



Highlights of *Iran's Perilous Pursuit of Nuclear Weapons*

By David Albright with Sarah Burkhard and the Good ISIS Team

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Iran's Perilous Pursuit of Nuclear Weapons chronicles the Islamic Republic of Iran's effort to acquire nuclear weapons. It started slowly, building to a crash nuclear weapons program in the early 2000s to create five nuclear weapons and an industrial complex to produce many more. Under international pressure, fearful of military attack, the program was driven to downsize and deeper secrecy. Nonetheless, Iran remains on the brink of becoming a nuclear weapons power; its nuclear material production capabilities stronger than ever, its weaponization capabilities lurking under the surface.

But just how close did Iran get to nuclear weapons during its crash program and how close is it today? Up until the events of a cold, clear night in January 2018, the world could only guess. In a dramatic nighttime raid, the Israeli Foreign Intelligence Service Mossad broke into a warehouse in Tehran and seized a large cache of documents detailing Iran's darkest and long-denied secret. The Amad Plan, the codename for its crash nuclear weapons program, was far larger and made much more progress than previously known. Containing many top secret details, the seized documents offer unprecedented insights into Iran's progress—and the hurdles it faced in building nuclear weapons. With what Iran learned about building nuclear weapons during the Amad Plan, combined with its subsequent accomplishments, the Islamic Republic has developed a sophisticated capability to make nuclear weapons.

It would not take Iran long to build nuclear weapons today. The challenge rests in stopping the Islamic Republic from building them and sparking a regional nuclear arms race. *Iran's Perilous Pursuit of Nuclear Weapons* is a valuable resource for discussions and decisions on creating effective ways to stop Iran's nuclear weapons program.

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What's New in a Nutshell?

- Iran had accumulated enough information and experience by the end of the Amad Plan to be able to design and produce a workable implosion nuclear device. This device benefited from a relatively compact high explosives initiation system, the shock wave generator, and a specialized neutron initiator. The nuclear weapon design has a diameter roughly the same as a car tire.
- By the end of the Amad Plan, Iran was preparing to conduct a cold test of a nuclear explosive, typically the last step before building a prototype nuclear explosive and then making nuclear weapons.
- About half of the facilities in the Amad Plan were undiscovered or unknown until after the seizure of the Iranian Nuclear Archive in 2018.
- Iran decided under the Amad Plan that it would use low-enriched uranium from Natanz for further enrichment to weapon grade uranium at what is now known as the Fordow site.
- Iran's decision to halt the Amad Plan merely served as a tactical retreat, not an abandonment of its nuclear weapons ambitions or activities, a step taken earlier by other countries, notably Taiwan and South Africa.
- A major part of the halt was a series of "intensive meetings" over eight days in August and September 2003. The meetings were dominated by carrying out official orders to downsize and not build nuclear weapons but preserve the assets and many of the activities of the Amad Plan.
- After the closure of the Amad Plan, other organizations continued work on nuclear weapons. The evidence suggests that Iran not only maintained the capability to produce nuclear weapons, but actively worked on efforts to advance that capability in case Iran's leaders made a decision to build them.
- Mohsen Fakhrizadeh, from 1998 until his murder in November 2020, was the undisputed leader of Iran's nuclear weapons program. He was the Leslie Groves of Iran's nuclear weapons program, someone who brought great managerial skills and political clout to the task of shepherding various pieces and talents into a nuclear weapons effort.
- Three of the five key leaders of the Amad Plan and post-Amad organizations have died violent deaths. Two others narrowly escaped death.
- The post-Amad reorientation strategy shines a new light on controversial Atomic Energy of Iran (AEOI) nuclear activities that followed after 2004, particularly the Fordow enrichment plant, which was originally the Amad Plan's intended facility to produce weapon-grade uranium and was repurposed to low enriched uranium production after its discovery in 2009. Similarly, recent AEOI uranium metal production activities may be follow-on activities of the Amad Plan.

What's New (cont.)

- Unlike in 2003, Iran now has a robust capability to make weapon-grade uranium, a capability that will eventually grow more than ten-fold if the Joint Comprehensive Plan of Action (JCPOA) limits expire.
- Former President Hassan Rouhani was key in deciding to build nuclear weapons in the Amad Plan, reduce it in scope, and cover it up. The current head of the IRGC Aerospace Force, Amir Hajizadeh, was deeply involved in building Amad's underground site to make the nuclear cores of nuclear weapons, weapons small enough to fit on several of Iran's ballistic missiles.
- Iran has a long history of hiding nuclear weapons activities and assets.
- An unanswered question is whether Iran has conducted a cold test or built a nuclear weapon prototype, as called for by Fakhrizadeh in 2003. Based on the available information and residual Amad Plan capabilities, either or both may have occurred.
- The existence and maintenance of a secret archive containing nuclear weapon design and manufacturing data is not compatible with Iran's legally binding nuclear non-proliferation commitments.
- Today, Iran does not appear to have a program focused on the actual building of nuclear weapons. At best, its intentions remain unclear. But it does appear to have a program to be prepared to make nuclear weapons and to do so on short order. Rather than a crash nuclear weapons program, Iran threatens the world with a program ready to produce nuclear weapons "on-demand."
- Today, Iran is closer to being able to build nuclear weapons than it was in 2003.
- A reinstated JCPOA, combined with less than vigorous IAEA verification of Iran's military sites, of the type that existed from 2015 until 2018, appears particularly unstable and dangerous, likely leading to a worsening Middle East security situation, more violence against nuclear sites and personnel, and greater missile and nuclear proliferation.

