INSTITUTE FOR SCIENCE AND INTERNATIONAL SECURITY

Analysis of the IAEA's Iran NPT Safeguards Report - February 2024

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Highlights

For the first time, the latest quarterly International Atomic Energy Agency (IAEA) safeguards report on Iran's compliance with the Nuclear Non-Proliferation Treaty (NPT) draws a direct line between Iran's non-compliance with its comprehensive safeguards agreement (CSA) and concern about Iran's current ability to make nuclear weapons. A former high-level Iranian official recently made comments about the regime's ability to make nuclear weapons. The IAEA writes, "Public statements made in Iran regarding its technical capabilities to produce nuclear weapons only increase the Director General's concerns about the correctness and completeness of Iran's safeguards declarations."

The report emphasizes Iran's lack of complete nuclear declarations, as required by its safeguards agreement. In particular, the IAEA stated that it had not changed its assessment of the undeclared nuclear material and/or activities at four sites – Lavisan-Shian, Varamin, Marivan, and Turquzabad. While inspectors are still seeking Iran's clarification of activities at Varamin and Turquzabad – in essence continuing to provide Iran the option of telling the truth – the report highlights Iran's complete lack of cooperation. With Iran's refusal to cooperate, the IAEA will likely finalize its investigation of these two sites in the same way as it did with the other two – namely, stating that Iran had undeclared nuclear materials and/or carried out nuclear weapons-related activities at the sites.

Concluding that a declaration is incomplete means Iran has violated its safeguards agreement. In its next report, the IAEA should take the next step and directly indicate that Iran is in violation of its CSA, to signal that this issue needs urgent consideration by the Board of Governors, in addition to the issues that the IAEA still considers outstanding.

The IAEA reports a successful effort to press Iran to admit that it falsely declared that nuclear waste, related to previously admitted undeclared nuclear activities, held more uranium than it actually did. After many rounds of verification activities at the Uranium Conversion Facility (UCF) to identify why an IAEA-verified amount of uranium transferred to the UCF was less than indicated in Iran's declaration, Iran admitted a mistake in its declaration and rectified it.

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However, this leaves the question of where the missing uranium is today, and whether it is related to Iran's undeclared use of a uranium metal disk for nuclear weapons development, which the IAEA established took place in the early 2000s at Lavisan-Shian. The IAEA's finding also highlights a concern that even when Iran admits to undeclared activities or materials, it is hiding something else.

The report once again expresses the IAEA's condemnation of Iran's de-designation of several of its key inspectors and failure to reinstate them.

The IAEA also details Iran's refusal to declare new nuclear facility construction as required under Modified Code 3.1 of the subsidiary arrangements to its CSA. The IAEA highlights that Iran broke ground on a new power reactor, the IR-360, without fulfilling its Modified Code 3.1 safeguards obligations. Recently, Iran even publicly announced new construction plans for several other nuclear reactors, but has refused to provide the IAEA with preliminary design information. This development adds to concern that Iran will not notify the IAEA if it constructs a new, secret enrichment facility. This concern is magnified by Iran's construction of a new facility in the mountains near Natanz that is deeply buried and could include a new enrichment plant.

Implementation of the March 2023 IAEA/Iran Joint Statement, whereby Iran pledged to take steps to cooperate with the IAEA, expedite a resolution over the outstanding safeguards issues, and allow the IAEA to implement appropriate verification and monitoring activities, may have failed.[2] The IAEA is seriously concerned that Iran has failed to live up to its end of the agreement and questions Iran's continued commitment to its implementation.

It is long overdue that the Board of Governors provide more support to the IAEA, not only condemning Iran's lack of cooperation as it did in its November 2022 resolution, but also providing a deadline for compliance. If it does not, the best-case scenario is that Iran will succeed in maintaining secrecy over past and potentially ongoing nuclear weapons activities indefinitely, weakening the IAEA in the process. At worst, it will succeed in building a nuclear weapon undetected until too late, causing irreparable damage to the IAEA and the NPT.

Background

Iran is obligated under its comprehensive safeguards agreement, a key part of the NPT, to cooperate with the IAEA and fully account for nuclear material and both past and present nuclear activities. The IAEA refers to this process as a country providing both a correct and complete nuclear declaration. Without a complete declaration, the IAEA cannot provide assurance that Iran's nuclear program is exclusively peaceful.

[2] "Joint Statement by the Atomic Energy Organization of Iran (AEOI) and the International Atomic Energy Agency (IAEA)," March 4, 2023, https://www.iaea.org/newscenter/pressreleases/joint-statement-by-the-atomic-energy-organization-of-iran-aeoi-and-the-international-atomic-energy-agency-iaea.

For more than five years, the IAEA has been investigating and reporting on undeclared uranium and nuclear-related activities at four Iranian sites. The sites are related to Iran's past work on nuclear weapons under the Amad Plan, Iran's crash nuclear weapons program dating to the early 2000s, but concern its NPT compliance today, including the current whereabouts of nuclear material and equipment, as well as whether Iran continues nuclear weapons-related activities.

A November 2022 IAEA Board of Governors resolution spelled out four steps Iran must take in order to clarify the outstanding safeguards issues. These include providing technically credible explanations for the presence of uranium at the three sites, informing the IAEA about the current location(s) of the nuclear material and/or contaminated equipment, providing all information the IAEA needs, and providing access to locations and materials as needed. The Board has not passed a new resolution since, nor has it referred Iran's case to the UN Security Council for countermeasures, over Iran's failure to comply with these demands.

This analysis summarizes and assesses information since the IAEA's last NPT safeguards report on Iran — the latest report was issued on February 26, 2024.

Findings

Concerning Comments by Former Iranian Official about Nuclear Weapons Capabilities

On February 12, former Iranian foreign minister and former head of the Atomic Energy Organization of Iran (AEOI), Ali Akbar Salehi, suggested in an interview that Iran has an unstructured nuclear weapons program and all the components needed to make nuclear weapons, and must only assemble them.[3] He said, "Here's an example: Imagine what a car needs; it needs a chassis, an engine, a steering wheel, a gearbox. You're asking if we've made the gearbox, I say yes. Have we made the engine? Yes, but each one serves its own purpose." In response, Director General Grossi said at the World Governments Summit in Dubai that Iran was "not entirely transparent" with its nuclear activities. "A very high official said, in fact, we have everything, it's disassembled," Grossi said. "Well, please let me know what you have," he urged.[4]

In its latest report, the IAEA writes, "Public statements made in Iran regarding its technical capabilities to produce nuclear weapons only increase the Director General's concerns about the correctness and completeness of Iran's safeguards declarations." The IAEA calls for constructive engagement and Iran's full cooperation.

[3] "Iran Signals It Is Closer to Building Nuclear Weapons," *Iran International,* February 12, 2024, https://www.iranintl.com/en/202402123916.

[4] Jon Gambrell, "The head of UN's nuclear watchdog warns Iran is 'not entirely transparent' on its atomic program," *The Associated Press,* February 13, 2024, https://apnews.com/article/iran-nuclear-program-iaea-gross-israel-hamas-gaza-war-ee164aefb63a533548a54179c952b5e1.

Investigation at Undeclared Sites Involving Undeclared Production or Use of Nuclear Material

The new report emphasizes Iran's lack of complete nuclear declarations, as required by its safeguards agreement. In effect, Iran remains in noncompliance with its CSA. In particular, the IAEA stated that it had not changed its assessment of the undeclared nuclear material and/or activities at four sites – Lavisan-Shian, Varamin, Marivan, and Turquzabad. While the inspectors are still seeking Iran's clarification of activities at Varamin and Turquzabad, the report highlights Iran's complete lack of cooperation. The IAEA will likely finalize its investigation of these two sites in the same way as the other two – namely, by stating that Iran had undeclared nuclear materials and/or carried out nuclear weapons-related activities at the sites.

