



Analysis of the IAEA's Report on the Possible Military Dimensions of Iran's Nuclear Program

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December 8, 2015

The International Atomic Energy Agency (IAEA) issued on December 2, 2015 a long awaited [report](#) on its investigation into the possible military dimensions (PMD) to Iran's nuclear program under the IAEA/Iran Roadmap to resolving these issues.² The completion of the Roadmap process and issuing of this report is linked, in the Joint Comprehensive Plan of Action (JCPOA), to Implementation Day. The JCPOA explicitly requires Iran to complete a set of agreed upon Roadmap steps with the IAEA prior to Adoption Day, which fell in mid-October 2015, and well before Implementation Day. The Roadmap stated that by mid-December the IAEA would issue a final assessment on these issues.

Overall, the report is evenhanded, albeit highly abbreviated in its assessments about Iran's nuclear weapons activities. It draws conclusions in the limited areas it is able to do so. However, Iran did not provide the IAEA with anywhere near a full declaration about its past nuclear weapons related activities, and it did not provide the kind of transparency and cooperation required for the IAEA to conclude its investigation. The IAEA was unable to fully explain Iran's nuclear weapons activities, including assessing with certainty that each activity and the program overall have ceased to exist. Most of its conclusions were based on incomplete information rather than a full Iranian declaration or cooperation.

Iran's answers and explanations for many of the IAEA's concerns were, at best, partial, but overall, obfuscating and stonewalling. Faced with evidence, Iran offered largely civilian or conventional (non-nuclear) military justifications for many of the outstanding issues of concern, denied the activities' relation to nuclear weapons work, or denied the activities or evidence outright. In many cases its answers appeared contrived. In no single case did Iran admit to the central conclusion reached by the IAEA in the report or by the United States and several other governments – that it had a structured nuclear weapons program prior to 2003 and a limited effort afterwards. It did not explain how the activities of concern related to this program. It also did not allow the IAEA to interview key scientists and other people of interest associated with the program. Needed access to sites was either denied or tightly controlled as to preclude adequate inspections.

¹ We wish to thank Mark Gorwitz for his valuable contributions to this report.

² The Roadmap referred to here is the *Roadmap for the Clarification of Past and Present Outstanding Issues Regarding Iran's Nuclear Programme* signed by Iran and the IAEA on July 14, 2015, <https://www.iaea.org/newscenter/statements/iaea-director-generals-statement-and-road-map-clarification-past-present-outstanding-issues-regarding-irans-nuclear-program>.

Faced with such outright Iranian efforts to deceive the inspectors, the IAEA broke relatively little new ground in its report. It is a testament to the IAEA's perseverance on this issue that it was able to make the conclusions that it did.

In a new revelation, the IAEA stated that its evidence of nuclear-weapons efforts extended to 2009. On one side, it stated that it had no credible evidence of nuclear weapons-related work after that year, but on the other, the IAEA was also unable to conclude with certainty that the program ended in 2009. Thus, the best that can be said is that the program continued to at least 2009. This revelation refutes the unclassified 2007 U.S. National Intelligence Estimate (NIE) which assessed that Iran's nuclear weapons program was halted in the fall of 2003, and that Iran had not restarted this program as of mid-2007.^{3,4} The IAEA's finding is more in line with the assessments of Britain, France, Germany, and Israel, which stated that nuclear weapons related activities continued after 2003. This IAEA finding also shows that Iranian government claims of a fatwa against nuclear weapons is more for outward show.

Iran's cooperation was certainly not sufficient to close the overall PMD file. Consequently, the IAEA's report can be viewed, at best, as a document that closes the process set forth by terms of the Roadmap. However, the IAEA's investigation must continue. As Olli Heinonen, Senior Fellow at the Belfer Center at Harvard University, [wrote](#) on December 8, 2015, "...Tehran yet again failed to fulfill its obligations under Security Council [resolutions](#) demanding it 'cooperate fully with the Agency on all outstanding issues, particularly those which gave rise to concerns about the possible military dimensions to Iran's nuclear programme, including by providing access without delay to all sites, equipment, persons and documents requested by the Agency.' Without Iran's cooperation and transparency, the file simply cannot be closed." Heinonen's assessment is of particular significance since he was deputy director of the IAEA safeguards department and was heavily involved in assessing the PMD evidence and carrying out investigations in Iran.

