQb

[82] Ibid.

[83] Ravid, Barak; Harel, Amos; Zrahiya, Zvi; Lis, Jonathan. "Netanyahu Trying to Persuade Cabinet to Support Attack on Iran." Ha'aretz. November 2, 2011. http://www.haaretz.com/print-edition/news/netanyahu-trying-to-persuade-cabinet-to-support-attack-on-iran-1.393214

His statement also seems to indicate that he believes that Iran has not yet committed itself to developing a nuclear weapon:

> "Iran is moving step-by-step towards a point where it will be able to decide if it wants to make a nuclear bomb. It has not decided yet whether to go that extra mile."[84]

Also in April, Yuval Diskin --the former director of the Shin Bet, Israel's internal security organization -- spoke out against what he believes is the aggressive leadership of Prime Minister Netanyahu and Defense Minister Barak on the Iran issue, and their alleged deception in pursuing policies that may not ensure Israeli security. Diskin stated:

> "I have no faith in the current leadership, which must lead us in an event on the scale of war with Iran or a regional war…I don't believe in a leadership that makes decisions based on messianic feelings…They are misleading the public on the Iran issue. They tell the public that if Israel acts, Iran won't have a nuclear bomb. This is misleading. Actually, many experts say that an Israeli attack would accelerate the Iranian nuclear race."[85]

Shortly after Diskin's statement, former Prime Minister Ehud Olmert expressed concern about an immediate strike against Iran. He stated, "There is enough time to try different avenues of pressure to change the balance of power with Iran without the need for a direct military confrontation with Iran and now is not the right time."[86]

In May, Prime Minister Netanyahu brought the Kadima Party into his government – partly in an effort to avoid an early election that could have removed Defense Minister Ehud Barak from the cabinet,. The leader of the Kadima Party, former Minister of Defense Shaul Mofaz, is yet another public figure that has spoken out against a strike on Iran. It is unclear what impact the new coalition will have on Israeli security policy pertaining to Iran. The new coalition could bring balance to the government as a counterweight to what some feel is Netanyahu and Barak's focus on a military solution. On the other hand, it also helps to protect Barak by avoiding early elections.[87]

In other cases, senior Israeli officials said that the US was the only power that would be fully capable of, and should, carrying out such an attack. Moreover, some Israeli (as well as some outside) experts disagree over whether the extent of Iran's threat to Israel is more than rhetoric, or if Iran would risk attacking a nuclear-armed Israel. Some feel that Iran finds Israel to be a convenient stalking horse and way of justifying a massive military and missile build-up that is primarily intended to give Iran leverage over the Gulf, other Arab states, and Iran's neighbors and limit US military freedom of action.

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[84] "Israel's Top General Says Iran Unlikely to Make Bomb." Reuters. Jeffrey Heller and Maayan Lubell. April 25, 2012. http://www.reuters.com/article/2012/04/25/us-israel-iran-idUSBRE83O1J820120425

[85] "Israel's Leaders Increasingly Isolated on Iran." ABC News. April 30, 2012. http://abcnews.go.com/blogs/headlines/2012/04/israels-leaders-increasingly-isolated-on-iran/

[86] "Former Israeli Premier Olmert Cautions Against Iran Strike." Bloomberg. Gwen Ackerman and Jonathan Ferziger. April 30, 2012. http://www.bloomberg.com/news/2012-04-30/former-israeli-premier-olmert-says-now-not-time-to-strike-iran.html

[87] Isabel Kershner. "New Israel Partner Offers Moderate Voice on Iran." New York Times. May 8, 2012. http://www.nytimes.com/2012/05/09/world/middleeast/netanyahu-new-partner-shaul-mofaz-less-hawkish-on-iran-nuclear-issue.html?_r=1

In any case, the rising Iranian threat led several Israel leaders to take a harder stance. Key policymakers like Israel's Prime Minister, Benjamin Netanyahu, Minister of Defense, Ehud Barak, and President Shimon Peres, sharply increased the frequency with which they discussed the possibility or likelihood of a preemptive attack on Iran's nuclear facilities in late 2011 – as Iran moved towards higher levels of enrichment and shifted to better sheltered facilities.

On October 31, 2011, Ehud Barak alluded to what seemed to be a potential unilateral Israeli attack by stating,

> "A situation could be created in the Middle East in which Israel must defend its vital interests in an independent fashion, without necessarily having to reply [sic] on other forces, regional or otherwise."[88]

In a November 8, 2011 interview, Barak also stated that,

> "I tell you there won't be 100,000 casualties, and not 10,000 casualties and not 1,000 casualties, and Israel won't be destroyed."[89]

Lastly, on November 2, 2011, Benjamin Netanyahu elucidated his perception of the Iranian nuclear threat, stating,

> "One of those regional powers is Iran, which is continuing its efforts to obtain nuclear weapons. A nuclear Iran would constitute a grave threat to the Middle East and the entire world, and of course it is a direct and grave threat on us."[90]

Senior Israeli officials provided an unusual amount detail in interviews for an article in the New York Times in late January 2012. [91] Israeli Minister of Defense, Ehud Barak, made it explicitly clear both that Israel saw an unacceptable threat, and that the US and Israel sometimes had different perspectives, [92]

> "I accept that Iran has other reasons for developing nuclear bombs, apart from its desire to destroy Israel, but we cannot ignore the risk," he told me earlier this month. "An Iranian bomb would ensure the survival of the current regime, which otherwise would not make it to its 40th anniversary in light of the admiration that the young generation in Iran has displayed for the West. With a bomb, it would be very hard to budge the administration." Barak went on: "The moment Iran goes nuclear, other countries in the region will feel compelled to do the same. The Saudi Arabians have told the Americans as much, and one can think of both Turkey and Egypt in this context, not to mention the danger that weapons-grade materials will leak out to terror groups.
>
> "From our point of view," Barak said, "a nuclear state offers an entirely different kind of protection to its proxies. Imagine if we enter another military confrontation with Hezbollah, which has over 50,000 rockets that threaten the whole area of Israel, including several thousand that can reach Tel Aviv. A nuclear Iran announces that an attack on Hezbollah is tantamount to an attack on Iran. We would not necessarily give up

[88] "Benjamin Netanyahu Pushes For Pre-Emptive Strike On Iran, According To Reports." Huffington Post. November2, 2011. http://www.huffingtonpost.com/mobileweb/2011/11/02/benjamin-netanyahu-iran-strike_n_1072136.html

[89] Teibel, Amy. "Israeli Minister Warns Iran Strike is Possible." Associated Press. November 8, 2011. http://articles.boston.com/2011-11-08/news/30373971_1_nuclear-program-israeli-military-strike-iranian-program

[90] Ravid, Barak; Harel, Amos; Zrahiya, Zvi; Lis, Jonathan. "Netanyahu Trying to Persuade Cabinet to Support Attack on Iran." Ha'aretz. November 2, 2011. http://www.haaretz.com/print-edition/news/netanyahu-trying-to-persuade-cabinet-to-support-attack-on-iran-1.393214

[91] Ronen Bergman, "Will Israel Attack Iran?", New York Times Magazine, January 29, 2012, pp. 22-29, 38.

[92] Ibid.

> on it, but it would definitely restrict our range of operations…"And if a nuclear Iran covets and occupies some gulf state, who will liberate it? The bottom line is that we must deal with the problem now
>
> …"Our discourse with the United States is based on listening and mutual respect, together with an understanding that it is our primary ally. The U.S. is what helps us to preserve the military advantage of Israel, more than ever before. This administration contributes to the security of Israel in an extraordinary way and does a lot to prevent a nuclear Iran. We're not in confrontation with America. We're not in agreement on every detail, we can have differences — and not unimportant ones — but we should not talk as if we are speaking about a hostile entity."."""

Israel's Deputy Prime Minister, Moshe Ya'lon was quoted as saying,[93]

> We have had some arguments with the U.S. administration over the past two years, but on the Iranian issue we have managed to close the gaps to a certain extent. The president's statements at his last meeting with the prime minister — that 'we are committed to prevent ' and 'all the options are on the table' — are highly important. They began with the sanctions too late, but they have moved from a policy of engagement to a much more active (sanctions) policy against Iran. All of these are positive developments…. (However) The main arguments are ahead of us. This is clear.

It is also important to note that even those Israeli officials who have taken a more cautious view of the urgency and pace of the Iranian threat in the past did back other forms of active attempts to halt Iran's efforts. Meir Dagan, then head of the Mossad, began to implement a "five-front strategy" to halt Iran using a combination of political pressure, covert measures, counter proliferation, sanctions and regime change no later than 2007. He sent a cable to his US counterparts in 2007 that was later leaked to the media, and that sated, "the United States, Israel and like-minded countries must push on all five fronts in a simultaneous joint effort…Some are bearing fruit now. Others…will bear fruit in due time, especially if they are given more attention."[94]

There is no public Israeli consensus as to when Iran would acquire meaningful nuclear capabilities. Meir Dagan, the former chief of Mossad, testified to the Knesset Foreign Affairs and Defense Committee on January 6, 2011 that he did not believe that Iran would have a nuclear weapons capability before "2015 approximately."[95] The Israeli newspaper *Haaretz* reported the next day that Dagan had had said Iran was a long way from being able to produce nuclear weapons, following a series of failures that had set its program back by several years.[96]

Other Israeli officials – including Prime Minister Netanyahu – contradicted Dagan. Moreover, other Israeli intelligence officers since have been more nuanced. According to *Haaretz* reports on January 25, 2011, Israel's head of military intelligence, Brigadier General Aviv Kochavi, testified to the same Foreign Affairs and Defense Committee that, "The question is not when Iran

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[93] Ronen Bergman, "Will Israel Attack Iran?", New York Times Magazine, January 29, 2012, pp. 22-29, 38.

[94] Ibid.