With regards to the IAEA's recent efforts to obtain clarification about the Varamin and Turquzabad sites, the IAEA states in its NPT report, "once again there has been no progress in resolving the outstanding safeguards issues during this reporting period." The IAEA again underscores that "despite numerous resolutions of the Board and many opportunities provided by the Director General over a number of years, Iran has neither provided the Agency with technically credible explanations for the presence of uranium particles of anthropogenic origin at two undeclared locations in Iran nor informed the Agency of the current location(s) of nuclear material and/or of contaminated equipment." In a renewed call for support from the board, the IAEA notes that no progress has been made since the board's November 2022 resolution.

Iran has stated that it exhausted all its efforts to discover the origin of such particles. Given that this statement is not recognized as true and in light of Iran's consistent non-cooperation, one can expect a conclusion by the IAEA that the materials and activities are undeclared.

De-designation of Inspectors

The IAEA reports no progress by Iran to restore the designation of around one-third of the agency's key enrichment-related inspectors, who it barred from the country last fall. In this report, as well as in the separate report on Iran's compliance with UN Resolution 2231, the IAEA again condemns Iran's "sudden" disbarring of inspectors in September" 2023, writing that the move "was exercised by Iran in a manner that directly and seriously affects the Agency's ability to conduct effectively its verification activities in Iran, in particular at the enrichment facilities." The IAEA "regards Iran's stance as not only unprecedented, but unambiguously contrary to the cooperation that is required and expected in order to facilitate the effective implementation of its NPT safeguards agreement." The IAEA reports that the de-designation of inspectors occurred after the withdrawal by Iran of the designation of another experienced IAEA inspector.

In September, Iran reportedly disbarred experienced French and German enrichment inspectors, and perhaps inspectors from one other country (*The Wall Street Journal* reports

eight inspectors were de-designated in total).[5] Iran took this action after several dozen states, led by the United States and Europe, signed a joint statement at the September 2023 IAEA board meeting demanding Iran's cooperation with the IAEA's investigation into undeclared nuclear weapons work.

The IAEA again writes, "The Director General regarded the linking by Iran of statements by IAEA Member States to the withdrawal by Iran of designations of Agency inspectors with the same nationality as extreme and unjustified: it effectively makes the independent technical work subject to political interpretation of other Member States' views about Iran's nuclear activities."

Director General Grossi previously reported that he wrote in an October 31 letter to AEOI head Mohammad Eslami, "Iran's sudden withdrawal of previously agreed designations for several Agency inspectors adversely affects the Agency's ability to conduct inspections and risks impeding the conduct of inspections…" Iran delayed addressing the matter, replying only on November 15 to the IAEA's overtures that Iran was "within its rights to de-designate agency inspectors." Eslami stated that the IAEA's assertion about impeding inspections "is not compelling and lacks any legal basis." Eslami said only that he was exploring possibilities to address the issue.

In a previous IAEA report on the matter, Grossi called upon Iran to "reconsider its decision and to return to a path of cooperation with the Agency." In the most recent report, he "deeply regrets that Iran has yet to reverse its decision."

Electronic Monitoring of Highly Enriched Uranium (HEU) Production at Fordow Fuel Enrichment Plant (FFEP) and Natanz Pilot Fuel Enrichment Plant (PFEP)

The IAEA reported in May 2023 in the NPT report that Iran permitted the installation of enrichment monitoring devices (EMDs) at the FFEP and PFEP. The IAEA reported in its September 2023 NPT report, "The evaluation of the data collected confirmed the general good functioning of the systems. Technical adjustments and changes to operational procedures required to enable their commissioning have been identified and are being discussed with Iran." The IAEA reported no new information about the status of the EMDs in this and the previous report.

Violation of Modified Code 3.1

The IAEA reports that Iran has violated a mandatory provision of the subsidiary arrangements to Iran's CSA, Modified Code 3.1, by starting construction on a new nuclear power reactor known as the IR-360.[6] Since February 2021, the IAEA has been seeking Iran's pledge that it will

[5] Laurence Norman, "Iran Maintains Steady Expansion of Nuclear Program," *The Wall Street Journal,* November 15, 2023, https://www.wsj.com/world/middle-east/iran-maintains-steady-expansion-of-nuclear-program-46df894a.
[6] Tzvi Joffre, "Iran Building New Nuclear Power Plant in Southwest of Country," *The Jerusalem Post*, December 4, 2022, https://www.jpost.com/middle-east/iran-news/article-723996.

adhere to the modified code. The code requires Iran to provide notification and early design information when it has taken a decision to build a new nuclear facility, including, for example, a reactor or an enrichment plant.

In November 2023, Eslami "made a statement referring to the excavation of the main building of the planned 360-megawatt reactor 'in the coming days.'" In December, the IAEA then observed through analysis of satellite imagery "excavations of the reactor site." The IAEA wrote a letter to Iran dated February 5, 2024, requesting updated design information for the site, as well as preliminary design information for the "Iran Hormoz" nuclear power plants. The AEOI also made available on its website information regarding the start of construction "by order of the president."

According to the IAEA, in a reply dated February 7, 2024, Iran "repeated its position that 'implementation of modified code 3.1 is suspended'; 'currently the legal obligation of the initial Code 3.1 is the legal obligation' for Iran 'under the Subsidiary Arrangements (General Part) of the CSA'; and that 'relevant safeguards information for any new facilities… will be provided in due time.'" The IAEA acknowledged that Iran "was no longer prepared to work with the Agency to find a mutually acceptable solution" regarding implementation of Modified Code 3.1.

Iran illegally reverting to the original Code 3.1 means Iran believes it must provide notification to the IAEA only six months before it introduces nuclear material into a facility, which experience has taught could be when the plant is essentially operational. By violating Modified Code 3.1 with the construction of the new reactor and failing to notify the IAEA or provide design information, Iran is indicating it could also outfit a clandestine enrichment facility, for example, and not notify the IAEA of the plant's existence until right before it begins operating, if at all.

The IAEA emphasizes Iran's violation of Modified Code 3.1, writing, "The Director General has reminded Iran on many occasions that implementation of modified Code 3.1 is a legal obligation" which Iran may not modify or suspend. "Iran continues not to implement modified Code 3.1," it concludes.

Discrepancy at the Uranium Conversion Facility (UCF); New Links to Undeclared Uranium at Lavisan-Shian

While the IAEA pressed Iran to resolve a discrepancy in the amount of uranium present at the UCF, the resolution re-opened the question of whether uranium went missing long ago from the Jaber Ibn Hayan Multipurpose Laboratory (JHL).

The discrepancy at the UCF involved the dissolution of what Iran stated was 302.7 kilograms (kg) of natural uranium and an IAEA-verified amount that was less than this. The uranium came from the JHL, which housed undeclared nuclear activities and materials in the late 1990s and early 2000s. Newly in this report, the IAEA specifically states that "the amount of the uranium contained in the solid waste, arising from undeclared conversion experiments between 1995 and 2002, sent from JHL to UCF for dissolution, was less than had been declared by Iran in 2003

- 2004." JHL has figured prominently in past IAEA efforts to understand the fate of undeclared uranium dating to Amad Plan activities at the Lavisan-Shian site in Tehran (see Annex). According to *The Wall Street Journal*, the discrepancy was "connected to Iran's dissolution of a natural uranium metal disc the IAEA has been looking for as part of a probe into undeclared nuclear material found in Iran."[7]

During this reporting period, Iran and the IAEA held technical discussions on this issue and Iran "agreed to the Agency's request to correct the nuclear material accounting records and reports." Thus, the IAEA now considers the discrepancy of uranium at the UCF as "rectified."

However, this development actually indicates that instead of uranium missing at the UCF, uranium may have gone missing at JHL, before it was transferred to the UCF. The IAEA previously identified a "possible discrepancy of several kilogrammes in the accountancy records" of previously undeclared uranium conversion experiments. The IAEA notes in its report that "this new element requires further consideration by the Agency."