Seizure of the Nuclear Archive and its Contents

The Mossad's secret nighttime raid into a warehouse complex in a Tehran neighborhood in early 2018 is one of the most successful seizures of a nation's secret nuclear weapons information in the nuclear age.

The Iranian Atomic or Nuclear Archive contained previously unavailable data on the "Amad Plan," Iran's code name for its crash nuclear weapons program in the late 1990s and early 2000s.

The Nuclear Archive contained an immense level of detail about Iran's Amad Plan: its scope, secret facilities, equipment, personnel, theoretical calculations, results of scores of tests,

progress reports, and minutes of meetings involving senior personnel. The files contained designs, charts, blueprints, and many photos of nuclear activities, equipment, and personnel, videos and PowerPoint presentations, all of tremendous value in understanding the Amad Plan. Documents from late 2003 described the subsequent reorientation of Amad Plan into a more clandestine effort. Other files charted Iran's efforts to deceive the International Atomic Energy Agency (IAEA) over several years, with documents that stretch into about 2006. They also show that, at times, Iran knew in advance the inspectors' questions and the facilities they wanted to visit.

The Amad Plan

The Amad Plan, approved in 1999 or early 2000, was a crash nuclear weapons program—the Islamic Republic of Iran's dramatic scaling up of its nuclear weapons efforts of the preceding decade and an attempt to dash to the possession of an arsenal of nuclear-tipped ballistic missiles in four short years. Amad, led by Mohsen Fakhrizadeh, fully embraced the three pillars of a nuclear weapon: 1) encompassing the means to make nuclear explosive material, 2) weaponize that material into a warhead or an underground test device, and 3) deliver nuclear warheads on ballistic missiles. The plan aimed to reach its immediate goal of producing five nuclear weapons by early 2004, building four deliverable warheads for the Shahab 3 missile, and another one reserved for testing underground.

To achieve this goal, the program was building a nuclear weapons production complex on a scale of India's, Pakistan's, and South Africa's early nuclear weapons efforts, enabling the ongoing production of many more nuclear weapons in subsequent years.

The program preferred military sites for its own facilities and used existing military industries for many of its needs. Amad ran in parallel to the Atomic Energy Organization of Iran's nuclear programs but also coordinated with them, creating secret channels between the two major programs, connections that likely continue today.

Achievements of Amad

Nuclear Weapons Production Complex

The Amad Plan established and used a variety of facilities necessary for a manufacturing complex to research, develop and manufacture nuclear weapons. The existence of approximately half of these facilities was not known prior to the analysis of archive documents.

The sites discussed in the archive, including their location, include:

- A uranium mine and mill;
- A small-scale uranium conversion plant, with plans to build a production-scale plant;
- Four interrelated facilities, acting as a unit, to develop and test nuclear weapon subcomponents, conducting well over one hundred tests, many involving high

- explosives in specially designed, easily hidden high explosive chambers, built with the help of a former member of the Soviet nuclear weapons complex;
- Facilities to make the high quality high explosive material needed to detonate a nuclear weapon;
 - A small-scale facility to develop and manufacture the weapon-grade cores of nuclear weapons;
 - A tunnel complex for a production-scale facility to manufacture the weapon-grade cores of nuclear weapons;
 - A uranium enrichment plant near Qom called the Al Ghadir project, designed to make weapon-grade uranium; and
 - A project to establish an underground nuclear test site in a remote part of Iran.

The available Nuclear Archive documents discuss several key facilities, either already in existence during Amad or planned, but do not reveal their physical location:

- Facilities to integrate the nuclear warhead into the re-entry vehicle of a Shahab 3 ballistic missile;
- The nuclear weapon final assembly building;
- The manufacturing site of the neutron source or initiator.

This complex employed hundreds of specialized personnel and established secret links to several technical universities.

Figure 1 describes the role of these sites in making Iranian nuclear weapons.