[95] Yossi Melman. "Outgoing Mossad chief: Iran won't have nuclear capability before 2015." Haaretz, Jan. 6, 2011 http://www.haaretz.com/print-edition/news/outgoing-mossad-chief-iran-won-t-have-nuclear-capability-before-2015-1.335656

[96] Lis, Jonathan. "Former Mossad chief: Nuclear Iran must not be neglected like North Korea." *Haaretz.* January 17, 2011. http://www.haaretz.com/news/diplomacy-defense/former-mossad-chief-nuclear-iran-must-not-be-neglected-like-north-korea-1.337569

will acquire the bomb, but how long until the leader decides to begin enriching (uranium) at 90 percent… Once such a decision is made, it would take "a year or two" to produce a nuclear warhead," he said, adding that Iran would then need more time to develop an effective missile delivery system for it.[97]

Kochavi is reported to have said that it was unlikely that Iran, which currently enriched uranium to 20 percent, would start enriching it to the 90 percent level needed for a bomb because it would be in open breach of the nuclear Non-Proliferation Treaty, exposing it to harsher sanctions or even a U.S. or Israeli military strike. He said Iran was reluctant to do this at a time when the country was going through a period of "instability" and "religious tension." "At the moment, it's not in Iran's interest to move their program ahead," he told the committee.[98] These comments have come amid reports that Israel was involved in a plot to sabotage Iran's nuclear program through a destructive computer worm called Stuxnet, and might have been involved in the assassination of Iranian nuclear experts.

It is also important to note that Israel – like the United States – has a long history of revising its threat perceptions and changing such estimates. As *Haaretz* noted on January 6, 2011,[99]

> "The Israeli intelligence community's assessments of Iran's nuclear capability have changed during Dagan's tenure," the story noted. "In 2003, Israeli intelligence officials thought Iran would have its first bomb by 2007. In 2007, they thought it would be 2009, and a year later they put it at 2011. Now the date has moved to 2015. These adjustments were not the result of mistaken evaluations, but due to the difficulties Iran has encountered in advancing its program, largely because of the Mossad's efforts…Dagan's term centered around two main issues: the Iranian nuclear program; and the assassinations of Hezbollah and Hamas leaders and Iranian scientists, most if not all of which have been attributed to the Mossad."

Israeli officials have since had to deal with growing warnings from the President, the Secretary of Defense, and the Chairman of the Joint Chiefs that the US opposes an Israeli preventive strike. This led to a new series of conflicting statements by Israeli senior political figures, officials and officers, and made preventive strikes a key issue in Prime Minster Netanyahu's visit to Washington in March 2012. On the one hand it led to uncertain press reports of detailed Israeli strike plans, claims Iran was developing ICBMs to attack the US, and that Israel would not notify the US if it did launch a preventive strike. On the other hand, it led a senior statesman like Israel's President Shimon Peres to state that an Israeli strike might be necessary and that, [100]

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[97] Jonathan Lis. "New MI chief: Iran could have nukes within two years." Haaretz, Jan. 25 2010 http://www.haaretz.com/news/diplomacy-defense/new-mi-chief-iran-could-have-nukes-within-two-years-1.339137

[98] "Iran not working on bomb: Israel intelligence head." *AFP.* January 25, 2011. http://www.google.com/hostednews/afp/article/ALeqM5gShKfmWcoQ1ABBQ_DodMUUh61ckA

[99] Melman, Yossi. "Outgoing Mossad chief: Iran won't have nuclear capability before 2015." *Haaretz.* January 7, 2011. http://www.haaretz.com/print-edition/news/outgoing-mossad-chief-iran-won-t-have-nuclear-capability-before-2015-1.335656

[100] Jodi Rudoren, "Peres Says U.S. Must Put All Iran Options on Table," New York Times, March 1, 2012, http://www.nytimes.com/2012/03/02/world/middleeast/peres-says-us-must-put-all-iran-options-on-table.html?_r=1

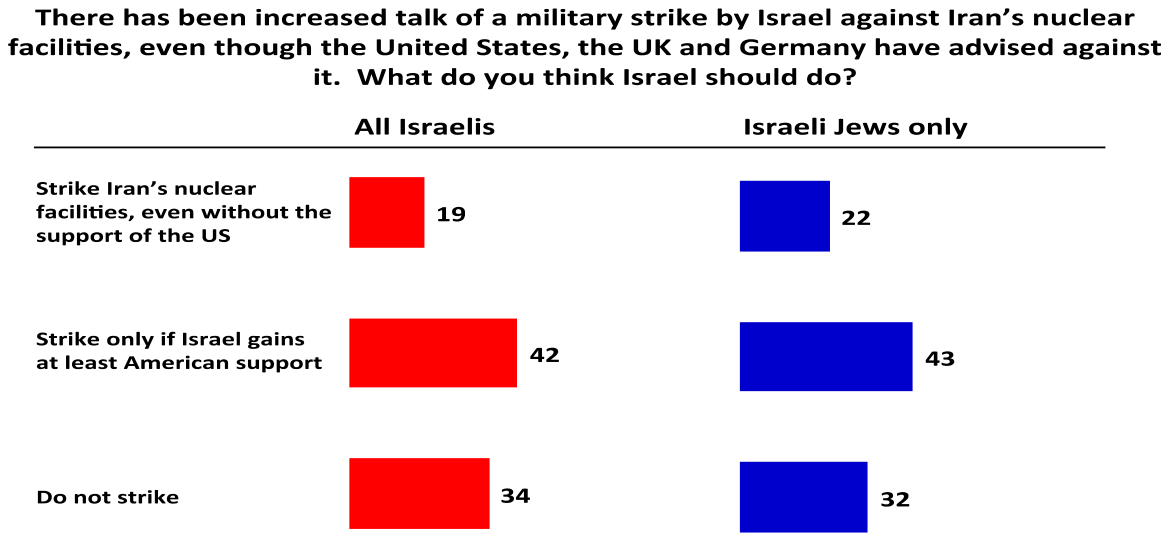
> We need a total and clear commitment that the catastrophe of Iran will not create an impossible situation.. If you can achieve it by economic and political measures, yes, that's the best way to start. But in order that the Iranians will take it seriously, you have to say, 'Gentlemen, we'll try the way which may be the best, but all the other options are on the table…You have to be decisive…You have to make a choice."

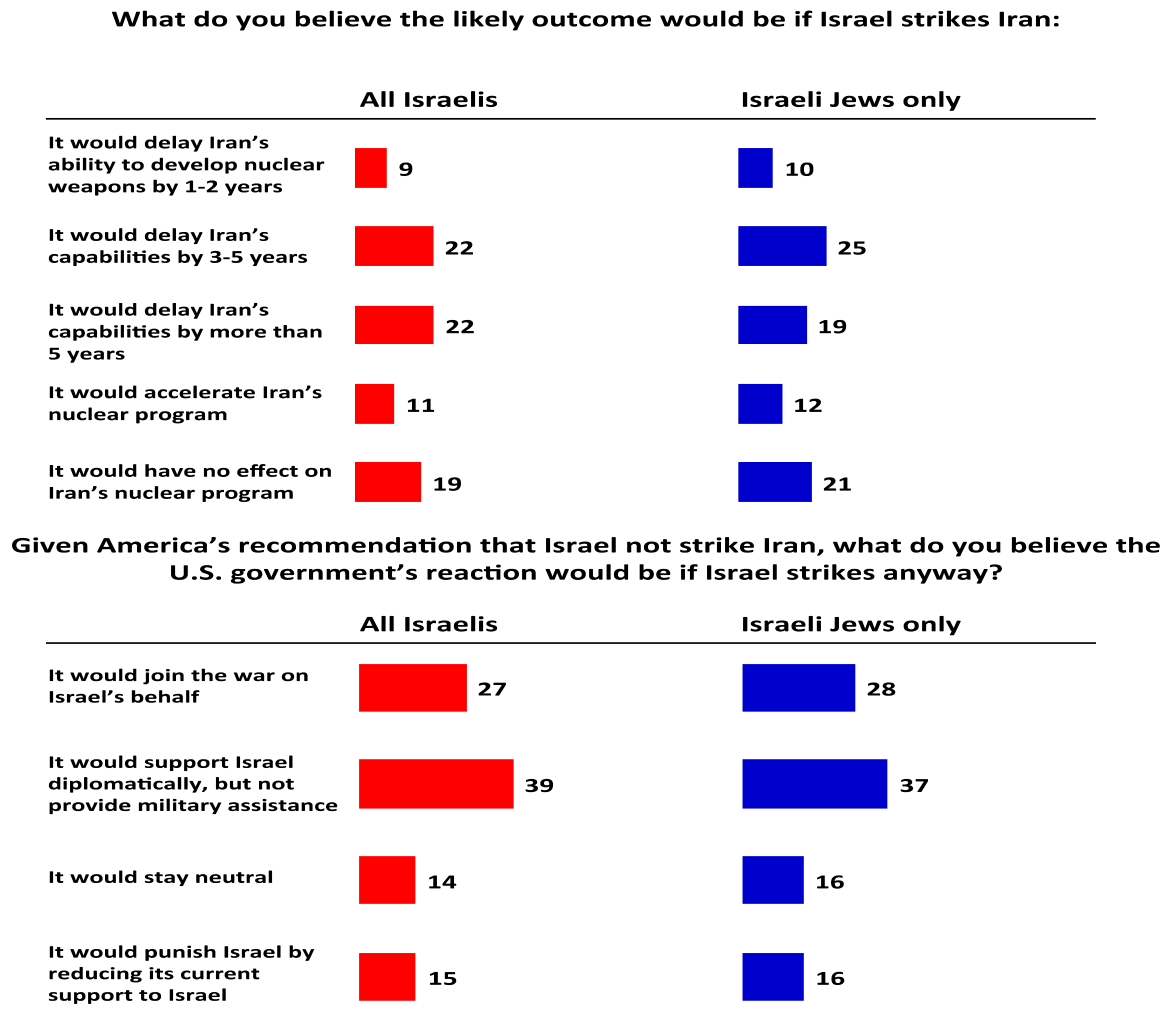
All of these Israeli statements are hard to put in context. Like the US, Israeli experts and officials have never provided public statements revealing their estimates of what Iran's ultimate force goals are, how many weapons it will have of what yield, and the progress it will have made in delivery systems. This means there is no unclassified basis for understanding the degree to which Israeli leaders and defense planners feel a combination of Israel's undeclared nuclear forces, missile and air defenses, and support from the US in the form of additional missile defenses and an as yet undefined US extended regional deterrent could safely contain an Iranian threat and deter nuclear and missile attacks.

