

EXECUTIVE SUMMARY

On May 31, 2012, the United States House of Representatives proposed an amendment to the 2013 Intelligence Authorization Bill that would require the director of National Intelligence to submit to the congressional intelligence committees “a report containing an assessment of the consequences of a military strike against Iran” within 60 days of the amendment’s passage.¹

With the failure of diplomatic talks in Moscow to bridge the “gulf of mistrust” between Iran and the world powers—Britain, China, France, Russia, the United States and Germany—the **possibility of military strikes against the Islamic Republic of Iran’s nuclear program in 2012 cannot be ignored.**²

With three high level talks—in Istanbul, Baghdad and now Moscow—led by European Union Foreign Policy Chief Catherine Ashton and the Supreme Leader’s personal representative and chief negotiator, Saeed Jalili, failing to build confidence in the Islamic Republic’s claims about the peaceful nature of its nuclear program, the hopes for a diplomatic breakthrough are diminishing. **Time is short, the stakes immense.**

As one of the leading advocates of military strikes against Iran, Israeli Prime Minister Benjamin Netanyahu has repeatedly warned of the existential threat to Israel of Iran’s nuclear program. Speaking before the American Israel Public Affairs Committee (AIPAC) in early March 2012, Netanyahu made it clear that time for a peaceful diplomatic resolution to the nuclear dispute was running out. As he put it: “We waited for diplomacy to work; we’ve waited for sanctions to work; none of us can afford to wait much longer.”³ Speaking in Prague in May of 2012, Netanyahu poured cold water on prospects for diplomacy, comparing Iran’s nuclear agenda to North Korea’s: “It looks as though they [the Islamic Republic] see these talks as another opportunity to deceive and delay, just like North Korea did for years.”⁴

While there has been considerable debate about the timing and targets of military strikes against Iran’s nuclear program, the costs and consequences of such strikes have not received sufficient attention. Military planners at the Pentagon do provide policymakers with estimates of civilian casualties; these estimates are typically for

operational purposes and not made available to the general public. Virtually no one has presented a scientific assessment of the consequences of military strikes on operational nuclear facilities. What is certain is the gravity of the risk to civilians: **The IAEA has verified an inventory of at least 371 metric tons of highly toxic uranium hexafluoride stored at Iran’s nuclear facilities.**⁵ The release of this material at sites that are only a few miles from major population centers such as Isfahan warrants a thorough and comprehensive assessment of the potential risks to thousands of civilians living in the vicinity of Iran’s nuclear sites.

As for the Islamic Republic, its leaders have had no interest in making the risks of their reckless nuclear policies obvious to its citizens even though the resulting economic toll—inflation, unemployment, and the loss of international credit—has devastated the Iranian people. The Iranian military has not provided the Iranian people with any description of potential casualties resulting from attacks on these nuclear facilities. Nor has the parliament encouraged an open assessment of the grave implications of the government’s policies for Iranian scientists, soldiers and civilians working at or living within the vicinity of Iran’s nuclear facilities. This study seeks to address this deficit.

Ayatollah Khamenei, Iran’s Supreme Leader, is making a deadly nuclear gamble. While no smoking gun has emerged to prove that Iran is pursuing a weapon, questions abound in the international community and among Iran’s neighbors. The International Atomic Energy Agency (IAEA) is asking for access to nuclear facilities that could have had military applications. Whatever the technical reality, the political reality is this: Israel continues to threaten military strikes, should diplomacy fail. In a post-election United States, either a newly re-elected President Barack Obama or an incoming President Mitt Romney will face a ticking clock that will add an element of urgency to their decisions on Iran’s nuclear program. The risks to the Iranian people of military strikes have never been greater. These risks are difficult but important to quantify. The human dimension matters. By quantifying the costs of military strikes, we have sought to make the scale of the Ayatollah’s reckless gamble and the gamble of possible U.S. and/or Israeli strikes apparent not only to the Iranian people but also to the international community, including policymakers in the United States and Israel.

Nuclear gambles can have short- and long-term local, regional,

1 Pete Kasperowicz, “Dems push for report on consequences of military strike on Iran,” *The Hill*, 31 May 2012.

2 <<http://www.nytimes.com/2012/06/20/world/middleeast/tense-iran-nuclear-talks-resume-in-moscow.html>>.

