Response Essay

Civilian Casualties of a Military Strike in Iran

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Introduction

The Iranian nuclear issue, including how the acquisition of nuclear weapons by Iran would affect the region and the world, and how this challenge might best be confronted, has been widely discussed and debated. Three main possibilities for resolving this issue, with numerous potential variations, have been identified: the diplomatic solution (i.e., engagement), including sanctions; a regime change in Iran; and the military option, i.e., destruction of or severe damage to Iran's nuclear weapons development capabilities. The diplomatic solution has been and still is the focus of major international efforts, though as yet is unsuccessful.[1] The "biting" sanctions have hurt Iran, but have yet to become a game changer. Covert operations, hostile measures short of an outright military strike, have been effective in slowing down the Iranian program, but not in bringing it to a halt. The timing of a regime change in Iran is difficult to predict, and there is no assurance that the new regime will adopt an anti-nuclear weapons policy. The last resort, which is the military option, is fraught with dangers. The pros and cons of a military attack on Iran's nuclear facilities and its local, regional, and global effects are the subject of heated discussions.

While estimating political effects of a military strike is much a matter for analytical speculation, the direct physical effects of a military attack, including the assessment of the number of civilian casualties resulting from this action, are somewhat easier to estimate, depending mainly

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on technical models and data. This is the main topic of the following essay, which seeks to address a lengthy and detailed report by Khosrow B. Semnani, *The Ayatollah's Nuclear Gamble: The Human Cost of Military Strikes against Iran's Nuclear Facilities* (hereafter "the report").[2]

The purpose of the report is announced in the opening paragraph of the introduction:

> The goal of this study is to protect the Iranian people and to educate policymakers by providing an objective basis for evaluating the impact of military strikes on Iranian civilians and soldiers. Nevertheless, we do not defend a policy of engagement premised on building confidence in the peaceful intentions of a theocracy whose Supreme Leader is responsible for the death of thousands of Iranians and whose president dismisses the people as "dust and dirt."

Late in the report the author concludes that the preferred, and probably the only feasible, solution is to wait for a regime change in Iran. This option will be discussed below, but suffice it here to say that this could be a very long wait, without the certainty of resolving the nuclear issue.

The report received widespread attention, and its conclusions were widely quoted and taken as basic truisms.[3] The problem is that similar to other scientific related issues, conclusions that are erroneous or based on incorrect or partial information could be very misleading, and serve as the basis for misplaced decisions.

Environmental Effects of an Attack on Nuclear Installations

Estimating the environmental impact of civilian industry on the civilian population has long been an exercise in which industries tend to minimize the possible effects of both regular operations and accidents on their workers in particular and the greater population in general. On the other hand, environmentalists and many neighboring populations tend to present doomsday scenarios that maximize the environmental effects of both routine operations and emergency situations over which they have no control. There is no standard resolution of this conflict, and the middle of the road does not always offer a reasonable outlet for solving the problems. Therefore, each problem must be resolved on its own, by agreeing on the methodology to be used in an assessment, taking the best scientific data available, and arriving at an agreed solution.

This becomes very difficult when considering the specific issue of a possible attack on Iran's nuclear facilities. Many factors come into play here, some technical, some humanitarian, some economical, some political. Some are not quantifiable, and as such cannot serve as a basis for comparisons and evaluations. However, the technical issues, as they are quantifiable, are the first that should be considered, and when not manipulated can be used to evaluate the effects of a military attack on Iran's nuclear installations.

In general, industrial accidents, i.e., accidents that involve industrial facilities, can have serious environmental consequences if they involve the release of toxic materials into the atmosphere or the aquatic environment, or materials that could render the environment inaccessible for future development and thus cause serious economic consequences, even if they are not that harmful in their immediate effects. Nuclear industry accidents could also involve the release of radioactive materials that are by themselves harmful – radiotoxic materials – though not all radioactive materials are harmful. Radioactivity is omnipresent in the environment, albeit in rather low concentrations in most places. The main radiotoxic materials in Iranian nuclear industrial complexes would be present in operational nuclear reactors and their byproducts in high and potentially lethal concentrations.[4] Although the uranium industry involves the use of highly toxic materials, the uranium contents alone are of rather low toxicity (on the same level as lead, for example). The main toxicity of the uranium industry in Iran would come from the fluorine contents of the uranium compounds, because of their extreme corrosive properties. Releases of considerable quantities of these to the atmosphere could cause grave health problems if inhaled or if they come into contact with the human skin. The economic consequences would be overshadowed by the human consequences.