Israeli Public Opinion

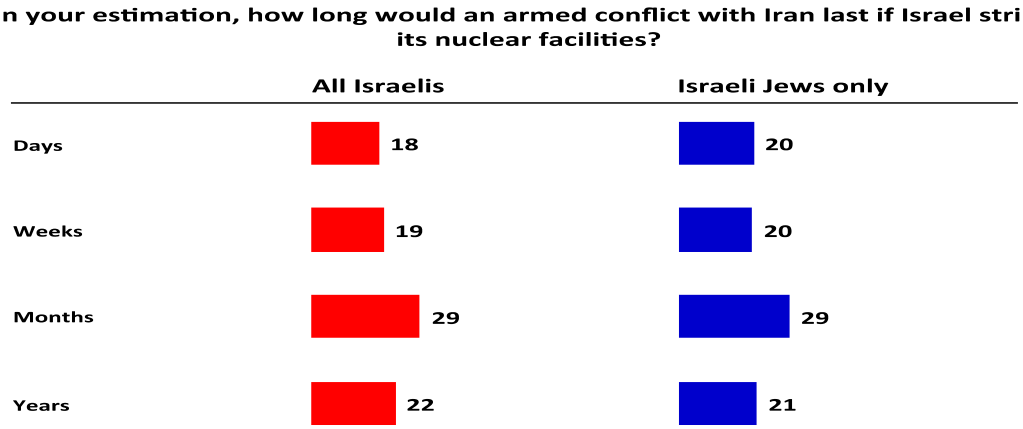
Figure IV.83 reflects Israeli public opinion regarding an Israeli strike on Iran's nuclear facilities, as well as the potential aftermath thereof. These data show that there is no unified public opinion regarding such a strike, and that there is a wide range of disparate views among Jewish and non-Jewish Israelis alike.

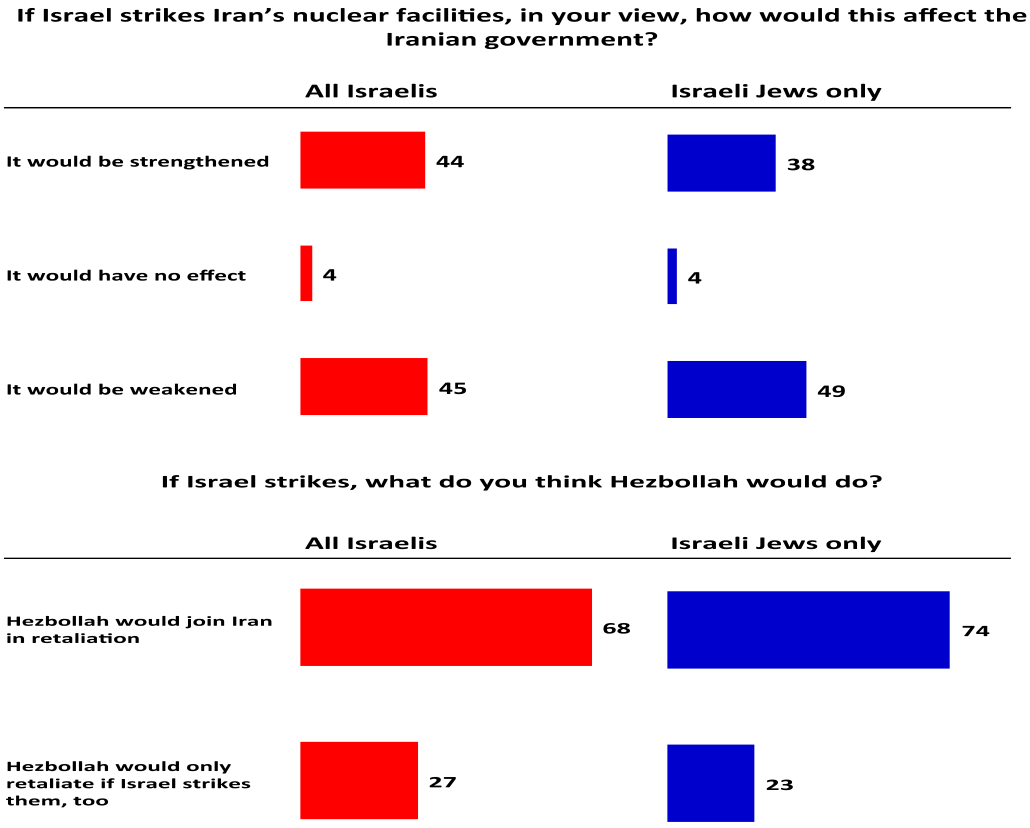
FigureIV.83: Israeli Public Opinion Regarding a Strike on Iran's Nuclear Facilities -1





FigureIV.83: Israeli Public Opinion Regarding a Strike on Iran's Nuclear Facilities - 2





Telhami, Shibley. "February 2012 Israeli Public Opinion Survey." Sadat Chair at the University of Maryland/Dahaf Institute, Israel. February 2012. http://Sadat.umd.edu/TelhamiIsraelPollFebruary2012[1].pdf

Potential Israeli Options for Striking Iran's Nuclear Program

Israeli officials have never publicly discussed the details of their country's options for striking against Iran's nuclear program. It is possible, however, to discuss Israel's potential capabilities and various scenarios.

Iran does have a long list of known nuclear facilities that may be usable for a weapons effort or weapons-related research. There are similar lists for missile, chemical, and biological facilities. Israel could not possibly strike the full range of these targets, although its intelligence almost certainly allows it to formulate a much shorter list. However, Israel faces serious limits on the level of strikes it could conduct, and the size of the Iranian target base it could cover. As a result, it seems likely that Israel would have to focus on Iran's largest and most critical facilities, although its targets might include suspect or secret sites that are omitted from unclassified lists. These facilities include:

- **Natanz Centrifuge Facility:** Efforts made to conceal Iran's main centrifuge facility.
- **Fordow Fuel Enrichment Plant –** In process

- **Fordow Fuel Enrichment Plant –** Similar efforts to conceal a centrifuge facility in a mountainside.
- **Bushehr City and Reactor Area:** Bushehr reactor vulnerable, and also within close proximity to populated areas.

Only two of these sites – Fordow and Natanz – are really hardened. Only one reactor – Bushehr – might produce serious radiological effects if attacked.

Illustrative Israeli options for attacking this set of targets include the following steps in the escalation ladder:

- Single set of strikes against limited number (approximately 4 to 8) of main forward facilities. "Close" entrance of Natanz and Fordow. Do not strike Bushehr reactor.
- Single set of strikes against limited number (approximately 4 to 8) of main forward facilities. Attempt major damage to Natanz and Fordow. Do strike Bushehr reactor.
- Single or multiple strikes against broad range of known and suspect facilities including centrifuge production and research reactor; hit all main sites. Possibly strike Bushehr reactor..
- Tailor strikes to stimulate maximum Iranian hostile attack: "Trigger force" to push US and Gulf states to respond.
- Restrike after Iran attempts to recover; escalation to other key infrastructure or military target to deter further Iranian efforts.
- Preventive/preemptive nuclear strike on Iranian force after test or deployment; threat to attack Iranian population centers if Iran responds.

There is no way to know how much Israel could accomplish if it attacked this more limited set of targets. It is possible, however, that even a relatively limited Israeli strike could set Iran's program back by a year or more by focusing on such key facilities. The main problems it would face include over flight of Arab territory, the distances Israeli aircraft would have to fly in penetrating Iranian airspace, finding ways to refuel and support enabling aircraft in hostile air space, range-payload problems in penetrating deeply into Iran, the risk of losing aircraft to fuel problems if they had to make combat maneuvers, and the ability to do lasting damage to Iranian hard targets like Fordow and Natanz.

Illustrative examples of Israeli capabilities to conduct such a strike include the courses of action described in **Figure IV.84** to **Figure IV.86**

- **Figure IV.84** shows what a low yield Israeli nuclear strike on Iran's nuclear facilities would look like. Israel would use either ballistic missiles or nuclear-armed strike aircraft to carry out such a mission.
- **Figure IV.85** and **Figure IV.86** present a picture of what an Israeli conventional strike using air power would look like. Israeli aircraft could take any one of three routes (northern, central, or southern), all of which would involve traversing unfriendly airspace to reach targets in Iran. The central route would involve flying 1,500-1,700 kilometers through Jordan and Iraq, the southern route would involve flying 1,900-2,100 kilometers through Saudi Arabia, and the northern route would involve flying 2,600-2,800 kilometers in a loop through Turkey.

It seems likely that any current Israeli preventive strike would be conventional. Iran does not yet have nuclear weapons and any Israeli first use of nuclear weapons of the kind shown in **Figure IV.84** would lead to an almost universal international condemnation of Israel, force a hostile reaction on Arab states that might otherwise tolerate a successful Israeli strike, present major

problems in terms of US-Israeli relations, lead to condemnation in the UN, and possibly even lead to sanctions and war crimes trials.

Moreover, it is unclear that Israel could count on the level of reliability and accuracy to use low yield weapons against hardened targets like Natanz and Fordow, and would have to use ground bursts against other targets to get suitable levels of damage. The use of a strike aircraft to deliver a low yield nuclear weapon would reduce these risks, but not the massive political risks in initiating a nuclear war against a state that did not yet have nuclear weapons.

An Israeli conventional strike on Iran's nuclear facilities of the kind shown in **Figure IV.85** and **Figure IV.86** seems more likely, but it would have an uncertain probability of lasting success for several reasons. Given the unfriendly airspace Israeli strike aircraft would have to traverse to reach Iran's facilities as well as Israel's geographic distance from Iran, the likelihood of Israel being able to carry out repeated strikes is low. Israeli strike aircraft would only have one opportunity to strike at Iran's nuclear facilities. Moreover, Iran's nuclear facilities are dispersed and fortified, and a single Israeli strike would probably only temporarily impede Iran's nuclear progress.