Iranian Pathway to a Nuclear Weapon Under the Amad Plan

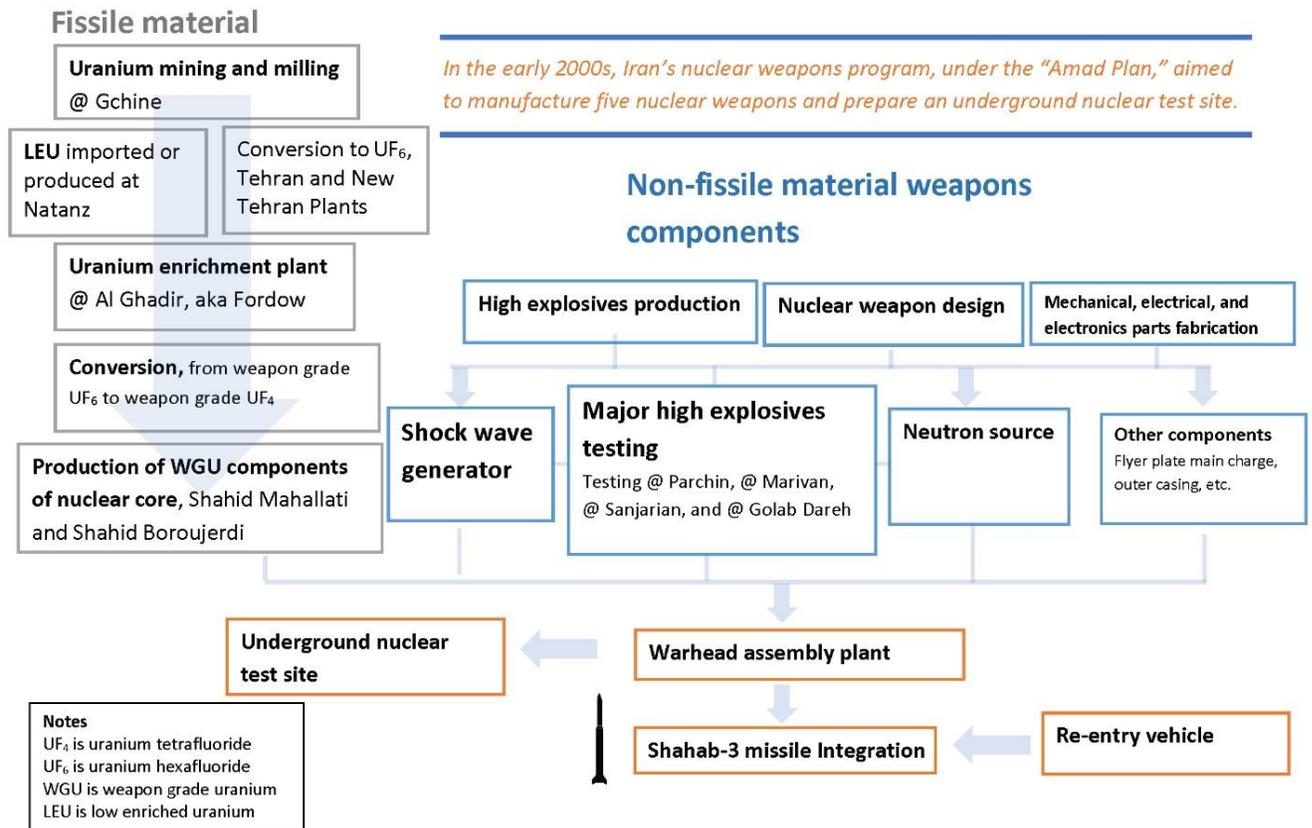
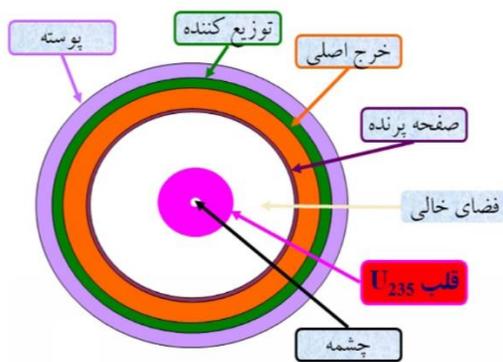


Figure 1. Pathway to Nuclear Weapons

Nuclear Weapon Design

By the end of 2003, the Amad Plan had arrived at a final, rather mature, design for a warhead – one that was 55 centimeters in diameter and required less than 25 kilograms of weapon-grade uranium. The diameter was small enough for the warhead to fit inside the nose cone of the re-entry vehicle of the Shahab 3 ballistic missile. Figure 2 shows a schematic of this design from the archive.

Iran’s design for nuclear weapons rested on a levitated nuclear core arrangement with miniaturization relying upon an innovative “shock wave generator” and uranium deuteride neutron initiator, called a neutron source in the archive documents.



From the bottom, and proceeding counterclockwise, the Farsi terms are:

- Neutron source
- Uranium 235 core
- Air gap
- Flyer plate
- Main charge
- “Detonation distributor” or shock wave generator, and
- Outer casing

Figure 2. A schematic, and translation, of a levitated nuclear weapon design, e.g. one with an air gap and flyer plate to increase compression of the core, based on the use of weapon-grade uranium. Schematic from the Nuclear Archive; translation by the Institute.

Thinking long term, Iran created robust nuclear weapons design capabilities, based on extensive theoretical and experimental work, developing many innovations that aided miniaturization and reduced the need to replenish key limited life nuclear components. This design was not a copy, but the product of a sophisticated nuclear weapons team, backed by sophisticated computer codes, and able to make further refinements to the design, including additional miniaturization or more powerful nuclear weapons.

By the end of the Amad program, Iran was preparing to conduct a cold test of a nuclear explosive, the final step before assembling a prototype of a nuclear weapon, which in turn is the last step before building them.

The inescapable conclusion is that Iran had accumulated enough information and experience by the end of the Amad Plan to be able to design and produce a workable implosion nuclear device. This device benefited from a relatively compact high explosives initiation system, the shock wave generator, and a specialized neutron initiator of the fission chain reaction made from uranium and deuterium.