Notably, this also means that in a perceived effort by Iran in 2004 to fully declare past undeclared nuclear materials and activities at JHL, it found a way to only declare select materials and activities.

Failure of the Joint Statement

In a March 2023 Joint Statement, Iran and the IAEA agreed to cooperate on restoring some monitoring and on resolving safeguards issues relating to the sites under IAEA investigation.[8] The Director General reports that "following some limited progress towards implementing the Joint Statement of 4 March 2023 in the reporting period March-June 2023, no further progress has been made since." According to the report, "The Director General is seriously concerned that Iran has unilaterally stopped implementing the Joint Statement and questions Iran's continued commitment to its implementation."

Recommendations

The IAEA should release a report summarizing its understandings and findings about Iran's past nuclear weapons program and any nuclear weapons-related materials, equipment, or activities that have continued up to today. While the IAEA's recent effort to focus exclusively on undeclared nuclear material is understandable, this amounts to exploring the tip of the iceberg. It is time for the IAEA to expose the entire iceberg and reconstruct the history and nature of all aspects of Iran's nuclear weapons activities.

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[7] Laurence Norman, "U.N. Agency Confirms Iran Produced Enriched Uranium Close to Weapons Grade," *The Wall Street Journal*, February 28, 2023, https://www.wsj.com/articles/u-n-agency-confirms-iran-produced-enriched-uranium-close-to-weapons-grade-7ccd4069.

[8] "Joint Statement by the Atomic Energy Organization of Iran (AEOI) and the International Atomic Energy Agency (IAEA)," March 4, 2023, https://www.iaea.org/newscenter/pressreleases/joint-statement-by-the-atomic-energy-organization-of-iran-aeoi-and-the-international-atomic-energy-agency-iaea.

Due to Iran's prolonged, ongoing lack of cooperation, the IAEA Board of Governors should pass a resolution condemning Iran's failure to fully meet the demands spelled out in the November 2022 resolution and provide one last chance, with a deadline, for Iran to meet these demands, after which the board will refer Iran's case to the UN Security Council. Such a referral would not in any way halt the IAEA's investigations of Iran's undeclared materials and activities; in fact, it should encourage IAEA members to provide additional information and resources aimed at assisting the IAEA in pressing Iran to come into compliance with its safeguards obligations.

Despite the IAEA hesitating to state the obvious, the agency has essentially concluded that Iran is non-compliant with its safeguards agreement. Non-compliance can trigger specific activities by the Director General and the Board of Governors under the IAEA's Statute when a country fails to take corrective action "within a reasonable time." Five years is certainly a reasonable time. Under Article XII.C of the Statute, "In the event of failure of the recipient State or States to take fully corrective action within a reasonable time, the Board may take one or both of the following measures: direct curtailment or suspension of assistance being provided by the Agency or by a member, and call for the return of materials and equipment made available to the recipient member or group of members. The Agency may also, in accordance with article XIX, suspend any non-complying member from the exercise of the privileges and rights of membership."

In anticipation of the near futility of additional efforts to convince Iran to rectify its violations and address outstanding demands, yet as a way to provide additional incentives for Iran to come into compliance, it is time for the Director General and board to start invoking the measures specified in, or implied by, the IAEA's Statute. This may include curtailing IAEA technical assistance, reducing Iran's privileges at the IAEA, and discouraging member states providing nuclear assistance, whether for nuclear research or nuclear power.

Annex. The Tip of the Iceberg: Four Locations Under IAEA Investigation

In 2018, the IAEA began investigating new information on four sites linked to Iran's former nuclear weapons program, called the Amad Plan, and more current efforts to preserve its nuclear weapons capabilities. The four sites are Turquz-Abad, Varamin, Marivan, and Lavisan-Shian.[9] Out of the four sites of concern, three were discussed in Iran's Nuclear Archive.[10]

It is unlikely that these four locations are the only remaining sites in Iran with traces of undeclared uranium or other evidentiary links to the Amad Plan. In reports and press briefings, Director General Grossi has voiced concerns about additional unknown locations from which or to which Iran may have moved nuclear material or contaminated equipment.[11] Further, the IAEA may have identified additional sites it seeks to access based on information in the Nuclear Archive. The IAEA has been corroborating information in the Nuclear Archive against Iran's mandatory declaration of nuclear material and activities, in line with the IAEA's mandate to ensure that Iran's declaration is correct and complete. In September 2022, the Institute published the location of yet another site identified in the Nuclear Archive, where Iran may have carried out tests using uranium.[12] The site, called Golab Dareh, is one of four known sites associated with explosive testing of nuclear weapons components and the development of associated, high-speed diagnostic equipment. It appears to be another site that may harbor traces of undeclared uranium, and there are likely others.

Location 1: Turquzabad Warehouse

The open-air warehouse in Tehran's Turquzabad district held cargo containers and other items that contained nuclear-related equipment and material (see Figure 1).[13] In 2018, the IAEA observed activities consistent with sanitization of the site. Commercial satellite imagery confirms this activity and documents Iran's speedy removal of all shipping containers and scraping of the grounds.[14] The IAEA requested access to the site and took environmental

[9] The Varamin site is also referred to in Iran's Nuclear Archive as the Tehran Plant.

[10] For fuller descriptions of these four locations and their relationship to today, see David Albright with Sarah Burkhard and the Good ISIS Team, *Iran's Perilous Pursuit of Nuclear Weapons* (Washington, D.C.: Institute for Science and International Security Press, 2021).

[11] For example, Grossi wrote in a May 2022 safeguards report: "[Some of the] isotopically altered particles [found at Turquz-Abad] must have come from another unknown location." See: IAEA Director General, "NPT Safeguards Agreement with the Islamic Republic of Iran," GOV/2022/26, May 30, 2022, https://isis-online.org/uploads/iaea-reports/documents/gov2022-26.pdf.

[12] David Albright and Sarah Burkhard, "The Fourth Nuclear-Weapons-Related Testing Site Located: Another Parchin Site, More Undeclared Nuclear Material Possible," *Institute for Science and International Security,* September 7, 2022, https://isis-online.org/isis-reports/detail/the-fourth-nuclear-weapons-related-testing-site-located/.

[13] John Irish and Arshad Mohammed, "Netanyahu, in U.N. Speech, Claims Secret Iranian Nuclear Site," *Reuters,* September 27, 2018, https://www.reuters.com/article/us-un-assembly-israel-iran/netanyahu-in-un-speech-claims-secret-iranian-nuclear-site-idUSKCN1M72FZ.

[14] David Albright, Sarah Burkhard, Olli Heinonen, and Frank Pabian, "Presence of Undeclared Natural Uranium at the Turquz-Abad Nuclear Weaponization Storage Location," *Institute for Science and International Security,*

samples in February 2019, detecting processed natural uranium particles, potentially produced through undeclared uranium conversion activities. Through additional analysis, the IAEA detected traces of isotopically altered uranium particles as well, including "low enriched uranium with a detectable presence of U-236, and of slightly depleted uranium."

The IAEA concluded the "containers that had been stored at this location had contained nuclear material and/or equipment that had been heavily contaminated by nuclear material, or both. The Agency also assesse[d] that while some of the containers at Turquzabad were dismantled, others were removed from the location intact in 2018 and moved to an unknown location." This finding is confirmed by available commercial satellite imagery.

Some containers present at Turquzabad came from the Varamin site, aka the Tehran Plant, which is another former site associated with Iran's pre-2004 crash nuclear weapons program known as the Amad Plan[15] (see below). However, the nuclear activities carried out at Varamin do not explain the presence of the multiple types of isotopically altered particles found at Turquzabad. The IAEA concluded that those isotopically altered particles must have come from yet another, unknown location or locations.