The upcoming IAEA Board of Governors meeting should pass a resolution re-affirming the IAEA's mandate and authority to continue its investigation into Iran's work on nuclear weapons. It should emphasize that the IAEA is still not in a position to provide assurances on the strictly peaceful nature of Iran's nuclear program. The resolution should state that Iran should provide a full declaration of its past efforts and cooperate on further investigatory efforts by the IAEA into its past nuclear weapons related activities. It should state that the IAEA has the authority to visit sites, take in-person samples, and interview persons of concern.

³ The 2007 NIE assessed with high confidence the 2003 halt of Iran's nuclear weapons program had occurred, but assessed with moderate confidence that Tehran had not restarted its nuclear weapons program as of mid-2007. It is also worth noting that the 2007 NIE stated with high confidence that the halt lasted at least several years, but specified that "because of intelligence gaps discussed elsewhere in this Estimate, however, DOE [Department of Energy] and the NIC [National Intelligence Council] assess with only moderate confidence that the halt to those activities represents a halt to Iran's entire nuclear weapons program." See *Iran: Nuclear Intentions and Capabilities*, National Intelligence Estimate, November 2007, http://www.dni.gov/files/documents/Newsroom/Reports%20and%20Pubs/20071203_release.pdf.

⁴ A 2012 NIE, which was not released but described to The New York Times, apparently assessed that Iran could have been reviving some limited efforts at developing a nuclear weapon. James Risen, "U.S. Faces a Tricky Task in Assessment of Data on Iran," *The New York Times*, March 17, 2012, <http://www.nytimes.com/2012/03/18/world/middleeast/iran-intelligence-crisis-showed-difficulty-of-assessing-nuclear-data.html?scp=8&sq=iran%20nuclear&st=cse>

Given the lack of any real Iranian cooperation, further progress on this issue should be required prior to Implementation Day. Sanctions relief should be conditioned on obtaining a certain amount of cooperation that furthers progress.

The resolution should also affirm that regardless of the status of this investigation up to Implementation Day, the investigation into Iran's past nuclear weapons activities must continue in the years ahead as the IAEA seeks to reach a broader conclusion under Additional Protocol. As Heinonen states, as the IAEA seeks a broader conclusion, "...A comprehensive understanding of the Iranian nuclear program's weaponization related activities is essential to set up credible baselines against which to monitor and detect any reconstitution efforts." To that end, denial of access in the future relating to continued IAEA efforts would be justification for the E3+3 to invoke the JCPOA's access provision.

Finally, a full conclusion to the possible military dimensions to Iran's program must include an Iranian statement that the effort existed and will not continue. Former Iranian president Rafsanjani recently went part of the way by [admitting](#) as much to an Iranian news source. However, Iranian Ambassador to the IAEA Reza Najafi appeared to [deny](#) agreement with the IAEA's findings about its activities and promised a report by Iran responding to the findings of the IAEA report. It is time for the Iranian regime to officially admit that it had a nuclear weapons program and pledge that it has officially abandoned any such effort.

IAEA's Overall Assessment

Following are the major conclusions reached by the IAEA during its Roadmap investigation:

Major Finding 1: "The Agency assesses that a range of activities relevant to the development of a nuclear explosive device were conducted in Iran prior to the end of 2003 as a coordinated effort, and some activities took place after 2003. The Agency also assesses that these activities did not advance beyond feasibility and scientific studies, and the acquisition of certain relevant technical competences and capabilities. The Agency has no credible indications of activities in Iran relevant to the development of a nuclear explosive device after 2009."