Status of Amad in 2003

While Iran learned *how* to build nuclear weapons, there were several steps to accomplish before their *actual* construction. The biggest constraint was that Iran did not yet have a means to make weapon-grade uranium by the time of the Amad Plan’s closure in 2003. Excluding this issue, the available documents in the archive further answer the question of why the Amad Plan could not yet build nuclear weapons in late 2003. The program faced organizational issues, slowing progress. It may have encountered resource limitations. It also had more technical work to do, in particular conducting a cold test, wrapping up some theoretical work, finishing its neutron initiator, and producing the nuclear weapon prototype. Its work on

integrating a warhead into a ballistic missile was also incomplete. These were significant challenges, but Iran did not stop working on overcoming them after 2003. However, none of the problems seemed insurmountable—there is no evidence that these tasks were not implemented in subsequent years by Amad’s successor organizations.

Downsizing but Not Ending the Nuclear Weapons Program

In the fall 2002, the news broke that Iran was secretly building nuclear sites at Natanz and Arak, raising concern that Iran was building nuclear weapons. However, many, if not most, of the activities and facilities in the Amad Plan were undetected.

The U.S. invasion of Iraq in March 2003 evidently caused serious consternation with Iranian leadership. U.S. forces were already in Afghanistan, following the 2001 invasion to overthrow the Taliban and destroy al Qaeda. If seeking nuclear weapons could justify a U.S. invasion of Iraq, Iran had a lot to worry about. By the end of 2003, international pressure and fears of military strikes worked to dissuade Iran from proceeding to construct nuclear weapons.

However, that did not mean that Iran stopped its nuclear weapons program. The regime’s concern led to a series of actions, aimed at defusing the situation without revealing the Amad facilities while laying the groundwork for further advances in its nuclear weapons program.

Iran’s downsizing decision merely served as a tactical retreat, not an abandonment of its nuclear weapons ambitions, a step taken earlier by other countries, notably Taiwan and South Africa. By late summer 2003, the Amad Plan had entered a period where its senior leaders had to make decisions about reducing the scale of the program and better hiding it, while still making progress on building nuclear weapons, if a decision were made to resume the crash effort.

The beginning of this shift is captured in a series of notes by the Amad Plan Technical Committee, which held a series of “intensive meetings” over eight days in August and September 2003. The meetings were dominated by carrying out official orders to downsize but preserve the assets and activities of the Amad Plan. Discussions were multi-faceted, encompassing goals of better camouflaging their remaining activities, preserving the number of project personnel, and maintaining a capability to build nuclear weapons, in order to someday finish building them.

A document in the archive that summarizes a discussion among senior Amad leaders, outlines several organizational issues facing the nuclear weaponization pillar in the fall of 2003. Mohsen Fakhrizadeh reminded the meeting participants that they wanted to “produce a product with the title Saqib-1,” the fundamental nuclear explosive. He emphasized that the “main goal is to make an industrial prototype,” signifying Iran’s post-Amad commitment to building a nuclear weapon prototype.

A 69-page Iranian document from late 2003 outlines in detail the changes in the nuclear weaponization project that resulted from the meetings and the Defense Minister's new measures concerning Amad. According to the document, "The work is divided into two parts: non-contaminated and contaminated work. In the contaminated part, which is intended to be done after the non-contaminated work, the team's efforts focus on portability to be safe from espionage activities and to avoid detectable contamination." The document is an explicit plan laying out how to transform the Amad Plan and carry the redesigned project into the future. Every major component in the nuclear weapon is analyzed and discussed in the context of its place in the future effort.

In late 2003, during Iran's decision-making process about the future of the Amad Plan, certain projects were viewed as too important to downsize or halt. One would later become known as the Fordow gas centrifuge uranium enrichment project.

Uranium Enrichment and Fordow

The Amad Plan project was creating the capability to make weapon-grade uranium in the Al Ghadir project and was building an enrichment facility near Qom. This project was not known outside of Iran prior to the seizure of the nuclear archive in early 2018.

After the end of the Amad Plan in 2003, Iran continued building this secret site. Western intelligence agencies eventually identified it by early 2009, although they did not learn its original purpose at the time. However, IAEA inspectors who visited the site just after its discovery assessed independently that the plant's likely purpose was to make weapon-grade uranium. Iran repurposed the site, denied any military purpose, and allowed the IAEA to place it under safeguards. This enrichment plant is now known as the Fordow enrichment plant.

This plant was designed to be a secret, deeply buried site even more protected from military attack than the Natanz site, which was also buried but not under a mountain, making it more vulnerable to aerial destruction.

The Al Ghadir site is relatively small compared to the Natanz facility, limiting its production of weapon-grade uranium. To overcome this problem, Iran decided to link the Al Ghadir and Natanz facilities; the production of weapon-grade uranium would occur in the Al Ghadir plant, but would utilize low enriched uranium from the AEOI's centrifuge plants. In this way, although the Al Ghadir enrichment plant was to have less than one-tenth the number of centrifuges of Natanz, it would be able to make enough weapon-grade uranium for a small nuclear arsenal.