Even if Israel had the attack capabilities needed for the destruction of all elements of the Iranian nuclear program, it is doubtful whether Israel has the kind of intelligence needed to be certain that all the necessary elements of the program were traced and destroyed fully. Israel has good photographic coverage of Iran with the Ofeq series of reconnaissance satellites, but being so distant from Iran, one can assume that other kinds of intelligence coverage are rather partial and weak.

An Illustrative Air Strike

Israel would have to make difficult calculations of how many combat aircraft it could actually support in operations over Iranian air space, knowing that two of the most hardened targets which would require the highest payload to attack are Fordow and Natanz, which are relatively deep in Iran. It would have to choose between a maximum force with maximum effectiveness, and a smaller force that would be easier to refuel and support. It would have to decide whether it would use only strike aircraft, send in fighter escorts, and how many fighters it would use that carried anti-radiation missiles and electronic jammers and warfare equipment versus ground attack payloads.

Air defense and strike fighters are not passenger or cargo aircraft. They are small aircraft with limited range and payload. Every mile flown outside the direct flight path to targets in Iran would burn critical fuel. A Jordan that tolerated Israeli flights and denied any knowledge of such an attack would ease – but scarcely eliminate – Israel's problems and present a serious risk of political complications for Jordan. Flying through a Syria in political chaos might be easier, but the least vulnerable routes through Syria are to the north and might require the Israeli aircraft to fly out over the Mediterranean and penetrate through northern Syria, adding to the range. Flying through Saudi Arabia would risk encountering a modern fighter force and it is unclear that the Saudi government would ever give even tacit permission. Iraq has no meaningful air force and no surface-to-air missiles, but over flights of Iraq would present political problems for the US.

Flying low to avoid or minimize radar detection burns far more fuel than flying higher in more detectable flight profiles. A major electronic warfare effort to protect fighters might give warning

to Iran. Any major maneuver to avoid Iranian fighters, or an Iranian surface-to-air missile would consume far more fuel than a simple penetration and attack profile, and create serious risks in terms of need for refueling or loss of the aircraft. This would be particularly true if the Israeli fighters had to use afterburners for more than a brief time.

Israel could mount a relatively large attack force relative to the number of major Iranian targets if it chose to do so. In a conventional strike, Israel could launch and refuel two to three full squadrons of 36 to 54 combat aircraft for a single set of strikes with refueling. It could use either its best F-15s (28 F-15C/Ds, 25 F- 15I Ra'ams or part of its 126 F-16 CDs and 23 F-16I Sufas. It has at least three specially configured squadrons with conformal fuel tanks specially designed for extended range use. It could add fighter escorts, but refueling and increased warning and detection would be major problems.

Israel's primary strike aircraft would probably be the F-15I, although again this is guesswork. Global Security describes the F15I as follows:

> The key aspects are that Boeing's (formerly McDonnell Douglas) F-15E Strike Eagle entered service with the IDF/Heyl Ha'Avir (Israeli Air Force) in January of 1998 and was designated the F-15I Ra'am (Thunder). The F-15E Strike Eagle is the ground attack variant of the F-15 air superiority fighter, capable of attacking targets day or night, and in all weather conditions.
>
> The two-seat F-15I, known as the Thunder in Israel, incorporates new and unique weapons, avionics, electronic warfare, and communications capabilities that make it one of the most advanced F-15s. Israel finalized its decision to purchase 25 F-15Is in November 1995. The F-15I, like the US Air Force's F-15E Strike Eagle, is a dual-role fighter that combines long-range interdiction with the Eagle's air superiority capabilities. All aircraft are to be configured with either the F100-PW-229 or F110-GE-129 engines by direct commercial sale; Night Vision Goggle compatible cockpits; an Elbit display and sight helmet (DASH) system; conformal fuel tanks; and the capability to employ the AIM-120, AIM-7, AIM-9, and a wide variety of air-to-surface munitions.
>
> Though externally the Ra'am looks similar to its USAF counterpart, there are some differences, mainly in the electronic countermeasures gear and the exhaust nozzles. The Ra'am has a counterbalance on the port vertical stabilizer instead of the AN/ALQ-128 EWWS (Electronic Warfare Warning System) antenna found on USAF Strike Eagles. The Ra'am uses two AN/ALQ- 135B band 3 antennas, one mounted vertically (starboard side) and one horizontally (port side). These are located on the end of the tail booms. They are distinguished by their chiseled ends, unlike the original AN/ALQ-135 antenna, which is round and located on the port tail boom of USAF Eagles.
>
> The Ra'am utilizes extra chaff/flare dispensers mounted in the bottom side of the tail booms. Unlike USAF Eagles, the Ra'am still use engine actuator covers (turkey feathers) on their afterburner cans. The US Air Force removed them because of cost and nozzle maintenance, though curiously, USAF F-16s still have their actuator covers installed. Israeli Strike Eagles and some USAF Eagles based in Europe use CFT air scoops. These scoops provide extra cooling to the engines.
>
> The 25 F-15Is operational since 1999 [and the 100 F-16Is] were procured first and foremost to deal with the Iranian threat. In August 2003 the Israeli Air Force demonstrated the strategic capability to strike far-off targets such as Iran [which is 1,300 kilometers away], by flying three F- 15 jets to Poland 1,600 nautical miles away. After they celebrated that country's air force's 85th birthday, on their return trip, the IAF warplanes staged a fly-past over the Auschwitz death camp.

The Limits to Israeli Capabilities: Hard Target Kills

Israeli strike aircraft would probably need to carry close to their maximum payloads to achieve the necessary level of damage against some Iranian surface targets suspected of WMD activity as

well, although many structures could be destroyed with 1-3 weapons. (This would include the main Bushehr reactor enclosure, but its real-world potential value to an Iranian nuclear program is limited compared to more dispersed and/or hardened targets). At least limited refueling would be required, and back-up refueling and recovery would be an issue.

Israel's fighters would face more serious range problems in carrying the higher payloads necessary to destroy hardened targets. One key weapon that might be used against hard targets and underground sites like Natanz would be the GBU-28 – although the US may have quietly given Israel more sophisticated systems or Israel may have developed its own hard target killers – including a nuclear armed variant.

In September 2011, reports surfaced that the Obama administration had transferred an unknown number of 5,000 lb. GUB-28 Hard Target Penetrator bunker busters to Israel. Israel reportedly requested the weapons as early as 2005.[101] Although it is uncertain to what level exactly these bombs could enable Israel to launch an effective strike on Iran's nuclear facilities or damage its program in a meaningful way, they do provide Israel with an increased comparative capability to do so.

The F-15I can carry the GBU-28. It is a "5,000 pound" laser-guided bomb with a 4,400-pound earth-penetrating warhead that can be upgraded by the IAF to use electro-optical or GPS targeting. It is a vintage weapon dating back to the early 1990s, and the IAF is reported to have bought at least 100. It has been steadily upgraded since 1991 and the USAF ordered an improved version in 1996. It looks like a long steel tube with rear fins and a forward guidance module. It can glide some 3-7 miles depending on the height of delivery. It is 153" long x 14.5" in diameter.

Israel did, however, buy 500 smaller "bunker-busters" from the US in February 2005. Experts speculated whether the purchase was a power projection move or whether Israel was planning to use these bombs against Iranian nuclear sites. These speculations were further exacerbated when the Israeli Chief of Staff, Lt. General Dan Halutz, was asked how far Israel would go to stop Iran's nuclear program, he said "2,000 kilometers." It is important to note, however, that these bombs are systems designed to kill hardened surface targets and not deeply buried underground facilities. They could damage entrances to such facilities but not the underground areas.

Moreover, it should be stressed that Israel has the technology base to develop its own weapons or modifications and to reverse engineer US and European systems. It is not possible to estimate the limits to the lethality and range-payload of Israeli strike capabilities simply by examining known transfers of US systems.

Choosing Target Numbers

Israel would also have to make hard choices as to how many known and suspect targets would be attacked with what level of lasting damage, civilian casualties, and collateral damage. Multiple strikes on the dispersed buildings and entries in a number of facilities would be necessary to ensure adequate damage without restrikes – which may not be feasible for Israel given the limits to its sortie generation capability over even Iranian soft targets. As for hardened and

[101] "Report: Obama gave 'bunker-busters' to Israel." September 23, 2011. Politico. http://www.politico.com/news/stories/0911/64260.html

underground targets, the IAF's mix of standoff precision-guided missiles – such as Harpoon or Popeye – would not have the required lethality with conventional warheads, and Israel's use of even small nuclear warheads would cause obvious problems.

The "shell game" or "lottery targeting" problems Israel would face in choosing which and how many targets to attack are illustrated by comparing the two very different target lists shown in **Figure IV.69** and **Figure IV.70**.

Israel may or may not feel it has an accurate targeting list of all key Iranian facilities. It is very unlikely, however, that Israel feels that this list is perfect, that the Israeli list of known and suspect targets is far too long for Israel to strike at all targets, and that the Israel would tailor its strikes to deal with the fact that some strikes could involve significant innocent civilian casualties and collateral damage. Moreover, Israeli planners almost certainly must feel that Iran is now hiding and dispersing some of its highly enriched material, as well as key elements of its ability to produce advanced centrifuges and reconstitute its nuclear programs. Furthermore, at least some suspect facilities are in northeast Iran, greatly complicating the range-payload and survivable strike problems Israel would face, and radically altering the kind of strike profiles shown in **Figure IV.67** and **Figure IV.68**.

Unless Israel has near total, real-time transparency into Iran's programs, it could probably only hit a limited number of nuclear facilities – and would probably not strike Iran's additional missile, biological, or chemical facilities unless it was certain these posed so active a threat that they could not be avoided. This means, however, that an Israeli strike on Iran's best known nuclear targets might appear to be successful, but actually be a failure in halting key elements of Iran's program. It also raises the critical issue that an attack might effectively legitimize an Iranian nuclear weapons program in the eyes of Iranians and many outside Iran. The end result could then be to create a new form of Iranian nuclear threat under conditions involving far more Iranian resources and where Iran found a workable excuse to withdraw from the NNPT and halt all inspection.