The IAEA previously reported that at a September 2023 meeting between the IAEA and Iran, the agency requested additional information regarding the whereabouts of the containers at Turquzabad "but Iran did not provide the information during the discussions, or subsequently." The IAEA held a subsequent technical meeting with Iran on January 29, 2024, and the IAEA repeated its request, but "to date, the Agency has not received any such information." That situation remains the same today.

November 20, 2019, https://isis-online.org/isis-reports/detail/presence-of-undeclared-natural-uranium-at-the-turquz-abad-nuclear-weaponiza.

[15] *Iran's Perilous Pursuit of Nuclear Weapons*.

Figure 1. Turquzabad, also known as the "Atomic Warehouse," where Iran secretly stored shipping containers and other items associated with the Amad Plan and possibly other undeclared nuclear activities. Iran later emptied it.

Location 2: Lavisan-Shian

The IAEA concluded that the use and processing of uranium metal and related activities at Lavisan-Shian were undeclared and constituted violations of Iran's safeguards agreement. It found, "activities and the nuclear material used therein at Lavisan-Shian were not declared by Iran to the Agency as required under the Safeguards Agreement." Specifically, the IAEA assesses that "in 2003 at Lavisan-Shian, at least one natural uranium metal disc, out of ten such discs available (totaling approximately 10 kg), underwent drilling to produce metallic flakes. These flakes were subsequently subjected to chemical processing on at least two occasions at the same location."

What was Lavisan-Shian? Lavisan-Shian was a former headquarters of Iran's nuclear weapons program and a key site during the Amad Plan.[16] Iran razed the site in 2003 and 2004 as the IAEA's investigation into its covert nuclear program intensified (see Figure 2).[17]

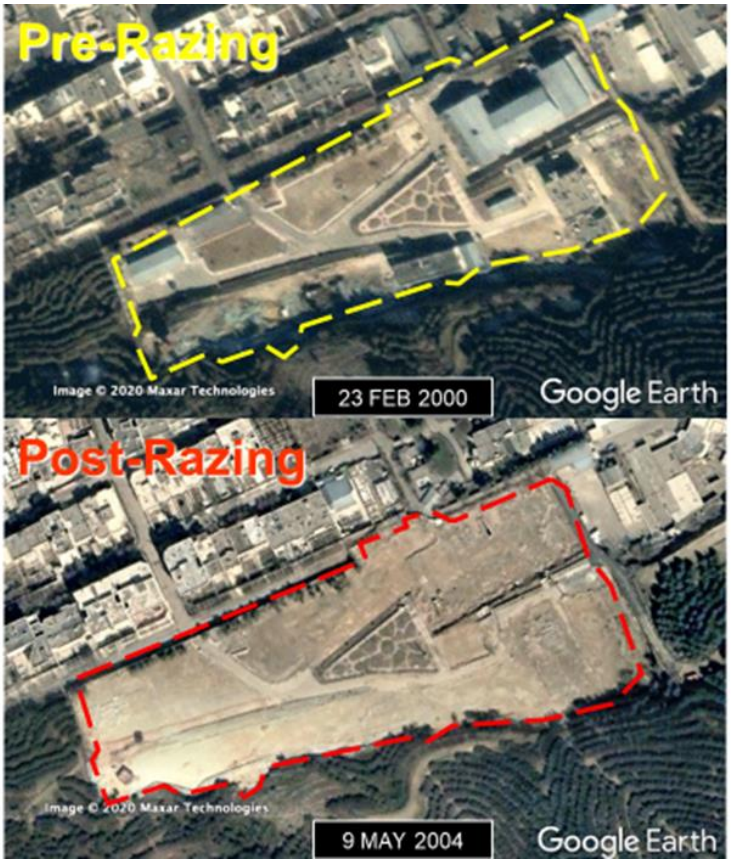

Figure 2. Before and after pictures from 2000 (above) and 2004 (below) show the extent of razing and sanitization that took place at Lavisan-Shian.

The metal disc at Lavisan was apparently part of Iran's nuclear weapons-related work, detailed in Iran's Nuclear Archive. Among the files was information about Iran's work on producing uranium deuteride (UD_3) for a neutron initiator used in nuclear weapons. The information detailed procedures Tehran used to make uranium deuteride, with an initial step involving drilling into a piece of uranium metal to obtain small pieces or flakes.[18]

[16] *Iran's Perilous Pursuit of Nuclear Weapons*.

[17] David Albright, Paul Brannan, and Andrea Stricker, "The Physics Research Center and Iran's Parallel Military Nuclear Program," *Institute for Science and International Security,* February 23, 2012, https://isis-online.org/uploads/isis-reports/documents/PHRC_report_23February2012.pdf. See also: *Iran's Perilous Pursuit of Nuclear Weapons.*

[18] "Neutron Source: Iran's Uranium Deuteride Neutron Initiator," *Institute for Science and International Security,* May 13, 2019, https://isis-online.org/isis-reports/detail/neutron-source-irans-uranium-deuteride-neutron-initiator-1/. See also, *Iran's Perilous Pursuit of Nuclear Weapons*.

The IAEA's assessment of the metal flakes undergoing chemical processing stops short of specifying the achieved or intended chemical product but is consistent with the production of uranium deuteride. Further, the IAEA stated in its June 5, 2020 report that the uranium metal disc had "indications of it undergoing drilling and hydriding."[19] The statement about "drilling and hydriding" more directly refers to the production of uranium deuteride.[20]

The production of UD_3 typically involves producing uranium metal chips or shavings from a solid uranium metal piece and combining them under controlled temperatures and pressures with deuterium gas. Iran's Nuclear Archive contains an image of equipment in a glove box producing the uranium metal flakes (see Figure 3); other documents in the archive describe a step-by-step effort to produce UD_3, including practicing its synthesis with surrogate materials. The testing of a UD_3 neutron initiator is also extensively discussed in the Nuclear Archive, incidentally, helping explain the IAEA's detection in 2015 of uranium from environmental sampling done at the Parchin high explosive chamber, despite Iran's extensive sanitization efforts.[21]

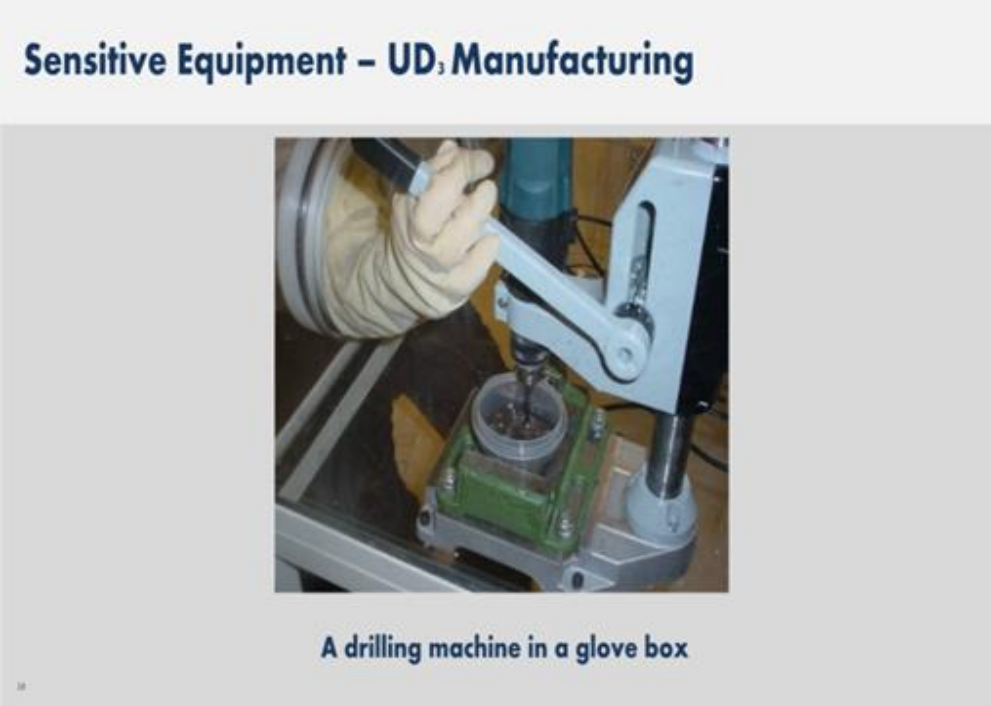

Figure 3. A photo from Iran's Nuclear Archive, obtained by the media and shared with the Institute, shows a glove box containing a drilling machine, with what appears to be a black object that is likely the uranium metal disc at issue at Lavisan-Shian.