3 Chris McGreal, “Netanyahu on Iran: ‘None of us can afford to wait much longer,’” *The Guardian*, 6 March 2012.

4 Tom Peter, “Netanyahu: Iran won’t take nuclear talks seriously,” *The Christian Science Monitor*, 18 May 2012.

5 “Implementation of NPT Safeguards Agreement and relevant provisions of Security Council resolutions,” IAEA Report to the Board of Governors, 18 February 2010: 6.

and global consequences that are impossible to predict, let alone contain. Conventional strikes involving the systematic bombing of nuclear installations can be far more devastating than nuclear and industrial accidents such as Chernobyl, Fukushima, Three Mile Island or Bhopal. The damage from strategic aerial bombardment is planned to be total and irreversible. It leaves no time for intervention, no chance for evacuation and no possibility for containment.

There are few historic precedents for assessing deaths and injuries from the impact of conventional strikes on operational nuclear processing facilities. We have defined casualties as the sum total of fatalities, as well as the acute and chronic injuries resulting from the thermal, physical, chemical and radiological impact of military strikes. Assessing the casualties and damage to the Iranian people depends mainly on two critical factors: the strategic military intent and capabilities of the United States and Israel, and Iran's logistical civil defense capabilities and preparations. These include variables such as the timing and severity of strikes, the nature and number of targets, as well as on-site conditions, such as the nature and amount of toxic inventories present, population distribution in the vicinity of the target sites, and remediation capabilities. Other important natural and environmental factors such as topography, wind direction and humidity are also critical in determining human casualties and other losses.

Conventional military strikes would almost certainly hit the nuclear sites at Isfahan, Natanz, Arak and Fordow. It is highly unlikely, but not completely impossible that the Bushehr nuclear power plant would be targeted as well. Despite some speculation, most experts also rule out the possible use of tactical nuclear weapons against Isfahan and Natanz as unnecessary, disproportionate and counter to U.S. strategic doctrine and international law. Yet virtually none dismiss the high probability of conventional military strikes against Iran's nuclear facilities near Isfahan, Natanz and Arak. We have not included the deeply buried Fordow site near Qom in our analysis due to the incomplete nature of information about this site. However, it is almost certain that Fordow would be targeted with powerful bunker busters.

For the purposes of this study, we have assumed a conservative strike scenario and analyzed the impact of conventional military strike against four targets: Isfahan, Natanz, Arak and Bushehr.

Beyond the sites, some military planners have suggested that any strike against Iran could extend to more than 400 targets, or "aim points." The goal of the strikes would be to permanently cripple Iran's ability to revive its nuclear program by targeting site personnel as well as the auxiliary and support infrastructure. After taking out Iran's air defense systems, highly probable aim points in any target list include leadership and command, communication structures, missile facilities, centrifuge workshops (some of which are located in urban centers), and any other secret nuclear sites known to western intelligence agencies. Other probable targets would include Revolutionary Guard assets that could be used in retaliation and the Parchin military complex where weaponization activities are suspected to have taken place. Uranium mines and mills could also be targeted. We have restricted our estimates of casualties to those injured or killed as a direct result of strikes at the four nuclear facilities and the immediate vicinities only.

Based on the best information available as well as discussions

with Iranian and Western nuclear experts, we have estimated the total number of people—scientists, workers, soldiers and support staff—at Iran's four nuclear facilities to be between 7,000 and 11,000. **It is highly likely that the casualty rate at the physical sites will be close to 100 percent. Assuming an average two-shift operation, between 3,500 and 5,500 people would be present at the time of the strikes, most of whom would be killed or injured as a result of the physical and thermal impact of the blasts. If one were to include casualties at other targets, one could extrapolate to other facilities, in which case the total number of people killed and injured could exceed 10,000.**

To grasp the political and psychological impact of the strikes, what our estimates suggest is that the potential civilian casualties Iran would suffer as a result of a strike—in the first day—could match, and possibly exceed, the 6,731 Palestinians and 1,083 Israelis reportedly killed in the Israeli-Palestinian conflict over the past decade.⁶ Bashar Assad's ground assaults on civilians in Syrian cities—the massacres in Homs and beyond—have taken a daily toll in the tens and hundreds in over a year. Yet the daily toll from the massacres in Syria would pale before the potential sudden death of thousands of civilians from a massive air assault on targets throughout Iran.

However, unlike traditional targets, the risks to civilians extend well beyond those killed from exposure to thermal and blast injuries at the nuclear sites. **Tens, and quite possibly, hundreds of thousands of civilians could be exposed to highly toxic chemical plumes and, in the case of operational reactors, radioactive fallout.**

An attack on the Uranium Conversion Facility at Isfahan and the Enrichment Plant at Natanz would release existing stocks of fluorine and fluorine compounds which would turn into hydrofluoric acid, a highly reactive agent that, when inhaled, would make people "drown in their lungs," as one scientist put it. As a point of reference, fluorine gases are more corrosive and toxic than the chlorine gas used in World War I. Once airborne, at lethal concentrations, these toxic plumes could kill virtually all life forms in their path. Depending on the volume of chemicals stored at the facilities, population densities around the sites, and prevailing wind and meteorological conditions, tens of thousands of workers and civilians in Isfahan and fewer in Natanz could be exposed to toxic plumes. **These plumes could destroy their lungs, blind them, severely burn their skin, and damage other tissues and vital organs.**

Isfahan will pay a particularly high price for the Ayatollah's gamble and the gamble of Israeli and/or U.S. strikes. The current volume and lethality of the toxic chemicals produced at the Isfahan facility alone makes it impossible to ignore the unacceptable risks to civilians if some, or all, of this material is stored at this location.