Refueling and Supporting Enablers

Another key problem would be refueling Israeli fighters – particularly if they had to engage in even preparatory air-to-air combat or surface-to-air missile evasion – and creating a survivable mix of tankers and any mix of enabling electronic warfare, intelligence, and air control aircraft. Israel's 5 KC-130H and 5 B-707 tankers are slow and vulnerable and would need escorts – and its ordinary B-707 AE&W, ELINT and electronic warfare aircraft are also slow fliers, although the new G-550 Shaved ELINT aircraft is a fast flier and the IAF has a long-range UAV capability that could support its aircraft before, during, and after such missions.

The bigger manned "slow fliers" would have serious problems penetrating and surviving in Iranian air space. The radars in the countries involved would probably detect all IAF and US missions relatively quickly, and very low-altitude penetration profiles would lead to serious range-payload problems. The countries overflown would then be confronted with the need to either react or have limited credibility in claiming surprise. An over flight of Iraq – which currently has no meaningful air force and no surface-to-air missiles – might be seen in the region as having been given a US "green light," although the problems the US has had in creating a meaningful strategic framework agreement with Iraq have reduced the implied level of US responsibility for protecting Iraqi airspace.

Israel has, however, specially configured some of its F-15s and F-16s with targeting, EW, SAM-suppression aids, and ELINT for this kind of mission. The full details of such capabilities are unknown. Israel would also have to stage such aircraft at some point over Arab territory as well as use fighters to escort and protect them. Assembling a mix of tankers and enablers to wait over Arab territory or the Gulf while Israeli fighters struck targets in Iran would increase the problem of detection and expose forces over Arab countries. Assembling a scattered force of tankers and enablers would present command and control problems and leave the individual elements more vulnerable. Staging them over the Mediterranean off the Syrian coast might be a partial solution, but would increase the risk that fighters might run out of fuel before completing their missions.

A "One Time" Option

Israel would find strikes to be a major political and military problem. Israel might get away with going through Jordan and then through Saudi Arabia or Iraq once, given the fears these countries have of Iran's nuclear efforts. However, any repeated effort would be too politically dangerous for Arab governments to easily tolerate. Israel would probably face problems in getting accurate restrike and battle damage data for missions against several of the targets involved using its intelligence satellites and UCAVs. A lack of totally reliable battle damage assessment and time-urgent retargeting capabilities for precision strikes with a target mix as complex as Iran's could be another major problem.

Much would depend on just how advanced Israel's long-range UAV capabilities really are and whether Israel could get access to US intelligence and IS&R capabilities for both its initial targeting and restrikes, but confirming the actual nature of damage, carrying out restrikes, and sending a clear signal that Israel can repeat its strikes if Iran rebuilds or creates new facilities would be a problem.

The Aftermath Problem

As senior US officers and officials have repeatedly warned, the aftermath of such an attack would also be a major problem. Iran would almost certainly see Jordanian, Turkish, and/or Saudi tolerance of such an IAF strike as a hostile act. It might well claim a US "green light" in any case in an effort to mobilize hostile Arab and Muslim (and possibly world) reactions. At a minimum, the attack would trigger years of Iranian efforts in the UN and other forums to charge Israel with aggression.

Israel would have to face the impact of US opposition to such an attack, as well as the Arab reaction to an attack on an Islamic – albeit dangerous – state. In late February 2012, reports surfaced that Israeli Prime Minister Benjamin Netanyahu and Israeli Defense Minister Ehud Barak had informed US officials that Israel would not provide the US with advance notice prior to an Israeli strike on Iran's nuclear facilities.[102]

In such a case, the US would have minimal time to prepare for and counter a range of probable Iranian responses, including those mentioned above. It is unknowable whether such an action would drag the US unexpectedly into a larger conflict with Iran, although such a scenario

[102] "Israel Would Not Notify U.S. of Impending Iran Attack: Report." Global Security Newswire. February 28, 2012. http://www.nti.org/gsn/article/israel-would-not-warn-us-impending-iran-attack-official/

remains a distinct possibility as the US would have to respond to potential Iranian counter attacks on Gulf commercial traffic, US forces in the region, and the US's Gulf Arab allies.

Key neighbors like Turkey and most of the rest of the world would also oppose such a strike. This reaction would also be determined to some extent by Israel's success and losses, and the outside world would probably see partial success as a serious failure. This would be particularly true if the Israeli attack caused the US major political problems or pushed it into having to follow up the Israeli attack to bring some level of stability to a failed or too limited Israeli effort – the "trigger force" problem.

If Israel used conventional air and missile power to strike at Iran's nuclear program, Iran would also be able to respond in a variety of different ways. Many of these options have already been discussed in Chapter III, and there is no way to be sure what approach Iran would take. In broad terms, its choices include:

- Withdraw from the NNPT and increase its long-term resolve to develop a nuclear deterrent program.
- Create an all-out nuclear weapons program with its surviving equipment and technology base, using Israel's strike and aggression as an excuse to openly pursue a nuclear program.
- Shift to genetically engineered biological weapons if such a program does not already exist.
- Immediately retaliate against Israel with ballistic missiles. Retaliation would consist of multiple launches of Shahab-3s, including the possibility of launching CBR warheads against Tel Aviv, Israeli military and civilian centers, and Israeli suspected nuclear weapons sites.
- Accuse the US of "green lighting" the Israeli strike, and being the real cause of the attacks.
- Launch political attacks on Arab regimes friendly to the US on the grounds that they did nothing to prevent an attack on Israel's greatest enemy.
- Use allied or proxy groups such as Hezbollah or Hamas to attack Israel proper with suicide bombings, covert CBR attacks, and rocket attacks from southern Lebanon.
- Launch asymmetric attacks against American interests and allies in the Arabian Gulf.
- Target US and Western shipping in the Gulf, and possibly attempt to interrupt the flow of oil through the Strait of Hormuz.
- Attack US forces, ships, or facilities in the Gulf or anywhere in the world as a way of showing that Iran could attack the "great Satan" and Israel's closest ally.
- Strike at Israeli or Jewish targets anywhere in the world using Iranian agents or anti-Israeli-proxies.
- Try to use the UN and/or International Criminal Court to prosecute Israel for aggression and war crimes.
- Transfer high-technology small air-to-surface and guided anti-armor weapons to Hamas, Hezbollah, or other anti-Israeli extremist groups. Provide them with more lethal rockets, UCAVs, and chemical weapons.
- Seek to use its leverage with Iraq, Syria, and Hezbollah to create an actual "Shi'ite crescent" to create a more intense range of threats to Israel.
- Try to use the transfer of funds and arms, the MOIS/Vevak, and other covert means to influence the new regimes coming out of unrest in the Arab world to be far more aggressively anti-Israel.

But Options Do Exist and Their Timing is Uncertain

All that said, Israel is almost certainly preparing for a strike on Iran's nuclear facilities. In early November of 2011, Israeli aircraft participated in a large exercise with Italy over Sardinia, over

2,300 km from Israel.[103] The exercise involved fighter jets, aerial refueling, and airborne warning and control aircraft. Furthermore, Israeli pilots were able to fly against adversaries flying unfamiliar aircraft such as the Eurofighter.

While a simulation of an attack on Iran was not the stated purpose of the exercises, an IAF Lieutenant Colonel identified only as "Yiftah" stated that such exercises are important because flying over unfamiliar territory "prepares people for battle over unfamiliar ground."[104] Moreover, he stated that, "we train for long-range flights and prepare ourselves for every type of terrain."[105]

A pilot of the Knights of the North squadron, identified only as "Major B.," stated that, "we're practicing in an unknown place. The size of our flight field is larger than the entire State of Israel, allowing us to practice things we can't back home."[106] While somewhat vague and unspecific, such statements are indicative of the emphasis the training placed on mounting a long-distance operation over large, unfamiliar terrain and airspace.

Although preparation for a strike on Iran was not the stated objective of the exercise, it could be considered a test-run for the kind of operation Israel would mount to strike at Iran. Given the similar distances of both objectives and the dispersed nature of Iran's nuclear program, Israel would have to engage in the same kind of operational planning to carry out such a strike as it did in its exercises with the Italian Air Force.

As for timing, there is no way to know if the latest round of speculation that Israel might actually be preparing for a strike in 2012 is any more valid than previous rounds of such speculation. Israel clearly finds it politically useful to constantly keep Iran aware it might be struck, and to use the threat of preventive strikes to push the US and other states into taking a strong stand on sanctions and negotiations. It seems unlikely, however, that Israel would launch a preemptive or preventive nuclear strike on Iran's nuclear facilities until it is more certain that Iran is actually developing or seeking deploy nuclear weapons.

Israel does face the risk that Iran's target base will become larger, harder to locate, and harder to destroy with time. There are no magic "red lines" however, and Israel must be sensitive to US opposition, the reactions of other states, and the willingness of other states to follow up Israeli action. Israel must also be as sensitive as the US to the fact that every military action has consequences that go far beyond the immediate military impact.