[19] IAEA Director General, "Verification and Monitoring in the Islamic Republic of Iran in Light of United Nations Security Council resolution 2231 (2015)," GOV/2020/26, June 5, 2020, https://isis-online.org/uploads/iaea-reports/documents/IAEA_Iran_Quarterly_Safeguards_Report_June_2020_.pdf.

[20] "Neutron Source: Iran's Uranium Deuteride Neutron Initiator."

[21] David Albright, Sarah Burkhard, Olli Heinonen, and Frank Pabian, "New Information about the Parchin Site: What the Atomic Archive Reveals About Iran's Past Nuclear Weapons Related High Explosive Work at the Parchin High Explosive Test Site," *Institute for Science and International Security,* October 23, 2018, http://isis-online.org/isis-reports/detail/new-information-about-the-parchin-site.

Under the Amad Plan, the production of uranium deuteride had a codename, Project 3.20. When the Amad Plan was downsized and reconstituted as a smaller, more disguised effort in late 2003 and early 2004, Project 3.20 was to be closed, but a few of the project staff needed to make the "Source" – a codeword for the uranium deuteride neutron initiator – were slated to continue their activities.[22]

Evidence of post-2003 Iranian work on UD_3 and neutron initiators includes an Iranian document that surfaced in 2009. The document, dated to 2007, discusses how although Iran had made progress on work related to neutron sources through 2003, Iran reduced its scale. It then decided to increase that work starting in about 2007, including continuing ongoing work on the production and testing of a UD_3 initiator.[23]

Location 3: Tehran Plant, near Varamin

Varamin is identified in Iran's Nuclear Archive as the "Tehran Plant," or what the IAEA calls the Varamin site, after a nearby town. The site, visible in Figure 4, was a secret pilot and laboratory-scale uranium conversion plant under the Amad Plan.[24] The November 2022 IAEA report adds more detail about the conversion facility; it provides an IAEA assessment that the site, used between 1999 and 2003, was an undeclared pilot plant for the processing and milling of uranium ore and conversion into uranium oxide, as well as for laboratory-scale conversion into uranium tetrafluoride and uranium hexafluoride.

Iran demolished the site in 2004. According to earlier IAEA reports, this location "underwent significant changes after 2003, including the demolition of most buildings, scraping and landscaping that was consistent with sanitisation, as well as the removal of containers." This can also be seen in commercial satellite imagery published by the Institute.

The IAEA originally asked for access to the site in January 2020, but Iran refused until August 2020. The IAEA took environmental samples whose analysis indicated the presence of undeclared man-made uranium particles.

Earlier IAEA reports link materials at this site to Turquzabad. The IAEA reported in its September 2021 report that Iran removed containers from the site in 2004 and that "there are

[22] Memorandum, Statement of Mohsen Fakhrizadeh, October 25, 2003. From Nuclear Archive. See: *Iran's Perilous Pursuit of Nuclear Weapons.*

[23] "New Document Reopens Question on Whether Iran's Nuclear Weaponization Work Continued Past 2003, *Institute for Science and International Security,* December 14, 2009, https://isis-online.org/isis-reports/detail/new-document-reopens-question-on-whether-irans-nuclear-weaponization-work-c/8; Farsi and English versions of the document are available at: http://isis-online.org/isis-reports/detail/farsi-and-english-versions-of-document-on-neutron-initiator/.

[24] *Iran's Perilous Pursuit of Nuclear Weapons*, Chapters 8 and 12; and David Albright, Sarah Burkhard, and Frank Pabian, "The Amad Plan Pilot Uranium Conversion Site, Which Iran Denies Ever Existed," *Institute for Science and International Security,* November 9, 2020, https://isis-online.org/isis-reports/detail/the-amad-plan-pilot-uranium-conversion-site/8.

indications, supported by the results of the environmental samples analysis, that containers moved from Location 3 [Varamin] were subsequently also present at Location 1 [Turquz-abad]." The November 2022 report states that the containers were "eventually transferred to Turquz-Abad." However, the IAEA further reports that the uranium conversion activities carried out at Varamin "do not explain the presence of the multiple types of isotopically altered particles" found at Turquzabad. This finding is in line with assessments that Turquzabad was a storage location for a wide variety of equipment related to Iran's undeclared nuclear activities.

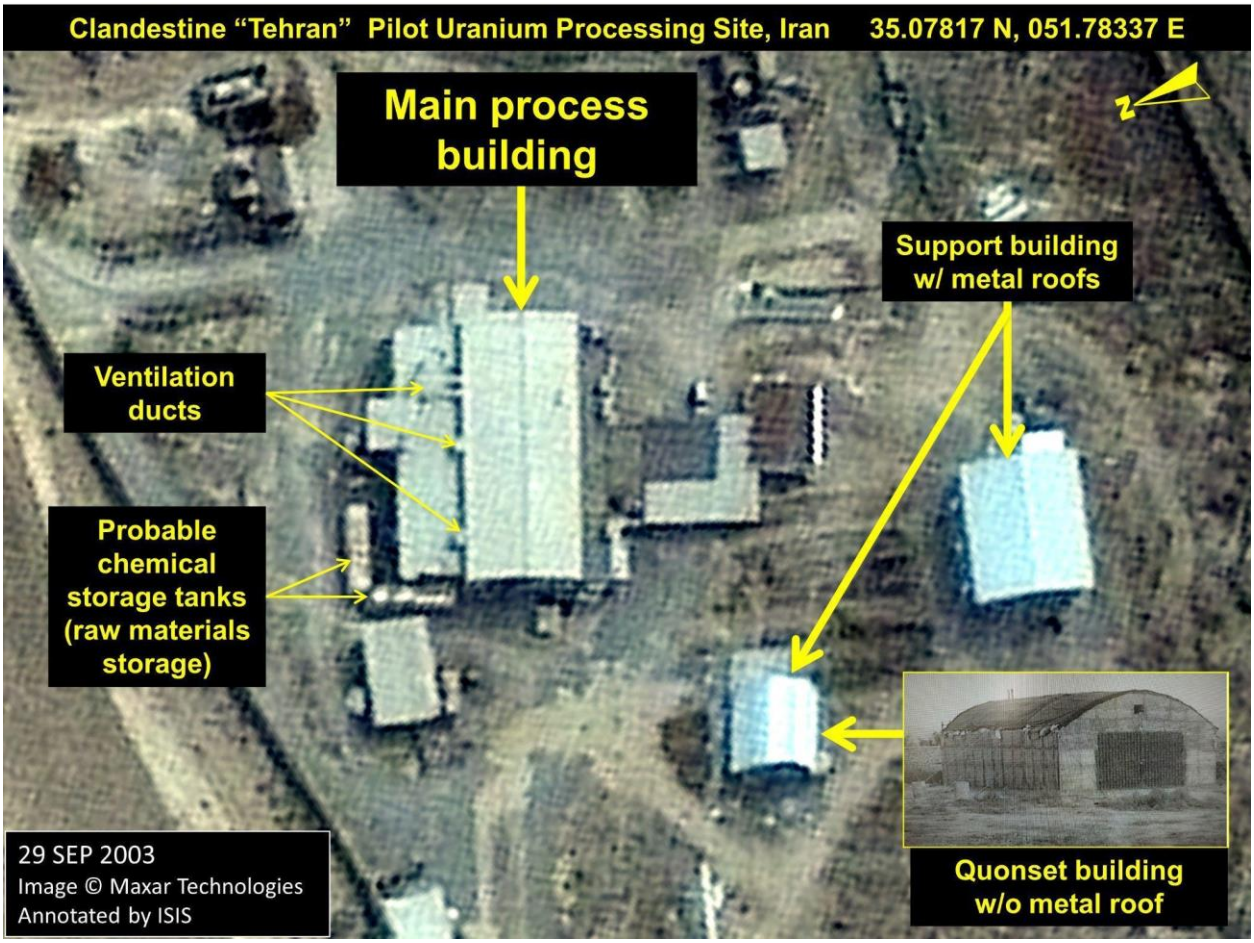

Figure 4. The undeclared Varamin uranium conversion facility, used between 1999 and 2003 as part of the Amad Plan.