According to the International Atomic Energy Agency, from 2004 to 2009, the Isfahan Uranium Conversion Facility (UCF) has produced in excess of 371 metric tons (409 US) of uranium hexafluoride which is stored at either Isfahan or Natanz.⁷ Based on our calculations, if

6 "B'Tselem: Since 2000, 7,454 Israelis, Palestinians killed," *Jerusalem Post*, 27 September 2010. See also: "27 September '10: 10 years to the second Intifada—summary of data," The Israeli Information Center for Human Rights in the Occupied Territories (B'Tselem), http://www.btselem.org/english/press_releases/20100927.asp

7 "Implementation of NPT Safeguards Agreement and relevant provisions of Security Council resolutions," IAEA Report to the Board of Governors, 18 February 2010: 6.

only 5% of 371 metric tons of uranium hexafluoride produced at the Isfahan facility becomes airborne during or after an attack, the toxic plumes could travel 5 miles with the Immediately Dangerous to Life or Health (IDLH) level of 25 milligrams per cubic liter covering a surface area of 13 square miles. With prevailing wind directions and speeds at 9.4 miles/hour moving towards the city, in about one hour, this plume could expose some of the 240,000 residents in Isfahan municipality's eastern districts, particularly districts 4 and 6. At a 20% release, the IDLH plume will travel 9 miles covering 41 square miles and could expose some of the 352,000 residents, mainly in districts 13, 4, and 6, as well as residents in the region north of district 4. **If we assume a conservative casualty rate of 5 to 20 percent among these populations, we can expect casualties in the range of 12,000-70,000 people.**

It is thus highly likely that the people of Isfahan would experience a tragedy similar in magnitude to the Bhopal accident at the Union Carbide plant in India in 1984. Additionally, the environmental degradation due to the spread of airborne uranium compounds, and their entry into water, soil and the food chain would introduce long-term, chronic health risks such as a spike in cancer rates and birth defects. Isfahan, an important cultural and economic hub comparable in terms of its history, architecture, and beauty to Florence and Kyoto, would be devastated. If, however, these materials have been moved from the Isfahan UFC, or are being stored elsewhere, the number of casualties will be reduced correspondingly.

In the case of Natanz Fuel Enrichment Plant and Pilot Fuel Enrichment Plant, the strikes will be particularly heavy because the target is buried. The on-site casualties will be significant, effectively turning the underground nuclear site into a mass grave. The threat from toxic plumes will not be as severe. The facility is not in close proximity to a major urban center, the surrounding area is sparsely populated and the prevailing winds blow away from the cities of Natanz and Kashan. We estimate casualties from exposure to toxic plumes in the Natanz rural region at between 800-7,000 people. Given Natanz's reputation as a fruit and agricultural center, the environmental consequences of strikes on the local economy would be significant.

Strikes on operational nuclear sites also pose grave radiological threats. A military strike on the Bushehr nuclear power plant, which is operating at 75 percent capacity, and Arak's Heavy Water Reactor, once it becomes operational, would pose an even more serious threat to the Iranian people than strikes on Isfahan and Natanz.

The port city of Bushehr is less than seven miles from the Bushehr nuclear facility. Prevailing wind directions blow towards the city, which has a population of 240,000. Although a less likely target, the city would suffer a fate similar to Pripjat, the Soviet city abandoned after Chernobyl, and hundreds of thousands of people in the region would be exposed to dangerous levels of radiation if military planners include the facility on their target list. **If only 1 to 5 percent of the population is exposed to significant radiation levels, 2,400 to 12,000 people could suffer from severe health effects such as those witnessed in the aftermath of Chernobyl.** Moreover, the damage would extend beyond Iran. An attack on the Bushehr nuclear power plant would pose a grave environmental and economic threat to civilians in Kuwait, the United Arab Emirates, Iraq and Saudi Arabia. It would not only devastate the important business centers and fishing communities of the Persian Gulf, but also contaminate desalination

plants, port facilities and oil fields. To gain an approximate idea of the economic consequences of a strike on Bushehr, one should consider that the government of Belarus has estimated the economic cost of Chernobyl to exceed \$200 billion.