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[103] Pfeffer, Anshel. "IDF Insists Preparedness Drills and Military Exercises are Not Tied to Iran Chatter." Haaretz. November 3, 2011. http://www.haaretz.com/print-edition/news/idf-insists-preparedness-drills-and-military-exercises-are-not-tied-to-iran-chatter-1.393384

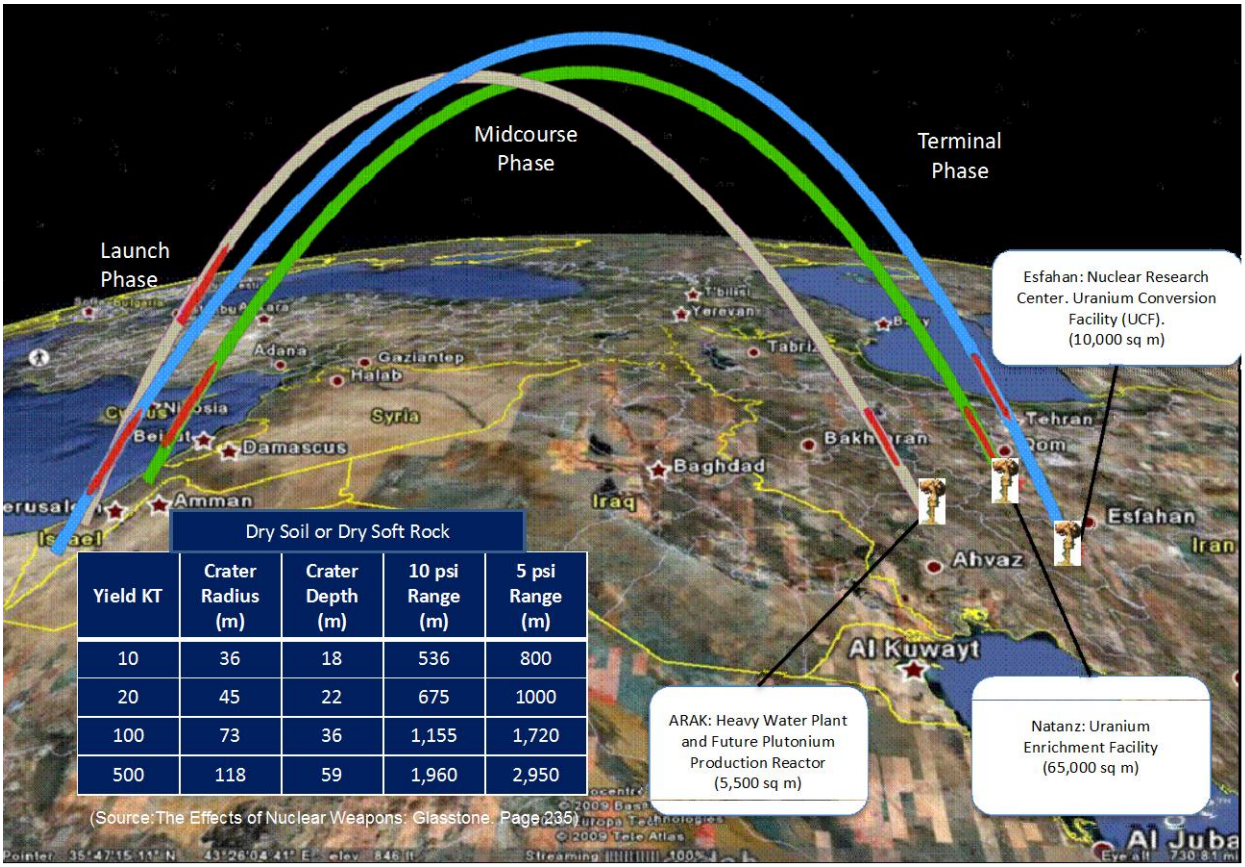
[104] Pfeffer, Anshel. "IDF Insists Preparedness Drills and Military Exercises are Not Tied to Iran Chatter." Haaretz. November 3, 2011. http://www.haaretz.com/print-edition/news/idf-insists-preparedness-drills-and-military-exercises-are-not-tied-to-iran-chatter-1.393384

[105] Pfeffer, Anshel. "IDF Insists Preparedness Drills and Military Exercises are Not Tied to Iran Chatter." Haaretz. November 3, 2011. http://www.haaretz.com/print-edition/news/idf-insists-preparedness-drills-and-military-exercises-are-not-tied-to-iran-chatter-1.393384

[106] idfspokesperson.com. "The Israeli and Italian Airforces Train Together in Joint Exercise in Sardinia." November 3, 2011. http://idfspokesperson.com/2011/11/03/the-israeli-and-italian-airforces-train-together-in-joint-exercise-in-sardinia/

In most cases, the law of unintended consequences dominates the real-world course of events over time. The risks to Israel, the US, US regional allies, and commercial shipping through the Strait of Hormuz from such strikes can be both easily exaggerated as well as dangerously underestimated. For all of the reasons cite earlier in this analysis, however, Israel's potential success and the political and military aftermath of any Israeli strikes would at best be uncertain and further destabilize a deeply unstable region.

FigureIV.84: Low-Yield Israeli Nuclear Strike on Iran's Nuclear Facilities

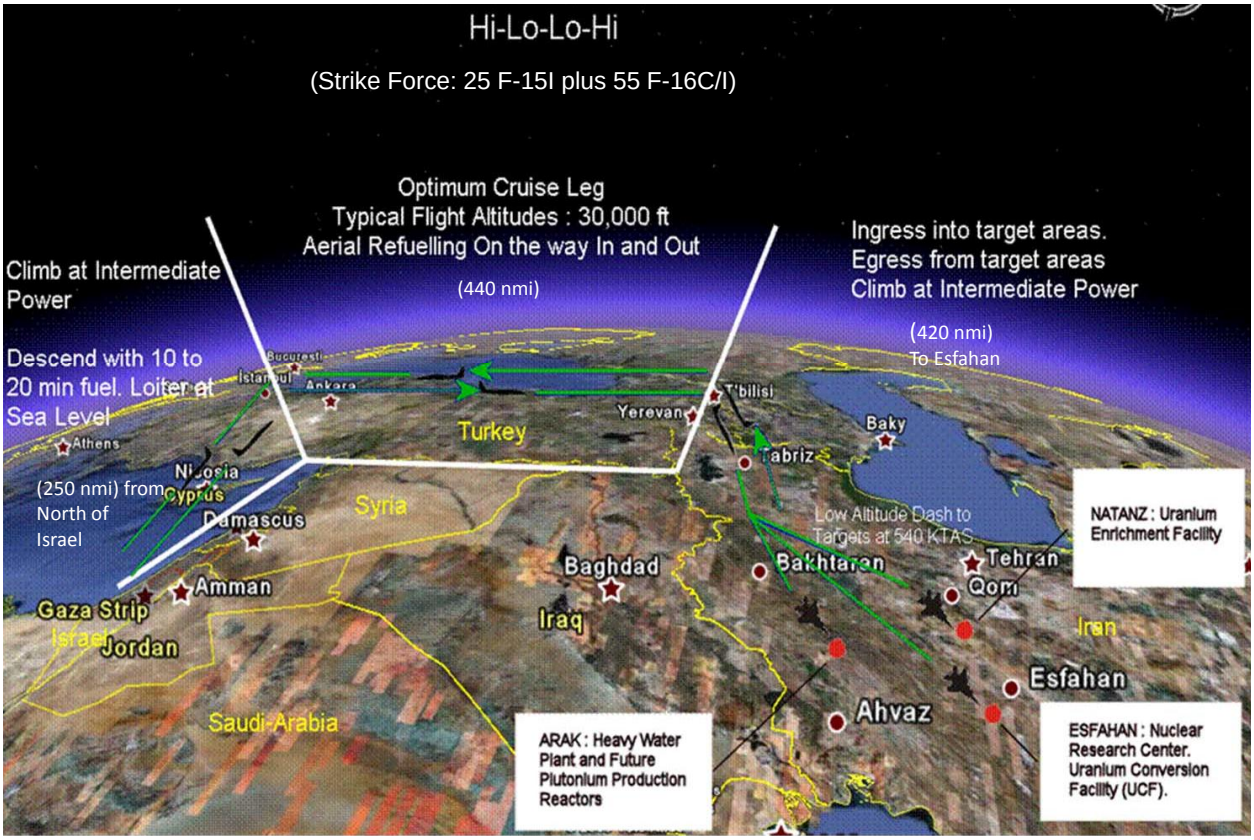


Dry Soil or Dry Soft Rock

Yield KT	Crater Radius (m)	Crater Depth (m)	10 psi Range (m)	5 psi Range (m)
10	36	18	536	800
20	45	22	675	1000
100	73	36	1,155	1,720
500	118	59	1,960	2,950