Another archive document gives the capacity of the Al Ghadir plant as 45 kilograms per year of weapon-grade hexafluoride. This translates to about 30 kilograms of weapon-grade uranium (uranium mass). Assuming 20 kilograms of weapon-grade uranium would be needed per weapon, the plant's output would be enough to make three nuclear weapons every two years.

Without the AEOI's aid, the Al Ghadir output may have not been able to produce only 10 kilograms of weapon-grade uranium annually—not enough for one nuclear weapon per year.

Natanz, Fordow, and associated centrifuge manufacturing facilities are now the bulwark of Iran's nuclear explosive material pillar and contain a formidable breakout capability to produce weapon-grade uranium in short order, with or without the JCPOA. With its sunsets in nuclear enrichment limits, the JCPOA legitimizes the eventual multi-fold expansion of Iran's nuclear explosive material pillar. Unlike 2003, Iran now has a robust capability to make weapon-grade uranium, a capability that will eventually grow more than ten-fold if JCPOA limits expire.

Post-Amad

The archive reveals that Iran's overarching nuclear ambitions did not change with the halt to the Amad Plan, only that some elements of the plan were altered and the timeframe was extended. The post-Amad goals are among the most critical revelations of the archive. They provide logic and context regarding the questions of why some facilities were still constructed, others were kept in standby mode, yet others were never finished. They provide context for controversial, publicly declared nuclear facilities and controversial non-nuclear military activities that followed the Amad Plan. Today, we know only that Iran did not achieve its original goal under the Amad Plan to build five nuclear weapons. There is no evidence that Iran did not make significant progress or achieve its post-Amad goals.

After the closure of the Amad Plan, other organizations continued work on nuclear weapons. They all possessed capabilities in nuclear weaponization, and were all headed by Mohsen Fakhrizadeh and staffed by many Amad personnel. The evidence suggests that Iran not only maintained the capability to produce nuclear weapons, but actively worked on efforts to advance that capability in case Iran's leaders made a decision to build them.

The Nuclear Archive documentation supports the European and Israeli assessments that the nuclear weapons program continued after 2003, but without the key decision to build nuclear weapons, an important dimension but not the only critical component of a more encompassing definition of a nuclear weapons program, and reminiscent of Taiwan's nuclear weapons program, whose goal it was to be able to build a nuclear weapon within a few months if needed.

SPND

For the last decade, Iran's nuclear weaponization work has involved the Ministry of Defense's organization known by its Farsi acronym, SPND. According to a senior European intelligence official, SPND is charged with "developing various nuclear capabilities that better position it to produce nuclear weapons, should Iran choose to do so." Iran's nuclear weaponization pillar is part of SPND's purview.

The U.S. government first sanctioned SPND in August 2014, calling it an entity “primarily responsible for research in the field of nuclear weapons development,” led by Fakhrizadeh.

According to a March 2019 U.S. Treasury announcement sanctioning SPND organizations, SPND is “engaged in proliferation-sensitive research and experiments on behalf of SPND organizations, which spend millions of dollars each year on a broad spectrum of defense-related projects.”

Continued SPND-related sanctions designations highlight ongoing Western government concerns about Iran’s nuclear weapons-related activities. Iran’s lack of cooperation with the IAEA up until today has increased concerns that a subset of SPND’s activities have remained focused on preserving or carrying forward the activities of the Amad Plan. Without access or meaningful declarations from Iran, and with SPND personnel out of reach to the IAEA, the nature of SPND’s activities have remained a dangerous mystery, engendering near-universal suspicion.

Because of the Nuclear Archive, the Amad Plan’s former personnel are much better known today than before. According to a group of scholars from Harvard University’s Belfer Center for Science and International Affairs, which also received a detailed briefing on the archive from Israeli officials in Tel Aviv, “Israeli officials estimate that about 70 percent of the staff who once worked in Project Amad transferred to SPND.”

SPND has also established itself as a bulwark in Iran’s resistance economy, in turn benefiting from international sanctions.

SPND’s current structure continues to indicate that it is a repository of Iran’s nuclear weaponization capabilities, including high explosives, electronics, metallurgy, materials science, neutronics, nuclear physics, and diagnostics. There are no indications that the post-Amad weaponization strategy has ended, although judging its exact status and scope remains challenging.

Mohsen Fakhrizadeh

Mohsen Fakhrizadeh was the undisputed leader of Iran’s nuclear weapons program. His killing in late 2020 was a major blow to SPND and Iran’s nuclear weapons readiness. In the short to medium term, his loss may be felt the most during any nuclear breakout to build or test nuclear weapons.

Until his death, much less was known about Fakhrizadeh’s role in creating and expanding the entire indigenous nuclear program of Iran, where he exercised his influence behind a curtain of secrecy. Few, if any, had his breadth of knowledge and experience about Iran’s nuclear weapons efforts. He has often been viewed publicly as the Robert Oppenheimer of Iran’s nuclear weapons program, but a more realistic characterization is General Leslie Groves, the leader of the U.S. Manhattan Project who brought great managerial skills and political clout to

the task of shepherding various pieces and talents into a nuclear weapons production complex, a test site, and deliverable nuclear weapons.

Regardless of the exact details of Fakhrizadeh's death, the attack was far more sophisticated than earlier ones that had killed his colleagues. The attack once again demonstrated that an enemy had deeply penetrated Iran, armed with enough intelligence and resources to kill Iran's most important defense scientist, the father of its nuclear program.