Location 4: Marivan Site

The IAEA concluded that undeclared nuclear activities took place at Marivan, constituting a safeguards violation.

The formerly secret Marivan site, near Abadeh, is another Amad Plan facility identified in the Nuclear Archive.[25] The IAEA noted that Marivan "consists of two proximate areas where the Agency found indications that Iran had, in 2003, planned to use and store nuclear material." Figure 5 shows these two areas at Marivan; one, an outdoor area for high explosive testing, and the second, a development site with several buildings about 1.5 kilometers away from the outdoor testing site.

Along with the Varamin site, the IAEA sought access to Marivan in January 2020, which Iran refused until August 2020, when the IAEA took environmental samples that revealed the presence of uranium particles in the development/support area.

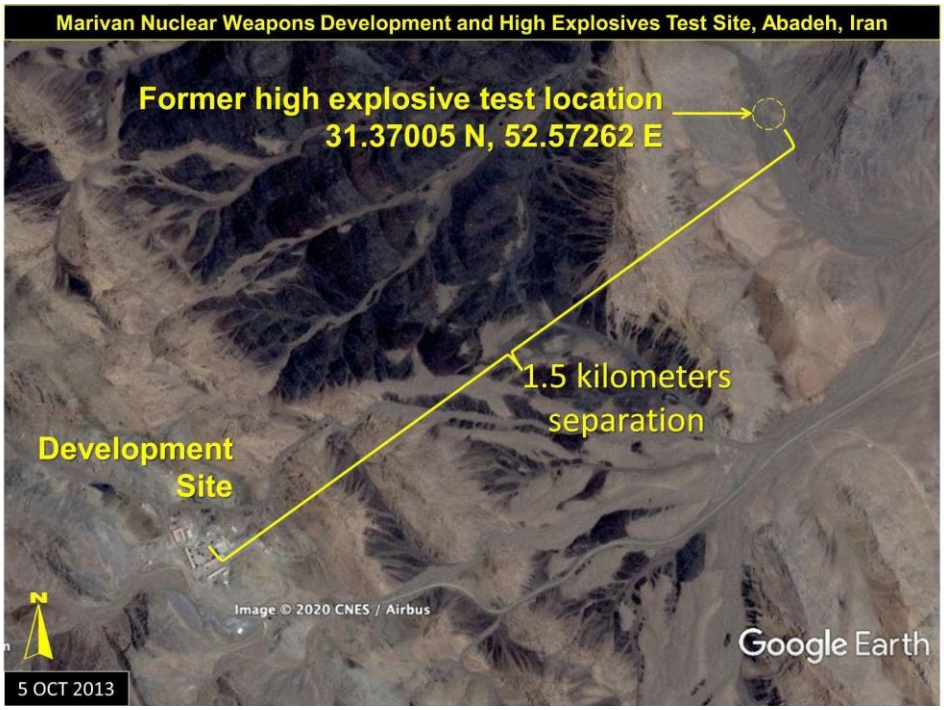

Figure 5. The Marivan high explosive test site and its relative location to the development site, also called the logistical support site.

In one area (see Figures 6 and 7), according to earlier IAEA reports, "where outdoor, conventional explosive testing may have taken place," the IAEA found "indications relating to the testing of shielding in preparation for the use of neutron detectors in that same area" (see Figure 8). In the November 2022 report, the IAEA was more definitive, stating: "The analysis of

[25] David Albright, Sarah Burkhard, and Frank Pabian, "Abadeh is Marivan: A Key, Former Secret Nuclear Weapons Development Test Site," *Institute for Science and International Security,* November 18, 2020, https://isis-online.org/isis-reports/detail/abadeh-is-marivan-irans-former-secret-nuclear-weapons-development-test-site.

all safeguards-relevant information available to the Agency related to 'Marivan' is consistent with Iran having conducted explosive testing with protective shielding in preparation for the use of neutron detectors." Iran did not address any of these IAEA statements. In all subsequent reports, the IAEA has stood by its assessment.

The November 2022 safeguards report indicated that the IAEA's environmental sampling revealed the presence of anthropogenic uranium particles not at this outdoor testing site, but at "another area" of Marivan, since identified by the IAEA as the development/support area.

The IAEA states in its November 2022 report that it "found indications that Iran had in 2003 planned to use and store nuclear material at 'Marivan' for explosive testing." This finding is independent of the origin of the uranium measured in environmental samples discussed above but relates to information found in the Nuclear Archive.

Earlier, the IAEA reported that from July 2019 onwards, it "observed via commercial satellite imagery, activities consistent with efforts to sanitize the area, including the demolition of buildings." Figure 9 shows the razed development site as of July 2020.

An Institute assessment of satellite imagery of the site found that Iran appeared to have conducted further demolition activities at the high explosive test site following the IAEA's visit, possibly to stymie future verification activities (see Figure 10).[26] Subsequently, the IAEA stated that following its access to the site, it "observed through the analysis of commercially available satellite imagery that the aforementioned bunkers had been removed."

The IAEA reported in its September 2021 report that in addition to explaining the presence of uranium, Iran must also provide answers regarding "the source of the neutrons that the neutron detectors were to measure" at the location. Iran did not do so. But the IAEA concluded that its assessment is correct, namely the source would be via the compression of a uranium deuteride neutron initiator during a cold test. The reports do not make clear if the IAEA has asked for the location of this or other neutron initiators.

In a cold test, the uranium deuteride neutron initiator would have been placed at the center of a nuclear weapons high explosive system lacking its fissile material. When the system is detonated, the inward compression from the high explosive would squeeze the surrogate core with the neutron initiator at its center, creating fusion of the deuterium and resulting in a spurt of neutrons. If the core had contained fissile material, or weapons-grade uranium in the Iranian design, the neutrons would have started the chain reaction and the nuclear explosion. This type of test is done near the end of a nuclear weapons development program, and in more recent proliferation cases, would be the last test before starting the manufacture of nuclear weapons. According to information in the Nuclear Archive, Iran was approaching the point at

[26] David Albright and Sarah Burkhard, "More Demolition at the Marivan Former Nuclear Weapons Development Site," *Institute for Science and International Security,* March 1, 2022, https://isis-online.org/isis-reports/detail/more-demolition-at-the-marivan-former-nuclear-weapons-development-site.

which it would conduct a cold test, but had not yet conducted one by the time the Amad Plan was halted in 2003. It is unknown if Iran conducted such a test elsewhere after 2003.

The IAEA further drew a connection between Marivan and Turquzabad, noting that based on analysis of commercially available satellite imagery, "trucks observed at Marivan and Turquz-Abad between mid-July and mid-August 2018 had similar features," and that major parts of the Marivan site were demolished right after the IAEA shared its sampling results from Turquzabad.