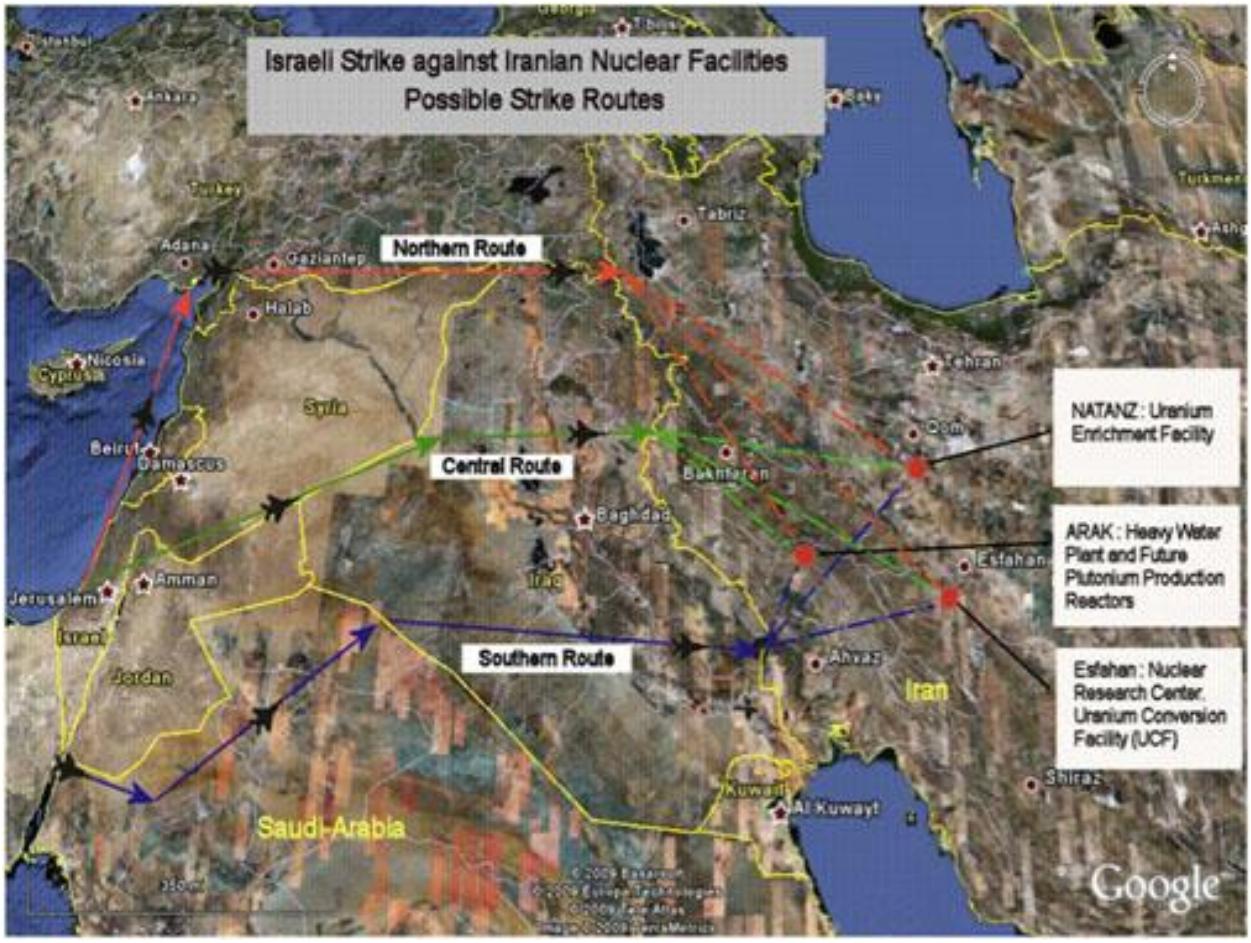
Source: Dr. Abdullah Toukan

Figure IV.85: Israeli Conventional Strike on Iran's Nuclear Facilities



Source: Dr. Abdullah Toukan

Figure IV.86: Prossible Israeli Strike Route



Source: Dr. Abdullah Toukan

US Policy Towards US and Israeli Preventive Strikes

President Obama laid out US policy towards Iran's nuclear efforts and preventive strikes in considerably more detail, and with considerable frankness, in an interview in the *Atlantic* in March 2012. Key excerpts from the President's statements illustrate both US concerns and US policy, and make it clear that the US prefers diplomatic options and has not given Israel any kind of support – or "green light" – in a preventive attack on Iran:

> "You're talking about the most volatile region in the world…It will not be tolerable to a number of states in that region for Iran to have a nuclear weapon and them not to have a nuclear weapon. Iran is known to sponsor terrorist organizations, so the threat of proliferation becomes that much more severe." He went on to say that "the dangers of an Iran getting nuclear weapons that then leads to a free-for-all in the Middle East is something that I think would be very dangerous for the world."
>
> …In addition to the profound threat that it poses to Israel, one of our strongest allies in the world; in addition to the outrageous language that has been directed toward Israel by the leaders of the Iranian government -- if Iran gets a nuclear weapon, this would run completely contrary to my policies of nonproliferation. The risks of an Iranian nuclear weapon falling into the hands of terrorist organizations are profound. It is almost certain that other players in the region would feel it necessary to get their own nuclear weapons. So now you have the prospect of a nuclear arms race in the most volatile region in the world, one that is rife with unstable governments and sectarian tensions. And it would also provide Iran the additional capability to sponsor and protect its proxies in carrying out terrorist attacks because they are less fearful of retaliation.
>
> …But I want to make clear that when we travel around the world and make presentations about this issue, that's not how we frame it. We frame it as: this is something in the national-security interests of the United States and in the interests of the world community. And I assure you that Europe would not have gone forward with sanctions on Iranian oil imports -- which are very difficult for them to carry out because they get a lot of oil from Iran -- had it not been for their understanding that it is in the world's interest, to prevent Iran from getting a nuclear weapon. China would not have abided by the existing sanctions coming out of the National Security Council, and other countries around the world would not have unified around those sanctions had it not been for us making the presentation about why this was important for everyone, not just one country.
>
> …I think it's important to recognize, though, that the prime minister (of Israel) is also head of a modern state that is mindful of the profound costs of any military action, and in our consultations with the Israeli government, I think they take those costs, and potential unintended consequences, very seriously.
>
> …as Israel's closest friend and ally, and as one that has devoted the last three years to making sure that Israel has additional security capabilities, and has worked to manage a series of difficult problems and questions over the past three years, I do point out to them that we have a sanctions architecture that is far more effective than anybody anticipated, that we have a world that is about as united as you get behind the sanctions; that our assessment, which is shared by the Israelis, is that Iran does not yet have a nuclear weapon and is not yet in a position to obtain a nuclear weapon without us having a pretty long lead time in which we will know that they are making that attempt.
>
> In that context, our argument is going to be that it is important for us to see if we can solve this thing permanently, as opposed to temporarily. And the only way, historically, that a country has ultimately decided not to get nuclear weapons without constant military intervention has been when they themselves take [nuclear weapons] off the table. That's what happened in Libya, that's what happened in South Africa. And we think that, without in any way being under an illusion about Iranian intentions, without in any way being naive about the nature of that regime, they are self-interested. They recognize that they are in a bad, bad place right now. It is possible for them to make a strategic calculation that, at minimum, pushes much further to the right whatever potential breakout capacity they may have, and that may turn out to be the best decision for Israel's security.

… I think the prime minister -- and certainly the defense minister -- would acknowledge that we've never had closer military and intelligence cooperation. When you look at what I've done with respect to security for Israel, from joint training and joint exercises that outstrip anything that's been done in the past, to helping finance and construct the Iron Dome program to make sure that Israeli families are less vulnerable to missile strikes, to ensuring that Israel maintains its qualitative military edge, to fighting back against delegitimization of Israel, whether at the [UN] Human Rights Council, or in front of the UN General Assembly, or during the Goldstone Report, or after the flare-up involving the flotilla -- the truth of the matter is that the relationship has functioned very well.

…There is no doubt they (Iran's leaders) are isolated. They have a very ingrown political system. They are founded and fueled on hostility towards the United States, Israel, and to some degree the West. And they have shown themselves willing to go outside international norms and international rules to achieve their objectives. All of this makes them dangerous. They've also been willing to crush opposition in their own country in brutal and bloody ways.

…If Iran gets a nuclear weapon, I won't name the countries, but there are probably four or five countries in the Middle East who say, "We are going to start a program and we will have nuclear weapons." And at that point, the prospect for miscalculation in a region that has that many tensions and fissures is profound. You essentially then duplicate the challenges of India and Pakistan fivefold or tenfold.

…The potential for escalation in those circumstances is profoundly dangerous, and in addition to just the potential human costs of a nuclear escalation like that in the Middle East, just imagine what would happen in terms of the world economy. The possibilities of the sort of energy disruptions that we've never seen before occurring, and the world economy basically coming to a halt, would be pretty profound. So when I say this is in the U.S. interest, I'm not saying this is something we'd like to solve. I'm saying this is something we have to solve.

…I think it's fair to say that the last three years, I've shown myself pretty clearly willing, when I believe it is in the core national interest of the United States, to direct military actions, even when they entail enormous risks. And obviously, the bin Laden operation is the most dramatic, but al-Qaeda was on its [knees] well before we took out bin Laden because of our activities and my direction.

… there's no doubt that Iran is much weaker now than it was a year ago, two years ago, three years ago. The Arab Spring, as bumpy as it has been, represents a strategic defeat for Iran because what people in the region have seen is that all the impulses towards freedom and self-determination and free speech and freedom of assembly have been constantly violated by Iran. [The Iranian leadership is] no friend of that movement toward human rights and political freedom. But more directly, it is now engulfing Syria, and Syria is basically their only true ally in the region.

And it is our estimation that [President Bashar al-Assad's] days are numbered. It's a matter not of if, but when. Now, can we accelerate that? We're working with the world community to try to do that. It is complicated by the fact that Syria is a much bigger, more sophisticated, and more complicated country than Libya, for example -- the opposition is hugely splintered -- that although there's unanimity within the Arab world at this point, internationally, countries like Russia are still blocking potential UN mandates or action. And so what we're trying to do - and the secretary of state just came back from helping to lead the Friends of Syria group in Tunisia -- is to try to come up with a series of strategies that can provide humanitarian relief. But they can also accelerate a transition to a peaceful and stable and representative Syrian government. If that happens, that will be a profound loss for Iran.

President Obama and Prime Minister Netanyahu

President Obama's speech had a special impact because it was timed to coincide with the coming visit of the Israeli Prime Minister. Israeli Prime Minister Benjamin Netanyahu first responded as follows,

> "I very much appreciated the fact that President Obama reiterated his position that Iran must not be allowed to develop nuclear weapons and that all options are on the table. I also appreciated the fact that he made clear that when it comes to a nuclear armed Iran, containment is simply not an option, and equally in my judgment, perhaps most important of all, I appreciated the fact that he said that Israel must be able to defend itself, by itself, against any threat. I appreciate all his statements and I look forward to discussing them further with President Obama tomorrow."[107]

On March 2, 2012, Prime Minister Netanyahu followed up his initial response by making explicit demands regarding Iran's uranium stockpile, and warned the international community against further talks and negotiations with Iran:

> "Right now, Iran is feeling the pressure from the economic sanctions, and it could try to evade that pressure by entering talks… I think the international community should not fall into this trap. I think the demands on Iran should be clear: Dismantle the underground nuclear facility in Qom, stop enrichment inside Iran and get all the enriched material out of Iran. And when I say all the material, I mean all the material."[108]

Prime Minister Netanyahu's statements make it clear that the Israeli leadership seeks not only a halt to nuclear activity, but also the surrender of Iran's enriched uranium and nuclear material.