It is because of the fear of the consequences of accidents in the nuclear industries that many protective actions are taken. The imposition of exclusion zones around nuclear complexes, built-in protective measures, and extensive emergency planning and preparedness programs are all intended to reduce the environmental consequences of nuclear accidents caused by any source, including military aggression.

Bushehr is not a Target

Returning to the report's introduction, some of its statements lead one to question whether this will in fact be the "objective basis" on which to base future policy decisions: "In terms of power and precision, military strikes against nuclear plants could result in damage similar, if not worse than, the damage caused by nuclear accidents, whether the result of human error, design flaws, or natural disasters." And:

> "No matter what safety and defensive measures are in place, there would be no time for intervention or evacuation: no way to shut down the plants, cool down the reactors in Bushehr, reinforce containment structures, save plant personnel, evacuate local residents, or bring in rescue workers. The subsequent contamination of air, water, and soil from the chemical and thermal impact of strikes on nuclear plants would be immediate, vast and, for the most part, irreversible."

However, labeling the Bushehr reactor as a main target for a strike is pure demagoguery, as no one in his right mind would consider striking an operating nuclear power reactor. First, the environmental consequences could be horrendous. Second, the utilization of this reactor for military purposes is not straightforward, while the subsequent stages for fissile materials production are also vulnerable and carry less potential for environmental consequences. Third, Iran is contractually obligated to return the irradiated fuel to Russia, so why attack this installation?

The author goes one step further, and in the discussion of the consequences of an attack on Bushehr uses the Chernobyl accident as an historical model for the situation that could arise in Bushehr. In addition, the Fukushima accident strengthens his stance that these consequences are unacceptable for Iran. Yet while for the reasons stated above this model cannot and should not be used here, the seed is sown, and the populist comparisons are inevitable.

Targeting the Uranium Compounds Inventories

Leaving aside the non-issue of attacking operating nuclear reactors, we arrive at the more important possible targets of a military attack: the uranium enrichment facilities. The first link in this chain is the Uranium Conversion Facility (UCF) where the uranium ore is converted into uranium hexafluoride (UF_6), which is the feed material for the uranium

enrichment facilities, located both at Natanz and at Fordow, near the city of Qom. At normal room temperature and pressure, UF_6 is a solid. At around 56°C it vaporizes, turning into a (highly toxic) gas.[5] It is stored in containers that are usually filled, under some pressure, with liquid UF_6, which later, after a period of cooling, solidifies, leaving a small quantity of the gas at the top of the container. Under normal conditions, if the container is ruptured, very small quantities of gas will escape to the environment and can cause injuries or even death to the workers at hand, but not to anyone beyond an immediate, circumscribed distance from the source.

There can be little doubt that the UF_6 produced at the UCF, near Isfahan, is stored underground. In May 2010, the IAEA reported that Iran declared that it was installing an underground analytical laboratory at the site "to meet security measures."[6] This laboratory, Iran indicated, "would be installed in an underground location in one of the UCF storage areas." Therefore, even if there is a direct hit on a container, it is doubtful that a significant part of its inventory would leak to the outside atmosphere, because of the heat that has to be supplied to the container in order to vaporize its contents, and because of the tortuous path the vapor would have to take, interacting with the contained environment and turning again into a non-gaseous compound before escaping, in very small quantities, if any, into the free atmosphere. As mentioned, after a period of cooling, the contents of the containers solidify. Since the vast majority of the UF_6 inventory is already years old, and with the exception of very small quantities in gaseous form is in the solid state, the possibility of release is reduced, even if container integrity is compromised.

Although it is not possible to foresee the consequences of direct hits on Iranian underground facilities, it is reasonable to assess that either the underground facilities will be penetrated and exploded from within, or hit and collapse into the inner cavities and turn into piles of rubble, or with their innards at least gravely harmed. These piles of rubble would act as filters, with their greater surface areas holding on to or reacting with the materials released within, and thus preventing the major contents from escaping to the atmosphere and causing grave environmental harm.

The report unrealistically assumes a release rate of up to 50 percent of the inventory, a figure that is patently absurd.[7] With the assumed source-term (the characteristics of the release) for the calculations being in the range of hundreds of tons UF_6 released into the atmosphere, the ensuing

result of 70,000 casualties is of course achievable. What the report fails to state explicitly is that the source-term for its calculations assumes a ground level, unprotected source, with the entire inventory in the liquid state. This certainly is beyond a worst case scenario.