In its May 31, 2023 Iran safeguards report, the IAEA states that Iran provided a possible answer about the presence of anthropogenic uranium particles at the support site. According to Iran, this uranium is linked to earlier mining activity at the site when miners used "laboratory instruments and equipment" that contaminated the area with depleted uranium particles with uranium 236. Unable to prove or disprove this statement, the IAEA stated that the issue of this uranium is no longer outstanding.

It is likely that there was a mining support camp at this location, later repurposed by Iran's nuclear weapons program. The area is replete with clay mines and mining activity is visible (typical of sedimentary extraction mining) all around the Marivan site including linear prospecting scars dug by backhoes. However, the site was entirely razed before the IAEA was able to go – and just following the IAEA's detection of uranium particles at Turquzabad. In addition, other abandoned mining camps in Iran are not razed, e.g. the Talmesi uranium mining camp. Previous mining was most likely for refractory illitic clay for ceramics, as the Abadeh region is the home of one of the largest refractory clay mines (Esteghlal Mine) in the Middle East for the manufacture of ceramics and high temperature fire-bricks for kilns. A mining support camp, later co-opted by the Amad project, circa 2002 and beyond, would likely raise less suspicion when used for high explosive testing, given that it is located in a known mining environment.

However, on the broader issue of the activities at the high explosive site and Marivan's purpose, the IAEA has not made any progress and "stands by its assessment of the activities that were undertaken by Iran at 'Marivan'." The IAEA is indicating that while Iran may have prevailed on the relatively small point of the uranium particles, the elephant in the proverbial Marivan tent remains present.

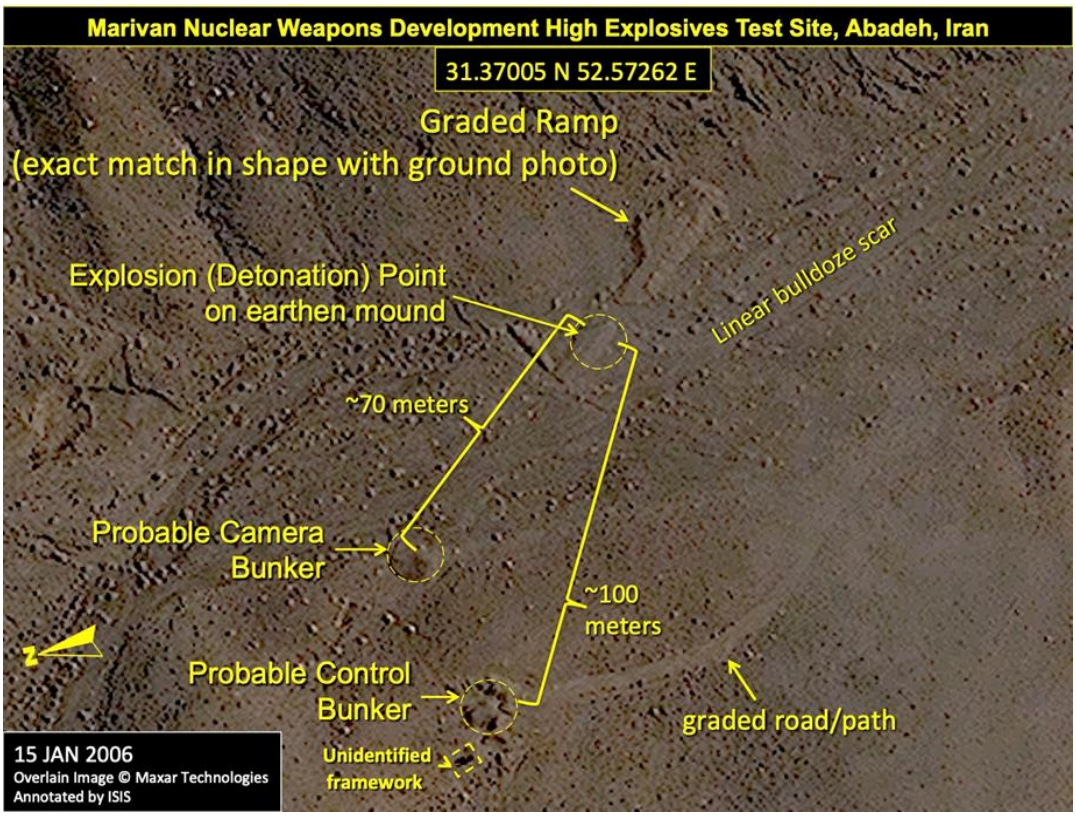

Figure 6. The Marivan high explosives test site near Abadeh, Iran, as it appeared in 2006, showing the location of the two bunkers and a future cold test that would be monitored by the neutron detectors.

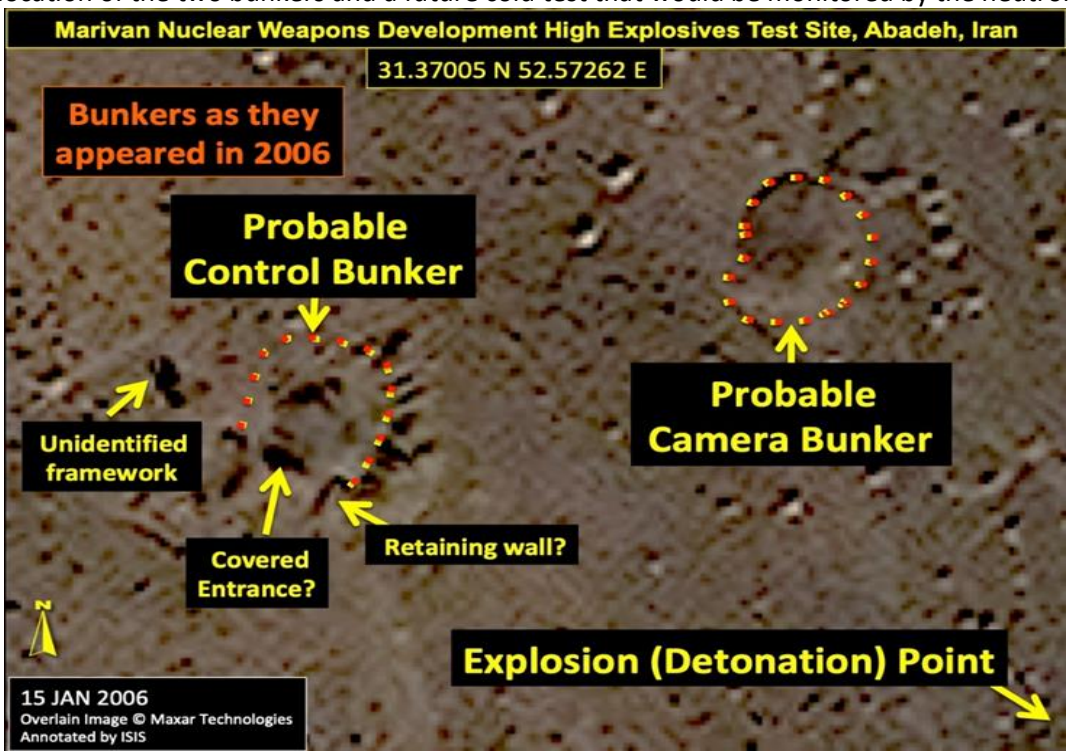

Figure 7. A close-up of the explosive test site's associated bunkers as they appeared in 2006, the nearest-in-time, available high-resolution image to the 2003 tests.