After decades of living in the shadows, Fakhrizadeh was buried as a national hero in one of Iran's holiest shrines, near his colleague Shahriari's grave. To Fereydoun Abbasi-Davani, who knew him for 33 years and originally hired him at the Ministry of the Revolutionary Guard Corps, Fakhrizadeh's "expertise and everything about him was nuclear."

Fakhrizadeh led the same department in the Ministry of Defense for 22 years, according to Abbasi-Davani, who was also a senior leader in Amad. Fakhrizadeh started in that position in 1998, when he assumed leadership of the Physics Research Center, and ended at SPND. His organizations' names changed, but Fakhrizadeh's role remained the same. Abbasi-Davani put it succinctly, "While Ministers of Defense came and went, Fakhrizadeh remained in the same position."

Killing of Key Leaders of Amad Plan and Post Amad

Of the five prominent leaders of Amad who also played key roles in Amad's reorganization and reorientation in late 2003, three have met violent deaths; two others escaped murder attempts. Masoud Alimohammadi, a senior member of the Amad Plan and its successor organizations and a university professor, was killed by a car bomb in 2010 just after leaving his house. Later that year, on November 29, 2010, Majid Shahriari, then listed publicly as a professor at Beheshti University but also a leader of Amad and post-Amad activities, was killed in his car by a limpet mine attached to the vehicle by two motorcyclists. On that same day, Abbasi-Davani narrowly escaped death. After surviving an earlier attempt, Fakhrizadeh was killed in late 2020. Rumors surfaced after Fakhrizadeh's death in late 2020 that a few weeks earlier there had been an assassination attempt against Mohammad Mehdi Tehrani, another key participant in the 2003 key reorganization meetings.

Although not known to have been part of the Amad effort, Mostafa Ahmadi Roshan, a senior Natanz official involved in overseas illegal procurements for Iran's centrifuge program was killed in 2012.

Nuclear Weapons Today

The Nuclear Archive illuminated the initial methods used by Mohsen Fakhrizadeh to keep critical parts of Iran's nuclear weapons efforts intact post-Amad. Fakhrizadeh orchestrated a careful parsing of many of Amad's programs into covert and overt nuclear weapons-related

activities, preserving key capabilities and personnel, while seeking progress on all three nuclear weapons pillars: nuclear explosive material, nuclear weaponization, and delivery.

Iran's nuclear weapons design and development activities have likely oscillated since Amad, both over time and in their level of effort, where some months or years witness increased activities, and others little or no activity. Such a pattern undermines the value of any snapshot of highly classified activities, when a snapshot is ultimately of limited worth in judging the overall status and readiness of Iran to build nuclear weapons.

The Nuclear Archive showed that Iran thinks holistically about building nuclear weapons, sustaining and strengthening each nuclear weapon pillar. In response, assessments of Iran's nuclear weapons program should look holistically, avoiding narrower assessments such as those limited to determining whether the nuclear weaponization program is developing or building key components. To do otherwise is to increase the risk of missing the forest for the trees.

At a minimum, Iran has a coordinated set of activities related to building a nuclear weapon. At worst, the weaponization team has already conducted a cold test, fulfilled its post-Amad goal of building an industrial prototype, and is regularly practicing and improving their nuclear weaponization craft under various covers or in clandestine locations. It has developed a roadmap and schedule for building them, harnessing all three pillars in order to do so.

Iran's nuclear weapons program has suffered numerous setbacks and delays, including the premature closure of the Amad Plan, the discovery of the Qom/Fordow enrichment plant, ongoing leaks about nuclear weapons efforts, at times tough IAEA inspections, killings of its key scientists, Stuxnet cyberattacks, increased sanctions against its programs, threats of military strikes, and widespread international opprobrium. Arms control in the shape of nuclear freezes and the JCPOA limited and increased monitoring of its declared fuel cycle activities. Iran's personnel know they have been, and remain, under intensive surveillance by multiple intelligence agencies and have been targets of espionage, or worse. The nuclear weapons program's current state is bound to be complex and highly camouflaged.

On the other hand, Iran persisted. Its nuclear weapons capabilities appear far more formidable today, particularly those that support the two more visible nuclear weapons pillars: production of weapon-grade uranium and nuclear-capable ballistic missiles.

Its experience also means that no one should be surprised if more is hidden. Iran has a long history of hiding nuclear weapons activities and assets, such as the Amad Plan, other sensitive nuclear activities such as the Natanz and Fordow enrichment plants, the Nuclear Archive, and Turquz-Abad with its shipping containers filled with nuclear-weapons related equipment and materiel. Against this background, the onus is much more on those who argue that the absence of evidence means that there are no secret nuclear weapons activities or that Iran is not currently engaged in key activities related to the design and development of a nuclear weapon. A far more credible view is that those activities may very well be happening or have been organized and carried out differently than might appear on the surface.

Today, Iran does not appear to have a program focused on the actual building of nuclear weapons. At best, its intentions remain unclear. But it does appear to have a program to be prepared to make nuclear weapons and to do so on short order. Rather than a crash nuclear weapons program, Iran threatens the world with a program ready to produce nuclear weapons “on-demand.”