President Obama then reiterated his policy on Iran's nuclear program in a March 4, 2012 speech to the annual conference of AIPAC:

> A nuclear-armed Iran is completely counter to Israel's security interests. But it is also counter to the national security interests of the United States. Indeed, the entire world has an interest in preventing Iran from acquiring a nuclear weapon. A nuclear-armed Iran would thoroughly undermine the non-proliferation regime that we have done so much to build. There are risks that an Iranian nuclear weapon could fall into the hands of a terrorist organization. It is almost certain that others in the region would feel compelled to get their own nuclear weapon, triggering an arms race in one of the most volatile regions in the world. It would embolden a regime that has brutalized its own people, and it would embolden Iran's proxies, who have carried out terrorist attacks from the Levant to southwest Asia.
>
> ...And so from my very first months in office, we put forward a very clear choice to the Iranian regime: a path that would allow them to rejoin the community of nations if they meet their international obligations, or a path that leads to an escalating series of consequences if they don't. In fact, our policy of engagement -- quickly rebuffed by the Iranian regime – allowed us to rally the international community as never before, to expose Iran's intransigence, and to apply pressure that goes far beyond anything that the United States could do on our own.
>
> Because of our efforts, Iran is under greater pressure than ever before. Some of you will recall, people predicted that Russia and China wouldn't join us to move toward pressure. They did. And in 2010 the U.N. Security Council overwhelmingly supported a comprehensive sanctions effort. Few thought that

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[107] "Amanpour: Israeli Restraint a Tough Challenge for Obama." CNN March 5, 2012. http://www.cnn.com/2012/03/05/world/meast/obama-netanyahu-iran-amanpour/?hpt=hp_t3

[108] Trifunov, David. "A nuclear Iran threatens entire world, Netanyahu says." Globalpost.com. March 2, 2012. http://www.globalpost.com/dispatch/news/regions/americas/120302/nuclear-iran-threatens-entire-world-netanyahu-says

sanctions could have an immediate bite on the Iranian regime. They have, slowing the Iranian nuclear program and virtually grinding the Iranian economy to a halt in 2011. Many questioned whether we could hold our coalition together as we moved against Iran's Central Bank and oil exports. But our friends in Europe and Asia and elsewhere are joining us. And in 2012, the Iranian government faces the prospect of even more crippling sanctions.

That is where we are today -- because of our work. Iran is isolated, its leadership divided and under pressure. And by the way, the Arab Spring has only increased these trends, as the hypocrisy of the Iranian regime is exposed, and its ally – the Assad regime – is crumbling.

Of course, so long as Iran fails to meet its obligations, this problem remains unresolved. The effective implementation of our policy is not enough – we must accomplish our objective. And in that effort, I firmly believe that an opportunity still remains for diplomacy – backed by pressure – to succeed.

The United States and Israel both assess that Iran does not yet have a nuclear weapon, and we are exceedingly vigilant in monitoring their program. Now, the international community has a responsibility to use the time and space that exists. Sanctions are continuing to increase, and this July – thanks to our diplomatic coordination – a European ban on Iranian oil imports will take hold. Faced with these increasingly dire consequences, Iran's leaders still have the opportunity to make the right decision. They can choose a path that brings them back into the community of nations, or they can continue down a dead end.

And given their history, there are, of course, no guarantees that the Iranian regime will make the right choice. But both Israel and the United States have an interest in seeing this challenge resolved diplomatically. After all, the only way to truly solve this problem is for the Iranian government to make a decision to forsake nuclear weapons. That's what history tells us.

...Moreover, as President and Commander-in-Chief, I have a deeply held preference for peace over war. I have sent men and women into harm's way. I've seen the consequences of those decisions in the eyes of those I meet who've come back gravely wounded, and the absence of those who don't make it home. Long after I leave this office, I will remember those moments as the most searing of my presidency. And for this reason, as part of my solemn obligation to the American people, I will only use force when the time and circumstances demand it. And I know that Israeli leaders also know all too well the costs and consequences of war, even as they recognize their obligation to defend their country.

We all prefer to resolve this issue diplomatically. Having said that, Iran's leaders should have no doubt about the resolve of the United States – just as they should not doubt Israel's sovereign right to make its own decisions about what is required to meet its security needs.

I have said that when it comes to preventing Iran from obtaining a nuclear weapon, I will take no options off the table, and I mean what I say. That includes all elements of American power: A political effort aimed at isolating Iran; a diplomatic effort to sustain our coalition and ensure that the Iranian program is monitored; an economic effort that imposes crippling sanctions; and, yes, a military effort to be prepared for any contingency.

Iran's leaders should understand that I do not have a policy of containment; I have a policy to prevent Iran from obtaining a nuclear weapon. And as I have made clear time and again during the course of my presidency, I will not hesitate to use force when it is necessary to defend the United States and its interests.

Moving forward, I would ask that we all remember the weightiness of these issues; the stakes involved for Israel, for America, and for the world. Already, there is too much loose talk of war. Over the last few weeks, such talk has only benefited the Iranian government, by driving up the price of oil, which they depend on to fund their nuclear program. For the sake of Israel's security, America's security, and the peace and security of the world, now is not the time for bluster. Now is the time to let our increased pressure sink in, and to sustain the broad international coalition we have built. Now is the time to heed the timeless advice from Teddy Roosevelt: Speak softly; carry a big stick. And as we do, rest assured that the Iranian government will know our resolve, and that our coordination with Israel will continue.

US Secretary of Defense Leon Panetta echoed President Obama's statements on March 7, 2012 in an interview with the National Journal. Secretary Panetta stated,

"Let me be clear – we do not have a policy of containment. We have a policy of preventing Iran from acquiring nuclear weapons."

Secretary Panetta also stated that US military planners are "absolutely" planning for a potential preventive strike on Iran's nuclear facilities.

Implications for US Policy

US and Iranian competition over Iran's nuclear programs has spilled over into the entire region and the world, and is at – or near – the crisis point. Given the importance of the Gulf in global energy security, Iran's goals of becoming a regional power, and socio-political instability in the Middle East, military competition between the US and Iran will either force some form of negotiation or continue to intensify.

If it intensifies, there are no good options. The choice moves toward preventive strikes of a kind where the consequences are at best unpredictable. Any preventive attack – in particular a limited attack by Israel -- could lead to Iranian responses ranging from a battle of attrition in the Gulf to a major air-sea conflict or an indirect attack on Israel through Hezbollah and Hamas.

A preventive attack could push Iran towards negotiations, but could also push the Iranians into a major acceleration of their nuclear program and exacerbate the ongoing regional arms race. This race might lead to the creation of a successful mix of deterrence and defense on the part of all the nations involved, but it might equally lead to Iran and Israel targeting their respective populations at a potentially catastrophic level and involving the US and Arab states in an ongoing race to find suitable forms of defense, deterrence, and containment.

A successful preventive attack would be a major air and missile war, and probably have to be followed by years of constant patrolling, threats to use force, and occasional restrikes. If not, such an action would be a temporary solution at best. The current level of maturity in Iran's program nearly guarantees that Iran could rebuild its facilities without constant US military monitoring and the willingness to use additional force. Moreover, without such follow up, a strike on Iran's nuclear infrastructure might provide the Iranian regime with a justification to pursue nuclear weapons, and drive the program deeper underground.

The best, most lasting solution to Iran's nuclear and missile programs is some form of negotiated political solution, and one driven by compromise and a "carrot and stick" approach. Such an approach would consist of offering Iran economic and other incentives to shelve its nuclear program, not simply penalizing it for continuing efforts at weaponization and refusing to comply with the IAEA.

The risk is all too obvious, however, that the present situation will remain intractable. Negotiations between the US, Iran, and other states during the last decade have collapsed time and again due to the refusal of both sides to accept the basic demands of the other. Furthermore, the historical tension between the US and Iran, as well as Iran's foreign policy and military doctrine that are centered on neutralizing US conventional power in the region, make it unlikely

that Iran will give up the added deterrence and perceived increase in regional influence that only a nuclear capability or deployed nuclear force can provide.

Iran is all too likely to continue to develop its ballistic missile program as both a weapon of intimidation, and a means to deliver a nuclear warhead should Iran successfully miniaturize a nuclear device. Given the range of Iran's ballistic missiles, US installations in the Gulf, US allies in the Middle East, and much of southeast Europe will then be in range of an Iranian nuclear missile.

Chapter V describes the progress the US and its allies have made in sanctions, and this seems to be the best course until Iran produces weapons grade material or moves towards a test. Grim and uncertain as the prospect is, however, the US must then consult with its Arab Gulf and European allies and seriously consider preventive attacks.

As discussed in Chapter VI, the US must work with the southern Gulf states to ensure it can launch the level of strikes and maintain the persistent restrike options necessary to ensure Iran cannot become a nuclear threat. At best, however, this will be a last resort. It also does not mean that the US should not do everything possible to discourage any Israeli strike unless all negotiating options have clearly failed, and Israel can do a far more effective job with far fewer negative consequences than seems likely for the unclassified data now available.

The alternative is for key US allies, the flow of world energy exports, and the US and global economies to continue to exist under the growing shadow of an Israeli-Iranian nuclear arms race. This is, moreover, an arms race where the forces involved ensure that the primary targets will be the other country's population centers.

Accepting this risk requires a belief in Iran's restraint, in mutual deterrence based on a new regional form of mutual assured destruction, and accepting the risk that other nations will join the race. It also means accepting the risk of some miscalculation or accident triggering a disaster with massive humanitarian and economic costs.

Accepting this risk further compels the US to do everything possible to provide its Arab allies, Turkey, and Europe with missile defenses and to improve Israel's missile defenses. It means making good on the US offer of extended deterrence to protect other states – potentially dragging the US into at least the periphery of a regional nuclear arms race and potential nuclear conflict. Finally, it means living with the near certainty that the enduring arms race in the Gulf—and the general instability in the region—will continue to be fueled by Iran's pursuit of nuclear weapons.

A "waiting option" that relies on diplomacy, sanctions, and the offer of incentives is scarcely a pleasant one, and it too is filled with risks that will increase on both a short term and long term basis. It is, however, probably the least bad of a range of bad options, and it does give time for regime change to take place in Iran. The prospects of such a change really altering Iran's actions and ambitions are uncertain – and many of the claims that the regime is fragile and easyily toppled seem a triumph of hope and ideology over common sense. Yet, successful negotiations, containment and waiting for regime change do seem to be the best option available.