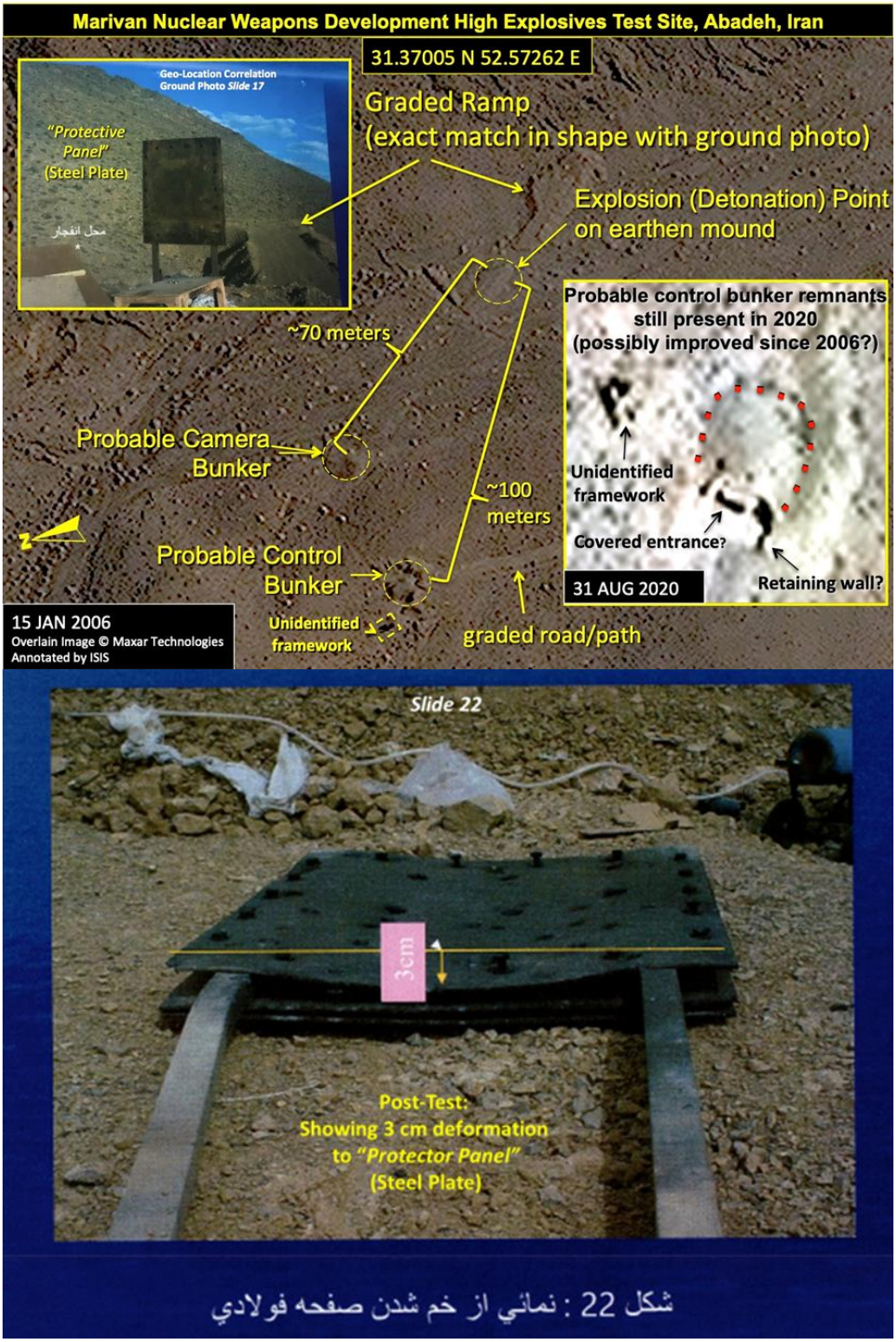

Figure 8. Top image: A 2006 image of the test site at Marivan, with a ground photo inset from the Nuclear Archive, showing shielding material, pre-test. Bottom image: Shielding material post-test.

Figure 9. During a September 2019 press conference, Prime Minister Benjamin Netanyahu used these before (left) and after (right) images of Marivan, also known after the nearby town of Abadeh, to show the site's abrupt razing in July 2019.

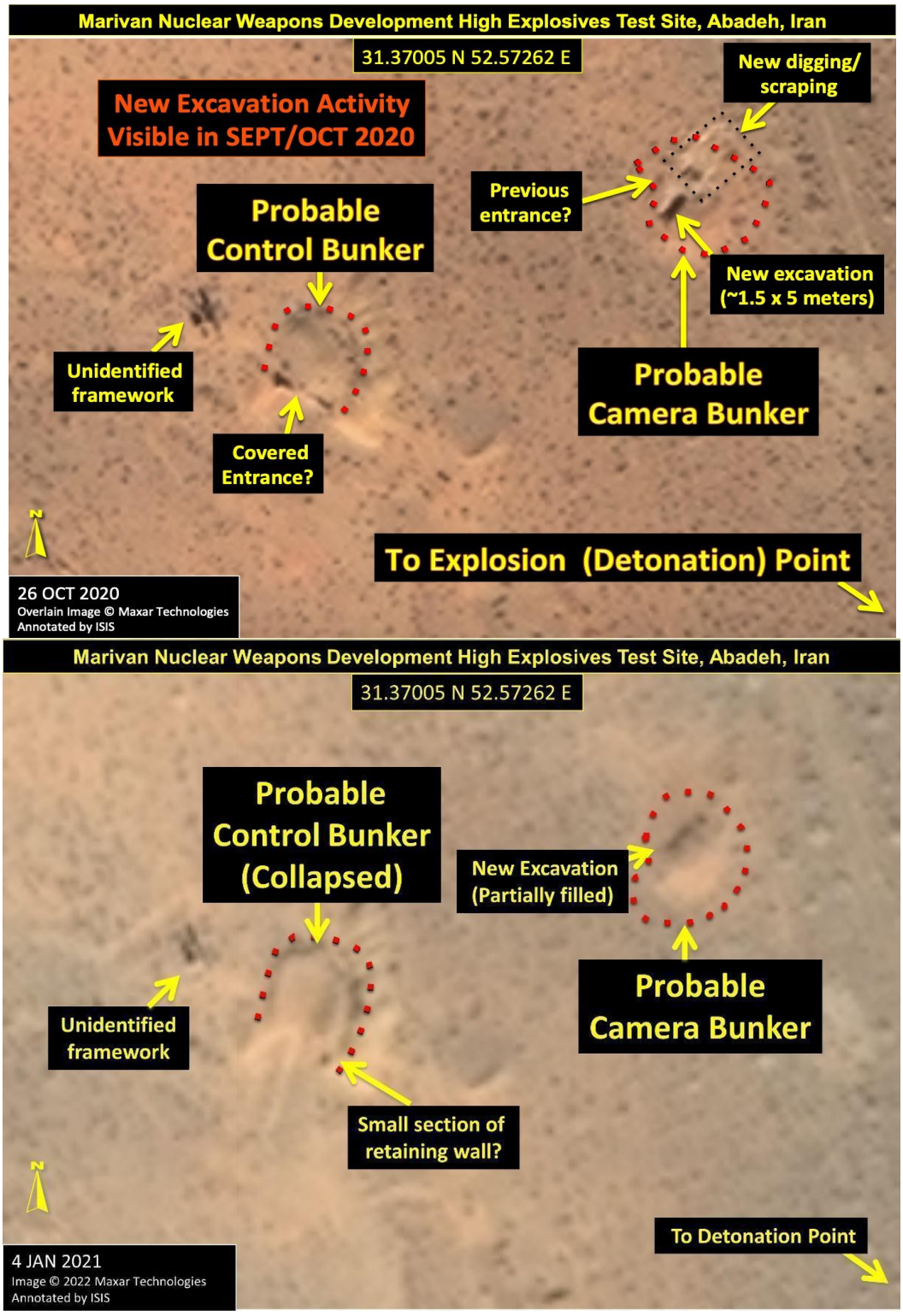

Figure 10. In top image, detected excavation and digging/scraping activity at the probable camera bunker, post-August 31, 2020. In bottom image, the excavation appears partially filled and the probable control bunker appears to have collapsed as of January 2021.