Time to Build or Test Nuclear Weapons

Debates about Iran building nuclear weapons too often focus on the time needed for Iran to field a nuclear-tipped ballistic missile. Iran is more likely to have an initial goal of conducting an underground test. When states conduct an underground nuclear test, the political and strategic effect is usually profound, even without any clear indication of them having deployed nuclear weapons. In the case of Iran, we would be left to ponder: how many nuclear weapons does Iran have? Where are they? The uncertainty would buy time for Iran to eventually, but inevitably, deploy nuclear-tipped ballistic missiles.

Despite some unfinished tasks, Iran appears to be ready to build nuclear weapons, if it decided to do so. But how long would it take? It cannot be argued today that Iran is several years from building nuclear weapons. At the end of the Amad Plan in 2003, that was the case. The biggest bottleneck then, the production of weapon-grade uranium, is no longer a bottleneck. Today, Iran may only be months from being able to test a nuclear weapon underground.

Iran is assessed in the book as being able to conduct an underground nuclear test in six to nine months, assuming late 2020 breakout timelines of three to four months, and build deliverable nuclear weapons in a year or two. Much of the work on weaponization would occur in parallel with the production of weapon-grade uranium. These estimates assume that while much of the weaponization work has been accomplished, a few significant tasks remain. However, these remaining tasks could be completed in a matter of several months. Moreover, with enriched uranium stocks at early 2021 levels, a second nuclear device would soon follow the first one.

Iran’s Violations of Its Non-Proliferation Commitments

The existence and maintenance of a secret archive containing nuclear weapon design and manufacturing data is not compatible with Iran’s legally binding nuclear non-proliferation commitments. It is not difficult to see that secretly storing and curating an extensive archive focused on developing and building missile-deliverable nuclear weapons is in violation of Iran’s JCPOA pledge that “under no circumstances will Iran ever seek, develop or acquire any nuclear weapons.”

Before Israel’s seizure of a portion of the Nuclear Archive, the fact that Iran was building both a pilot and production-scale plant to develop and make cores of nuclear weapons as part of the

Amad project was unknown to the IAEA. These sites have never been inspected, and Iran is not known to have discussed them with the IAEA. By themselves, these activities have made a mockery of Iran's commitment under the NPT to never build nuclear weapons.

Iran signed the CTBT in 1996, obligating it to refrain from carrying out any nuclear weapons tests. However, the country embarked on a multi-year project to build a nuclear test site, under Project Midan.

The Islamic Republic was building in secret a uranium enrichment plant to make weapon-grade uranium for nuclear weapons. This deeply buried enrichment plant, exposed by Western intelligence in 2009, is now called the Fordow plant and continues to operate under IAEA safeguards. But converting it to weapon-grade uranium production would take only a few weeks.

Based on materials in the archive, the IAEA has so far discovered five locations with undeclared uranium: Lavizan-Shian, Parchin, Marivan, the Tehran Plant, and Turqz Abad. The first four are all Amad facilities; the fifth is suspected to have been a secret site to store equipment and materials of the Amad project in easy-to-move shipping containers. According to the IAEA, Iran's explanations about undeclared uranium lack technical credibility.

The IAEA reported in late 2015 in its *Final Assessment on Past and Present Outstanding Issues Regarding Iran's Nuclear Programme*, that it had not found additional evidence of nuclear weapons work after 2009; however, in the same report, the IAEA stated that it was also unable to conclude with certainty that the program ended in 2009. It still cannot answer the fundamental question of whether Iran's nuclear program is a peaceful one or whether Iran continues working on nuclear weapons. The IAEA's ignorance about Iran's nuclear weapons efforts reflects Iran's better camouflaging of its programs, its incessant lying about its nuclear program, and lack of adequate IAEA access to military sites and personnel.

In retrospect, the West deceived itself in thinking that its knowledge of Amad, which was limited, could substitute for Iran's full cooperation with the IAEA. Instead, this approach turned out to be an illusion playing to Iran's deceptions, while undermining continued IAEA investigation of Iran's possible military nuclear work, one of the most effective methods to ensure Iran is not maintaining and building secret nuclear weapons capabilities today.

The AEOI learned that the IAEA's efforts to establish transparency can be subverted by subjecting clandestine facilities to safeguards after they are discovered, while falsely and fiercely denying any military intent. Iran also learned that simply by agreeing to negotiate with the IAEA over contested access or provision of information, it could diffuse pressure from the Board of Governors – in essence negotiations were rewarded instead of substantive progress. Iran learned to wear down the inspectors and their member state supporters on the Board of Governors.

As in many other cases of Iran's secret, undeclared nuclear weapons efforts, openness was not consistently demanded. Its successful deception and concealment of activities and facilities allowed Iran to continue its dangerous progress. The world has grown anesthetized to Iran's cheating, while the risk posed by Iran's nuclear programs increases dangerously.

The Nuclear Archive has opened a door to press Iran for a complete and honest nuclear declaration and more cooperation with the IAEA's verification of that declaration, steps key to ensuring that Iran's nuclear program is peaceful, any nuclear deal is meaningful, and a robust non-proliferation regime can be established.