Major Finding 2: "Based on all the information available to the Agency, including from the particular verification activities specified under the Framework for Cooperation (including the managed access to the Gchine mine) and the JPA, the Agency has not found indications of an undeclared nuclear fuel cycle in Iran, beyond those activities declared retrospectively by Iran. The Agency assesses that any quantity of nuclear material that may have been available to Iran under the AMAD Plan would have been within the uncertainties associated with nuclear material accountancy and related measurements."

ISIS Analysis:

Major Finding 1: The IAEA's findings about the existence of a structured nuclear weapons program prior to 2003 and that it continued in a dispersed fashion after 2003 support earlier findings of the IAEA and non-U.S. intelligence agencies. The finding that the activities did not advance beyond feasibility and scientific studies and the acquisition of certain competencies and capabilities is in line with earlier IAEA assessments. However, it should be pointed out that Iran learned enough in its pre-2003 efforts to be able to make a crude fission weapon from weapon-grade uranium, as the IAEA [assessed earlier](#). The finding that Iran knows how to make a crude nuclear weapon, and honed some of its nuclear weapons development skills after 2003, should temper statements that Iran's active nuclear weapons efforts may

have ended. Its existing knowledge will not disappear, and a revived nuclear weapons effort could rapidly progress to the building of nuclear weapons, if it obtained sufficient weapon-grade uranium. A sobering concern is that the investigation, even though incomplete, shows that the building of at least crude fission nuclear weapons is not a bottleneck in Iran's acquisition of nuclear weapons. Mitigating this threat requires a much deeper understanding of Iran's progress on nuclear weapons and greater assurances than have so far been given that these efforts have stopped.

The evidence does not allow a conclusion that Iran's nuclear weapons efforts ended in 2009, but notably the year 2009 coincides with the revelation of and then confirmed re-purposing of the Fordow enrichment facility. In September 2009, the United States, France, and Britain publicly revealed the existence of the then-secret Fordow enrichment facility. IAEA evidence supported the assessment that this enrichment site was part of an on-going secret nuclear weapons effort. The rapid modifications made at the site and its original nature (small, deeply buried, and unable to handle large natural uranium feed cylinders) pointed to a plant designed to make weapon-grade uranium. After the plant was revealed, Iran extensively modified the insides of the plant and declared that the site would produce low enriched uranium under safeguards. The revelation of the advanced construction of a secret centrifuge plant was highly embarrassing to Iran and shifted international opinion significantly against it. As in 2003, faced with the risk of further disclosures, Iran may have decided to close down any remaining nuclear weapons related work.

However, whether Iran actually has closed down all of its nuclear weapons related activities remains uncertain, given its poor level of cooperation with the IAEA, including the absence of any official admission of its past efforts. Some of its activities may continue in highly secret facilities or be actively retained for later use. When a country lies so often, as Iran has done on the nuclear issues, prudence requires continued pressure to reveal what it did and assessments that must assume the worst about its capabilities.

Major Finding 2: The finding on undeclared fuel cycles, in particular explicitly military fuel cycles run in parallel to secret ones of the Atomic Energy Organization of Iran, is difficult to assess. The IAEA does not state what Iran has admitted in this area. Nonetheless, the issue of whether Iran had a parallel military fuel cycle is not directly addressed. Any such fuel cycle would have existed prior to 2003 and the AMAD program. In the late 1980s and 1990s, this parallel program would have been located at the Physics Research Center (PHRC). The evidence, part of which is contained in about 1,500 [telexes](#) related to PHRC procurement efforts, supports that Iran's military was pursuing a range of fuel cycle activities, including development of gas centrifuges. Earlier, inspectors found indications that this program had at least one facility to develop centrifuges separate from those of the Atomic Energy Organization of Iran, which were then taking place secretly at the Tehran Nuclear Research Center. If this military program enriched any uranium, it would have involved extremely small quantities. Nonetheless, determining the extent of the PHRC's centrifuge and possible nuclear weaponization activities should remain a priority.

Area Assessments

The IAEA's conclusions are supported by its investigation into 12 areas of concern, which correspond to the list of areas of concern in the annex to the Director General's November 2011 report regarding Iran's potential work on nuclear weapons. The IAEA first describes its reasons for concern in each area. It then details the cooperation or explanations received by Iran or the additional actions it took to clarify the issue. It then, when possible, issues its own assessment about the activity.