The facilities at Arak would also be a definite target. Its 40-mega-watt reactor could be used for the production of Plutonium-239, ideal weapon-production material. The IAEA claims that, based on satellite imagery, the heavy water production plant at Arak is already operational. And the Islamic Republic claims that the Arak heavy water reactor is scheduled to come on line in the third quarter of 2013. An attack before the reactor becomes operational would kill most of the 500 employees at the site but it would not pose significant risks to the population centers around the site. However, once the reactor becomes operational, an attack would expose Khondab, a city of 72,000 residents two miles from the facility, to large quantities of radioactive material. **We estimate that if only 1 to 5 percent of the population is exposed, between 720 and 3,600 people could suffer from chronic effects.**

Beyond the strike force, the next crucial factor in determining casualty levels in the aftermath of military strikes is Iran's disaster management and emergency preparation capacities. In the event strikes lead to the exposure of large populations in Isfahan and elsewhere to toxic plumes, the historical record suggests poor disaster management and inadequate emergency preparation could magnify casualties by a factor of ten. For example, the fatalities in Iran in the aftermath of the Bam Earthquake were ten times those from a more powerful earthquake that hit a more densely populated region of Turkey. As far as exposure to radiation is concerned, it is important to note that the Islamic Republic of Iran lacks a substantial capacity to handle a threat of such a nature and scale. As far as radiation exposure, in the only case documented by the IAEA, the now infamous Gilan case, the Islamic Republic had no choice but to send a worker exposed to radiation to the Institut Curie in France for specialized treatment. In the event of a large scale disaster at an operational nuclear reactor, it would be extremely difficult for exposed civilians to receive appropriate medical attention or compensation from the Iranian government.

In evaluating the military option, some analysts have suggested that a military strike against Iran's nuclear sites could be as simple and effective as the strike on the Iraqi nuclear site at Osirak, Saddam Hussein's half-constructed, French-built reactor destroyed by Israel in 1981. Such an analogy is false. Iran's nuclear plants cannot be compared to Osirak. They are widespread, operational, heavily manned, and contain hundreds of tons of highly toxic chemicals and radioactive substances. Most recently, the former director of the Shin Bet, Yuval Diskin, warned that strikes could even speed up Iran's nuclear program: "What the Iranians prefer to do today slowly and quietly, they will do ... quickly and in much less time."⁸

Rather than dismiss them as collateral damage, it is time to factor the Iranian people into any equation involving military strikes. There is a strong moral, strategic, political and military argument for counting the Iranian people's interests as a key factor in the nuclear dispute. At a minimum, the Iranian people, particularly the people

⁸ Yaakov Lappin, "Former Shin Bet chief slams 'messianic' PM, Barak," *The Jerusalem Post*, 29 March 2012.

of Isfahan, should be warned about the consequences of military strikes. After all, it is they who would pay the price of a military strike, one that would implicate Israeli and American advocates of strikes in a strategic and moral quagmire as perpetrators of man-made nuclear disaster.

A key preventive step for mitigating the exposure of civilians is verifying the location and quantity of Iran's stockpile of highly toxic chemical and radioactive agents, making sure that they are not stored at sites near major population centers, and encouraging local officials to educate the public and adopt the necessary civil defense plans to ensure rapid evacuation and treatment of populations at risk of exposure to highly toxic chemical plumes, and, in some cases, radiation. It is incumbent on the United Nations Security Council, International Atomic Energy Agency, the Red Crescent, and other international organizations to address the humanitarian consequences of the bombing of Iran's nuclear facilities before, rather than after, the event. Beyond Iran, the bombing of nuclear sites establishes a dangerous precedent with profound ramifications not only for the nuclear industry, but also for all nations facing potential conflicts centered on their nuclear programs.

In the long run, neither a nuclear deal with Iran, nor military strikes would generate a satisfactory long-term solution to the nuclear impasse. Ayatollah Khamenei—the most powerful man in Iran today—can always renege on a nuclear deal and strikes might even strengthen his grip on power. **The best long-term strategy would be a democratic, transparent, and accountable government in Iran.** In such a scenario, political leaders would quickly understand that their people want jobs, dignity, opportunity, and political freedoms, not the false promise of nuclear weapons bought at a heavy, even existential, cost. A military strike would not only kill thousands of civilians and expose tens and possibly hundreds of thousands to highly toxic chemicals, it would also have a devastating effect on those who dream of democracy in Iran. Ayatollah Khamenei has proven that he cares little for the Iranian people. It is up to us in the international community, including the Iranian-American diaspora to demonstrate that we do.