Eliminating Iran's Nuclear Weapons' Pillars

By detailing so much of Iran's past crash nuclear weapons program, really for the first time, the Nuclear Archive opens a new way of thinking about Iran's future pursuit of nuclear weapons. It opens more doors to ensure Iran never builds nuclear weapons.

This book details how Iran's nuclear weapons program is best understood by considering its three pillars—the means to make nuclear explosive material, weaponize that material into a warhead or an underground test device, and deliver nuclear warheads on ballistic missiles. This approach also provides a way to identify the best methods of stopping it and judge the merits of negotiated outcomes.

Ideally, all three pillars should be verifiably dismantled, or rendered unusable to support nuclear weapons, as was done in Taiwan in the late 1980s. In that case, a denuclearized Taiwan, free to pursue nuclear power reactors, has proven quite stable and productive, despite very real military tensions between Beijing and Taipei. It is also useful to keep in mind a simple lesson of the Taiwan case: what one does not want one's ally doing, one definitely does not want an enemy doing.

In the case of Iran, the elimination of all three pillars should serve as the guiding vision of any effort to ensure that the country does not build nuclear weapons. While such a vision is undoubtedly hard to accomplish today, requiring a fundamental shift in the regime, it helps lay the basis for a path forward. What are the options? Which pillars are decisive in ensuring nuclear weapons cannot be built? What actions should be avoided so as not to further worsen the situation?

The most straightforward way to dramatically reduce Iran's prospects of building nuclear weapons is to focus on the nuclear explosive production and nuclear weaponization pillars. The elimination of the delivery system pillar is more difficult to thwart because Iran has so many options for delivering nuclear weapons, ranging from ballistic missiles to cruise missiles to ships. Negotiations should aim to limit ballistic missiles, but it should be recognized that eliminating this pillar in its entirety is impossible.

The other two pillars are more promising. In fact, the path to do so is straightforward and well-trodden. If either pillar were effectively eliminated, Iran would be very hard-pressed to build nuclear weapons.

Partial Elimination

What if none of the three pillars is eliminated? Is an adequate substitute the weakening of each pillar? This can be done, but the chances of successfully preventing Iran from building nuclear weapons would then be greatly reduced. Certain outcomes should be avoided. A reinstated JCPOA, combined with less than vigorous IAEA verification of Iran's military sites, appear particularly unstable and dangerous, likely leading to a worsening Middle East security situation and greater missile and nuclear proliferation.

A variety of steps are possible to strengthen the JCPOA's deficiencies both within the deal and under a new deal, such as guaranteeing a breakout timeline of two years rather than one or extending the sunsets for the nuclear limitations. Section T of the JCPOA, which banned several key nuclear weapons-related activities and capabilities, and subjected certain key dual-use equipment to controls, could be vigorously monitored and enforced. Inspection efforts could be stepped up providing more assurance of the absence of undeclared nuclear activities and facilities, including underground nuclear test sites and work on nuclear-related re-entry vehicles. ICBMs could be banned.

It goes without saying that whatever deal shapes up—and there is no singular diplomatic path to success—this accord should have bipartisan backing in the United States and be able to endure through successive presidential administrations.

To further improve the chances of a successful negotiation, more nations in the Middle East need to be included in the negotiations. The region looks considerably different today than it did in 2015, much more polarized, with Iran on one side and Israel and most of the Arab world on the other. Iran is perceived as a much greater regional security threat, where possession of nuclear weapons capabilities deeply threatens its neighbors. With this new reality, any new Iran nuclear negotiations should include direct input from countries in the Middle East, and any deal must be able to gain their support.

Even without a change of heart by the Islamic Republic's leadership, the Nuclear Archive has opened a door to press Iran for a complete nuclear declaration and more cooperation with the IAEA's verification of that declaration, steps important to maintaining a robust non-proliferation regime but also to further disrupting Iran's ability to develop or make nuclear weapons. The IAEA could accomplish so much more if it received the Board of Governor's full support, support provided by only a portion of the Board during the last several years. Internationally, as of this writing, Board members have opted more for avoiding conflict than fully supporting the IAEA in receiving speedy access to Iranian sites or credible answers concerning undeclared nuclear materials and activities. With full support, however, the IAEA

could greatly increase its chances of finally making progress on ensuring that Iran has no interest in obtaining nuclear weapons.

These partial efforts, while falling short of eliminating a major nuclear weapons pillar, have merit. However, they also contribute to maintaining an unstable situation. They all rest on the threat of the re-imposition or the increase of economic and financial sanctions, with up to three main triggering events: Iran refuses to cooperate on outstanding issues with the IAEA; Iran refuses to fix the nuclear deal; and Iran violates the limits of that deal. To this mix must be added Iran's shifting views of the meaning of compliance with the JCPOA and its growing commitment to a resistance economy countering sanctions pressure. With this instability, the prospect of addressing all the major nuclear issues remains uncertain.

As a result, negotiators may be left with a mixed, unsatisfactory approach to curbing Iran's nuclear weapons capabilities. The full range of counterproliferation methods to set back Iran's nuclear program are likely to be kept in play. The Iran situation is so risky and unstable that diplomacy and coercive methods will doubtless continue their uneasy coexistence.