The case for the UF_6 inventories at both the next links in the uranium enrichment chain, Natanz and Fordow, is not different from that of Isfahan. Both are underground installations and as such are well protected, and perhaps while not all that immune to military damage, would still be rather immune to significant atmospheric releases.[8] There would of course be some inventories of UF_6 in several above ground areas, and these could be sources of releases. The vulnerable inventories are all controlled by the local operators, and it is in their power and their duty to minimize these. It is not only a matter of preparing for a military strike. It is part of nuclear good practices, essential for all nuclear operations. The same argument should be made for the case of industrial toxic gases, which should be normally protected against accidents whose occurrence could cause damage and casualties to the workers and to the environment.

The question then arises as to whether the Iranians apply good safety practices in their industrial activities. Although there is much evidence that they pay serious attention to the issue of industrial safety, there is no way to judge the efficacy of the safety measures that are applied in the industrial sector. Presumably the Iranians would not embrace atypical standards in this field, but would apply a reasonable standard of operational safety. Without this their activities would have been in a much worse shape than they are in today.

Is Regime Change the Solution?

What then is to be done? The report states clearly that rather than carrying out a military attack that can be devastating for Iran, "it is time to recognize that the Iranian people pose a far greater threat to the Islamic Republic than the U.S. or Israeli military power." In other words, the best solution for the Iranian nuclear issue is an Iranian regime change. There are two major problems with this solution. First, the policy of the new regime is uncertain and could possibly opt to retain its nuclear capabilities. Only a comprehensive regime change, which would install in Iran a democratic secular government that would have a deep respect for human rights, for the international community, and for international

treaty obligations could inspire hope that Iran genuinely seeks to be an equal member of the region and not a hegemonic one. Such a state would be relied on to make decisions that would benefit its people, and not lead them into a disastrous situation from which it would be difficult to recover. Only such a regime would stand a chance of convincing the IAEA, the Security Council, and the world at large of the "exclusively peaceful purpose" of its nuclear program.

However, the acquisition of a military nuclear capability will probably prolong the life of the present regime in Iran, with all the added regional stability and proliferation issues. Hence the second problem in considering the regime change solution is the timetable for such a change. Not only could there be no guarantee of this change, but it could also be so delayed that it would give the present Iranian regime time to produce nuclear weapons that would be a game changer for all concerned. It is also not inconceivable that the present Iranian regime would resort to the actual use of nuclear weapons, should it consider it beneficial to do so.

Notes

1 As expected, the April 2013 Almaty talks between the P5+1 and Iran ended in failure, giving Iran more time to develop its nuclear weapons project.

2 Published by the Hinckley Institute of Politics at the University of Utah, September 2012. See http://nucleargamble.org/wordpress/wp-content/uploads/2012/09/Ayatollahs-Nuclear-Gamble-Full.pdf.

3 See, e.g., David Isenberg, "The Myth of 'Surgical Strikes' on Iran," *Time*, October 18, 2012, http://nation.time.com/2012/10/18/the-myth-of-surgical-strikes-on-iran/; and "Situation Report: What 371 Metric Tons of Uranium Hexaflouride Could mean to Iranians," *Foreign Policy*, September 27, 2012, http://www.foreignpolicy.com/articles/2012/09/27/what_371_metric_tons_of_uranium_hexafluoride_could_mean_to_iranians.

4 At present, there are three nuclear reactors in Iran: the operational power reactor in Bushehr, the relatively small research reactor in Tehran, and the heavy water reactor at Arak, which is still under construction.

5 "Interim Guidance on the Safe Transport of Uranium Hexafluoride, Appendix II: Properties of UF6 and Its Reaction Products," Vienna: IAEA, 1991, IAEA-TECDOC-608, http://www-pub.iaea.org/MTCD/publications/PDF/te_608_prn.pdf.

6 Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions 1737 (2006), 1747 (2007), 1803 (2008), and 1835 (2008) in the Islamic Republic of Iran, *Report by the [IAEA] Director General,* GOV/2010/28, May 31, 2010, http://www.iaea.org/Publications/Documents/Board/2010/gov2010-28.pdf.

7 See chapter II in the report: "Methodology and Assumptions - A. Inventories, Storage and Location, and B. Release."

8 In order to render these enrichment facilities damaged beyond repair, one does not have to blow them out. Destruction can be contained within, when the enrichment machines and pipings are damaged beyond repair, but the damage would be mainly contained inside the facilities.