A summary table of the issues, cooperation received, and IAEA assessment is provided here. The table is followed by a detailed analysis of the findings by each area of concern.

| Iran's PMD File | | | |
|-----------------|--|---|-------------------------------------|
| | PMD Issue | Iranian Cooperation/Responses | Was the IAEA Assessment Conclusive? |
| 1 | Programme Management Structure | Denial/Confirmed significant amount of information | Partially |
| 2 | Procurement Activities | Denial/Conventional military justification | No |
| 3 | Nuclear Material Acquisition | Limited/Access to mine and research laboratory | Partially |
| 4 | Nuclear Components for an Explosive Device | Denial/Refusal to discuss | No |
| 5 | Detonator Development | Denial/Civilian and conventional military justifications | No |
| 6 | Initiation of High Explosives and Associated Experiments | Denial/Conventional military justification | No |
| 7 | Hydrodynamic Experiments (Parchin) | Denial/Conventional military justification | No |
| 8 | Modelling and Calculations | Denial/Refusal to discuss/Unspecified conventional military justification | No |
| 9 | Neutron Initiator | Denial/General research justification | No |
| 10 | Conducting a Test | None | No |
| 11 | Integration into a Missile Delivery Vehicle | Limited/Provided access to 2 out of 3 workshops | No |
| 12 | Fuzing, Arming, and Firing System | None | No |

1) Program management structure

IAEA Concern: The IAEA states: “Information available to the Agency prior to November 2011 indicated that Iran had arranged, via a number of different and evolving management structures, for activities to be undertaken in support of a possible military dimension to its nuclear programme. According to this information, the organisational structures covered most of the areas of activity relevant to the development of a nuclear explosive device.”

Iranian Response: “In Iran’s submission of 15 August 2015 under the Roadmap, Iran provided the Agency with information concerning a number of organisations described in the 2011 Annex and on their Agency relation and functions. In this regard, Iran, inter alia, denied the existence of a coordinated programme aimed at the development of a nuclear explosive device, and specifically denied the existence of the AMAD Plan and the ‘Orchid Office’ as elements of such a programme. The Agency submitted questions to Iran on this subject on 8 September 2015, which were then discussed at technical-expert meetings in Tehran. A significant proportion of the information available to the Agency on the existence of organizational structures was confirmed by Iran during implementation of the Roadmap.”

IAEA Assessment: “The Agency assesses that, before the end of 2003, an organizational structure was in place in Iran suitable for the coordination of a range of activities relevant to the development of a nuclear explosive device. Although some activities took place after 2003, they were not part of a coordinated effort.”

ISIS Analysis: *The IAEA’s finding that Iran had the organizational structure aimed at coordinating activities relevant to the development of a nuclear explosive device until 2003 is very important. It appears to have been reached without Iran’s full acknowledgement about the purpose of the entities, although they appear to have confirmed the existence of some of the entities. The lack of*

Iranian confirmation about the organized structure, and thereby effort to develop nuclear weapons capabilities, is a key indicator that it did not seriously cooperate with the IAEA's investigation.

2) Procurement Activities

IAEA Concern: “According to information available to the Agency prior to November 2011, Iran was able to make procurements, primarily for its nuclear fuel cycle activities, through companies not directly associated with the AEOI or Ministry of Defence Armed Forces Logistics (MODAFL), thereby disguising the final user.” It continues, “The Agency also had indications of instances of procurements and attempted procurements of items with relevance, inter alia, to the development of a nuclear explosive device.”

Iranian Response: “During discussions with the Agency on 16 September 2015 under the Road-map, Iran confirmed its earlier statements that although, as identified by the Agency, it had made a procurement enquiry about a specific high speed camera, the camera had been for a conventional purpose and, ultimately, Iran had not purchased it. During these discussions, Iran also reiterated its earlier denial that a named company had attempted to acquire high-speed switches.”

IAEA Assessment: It states, “The Agency does not have information regarding any such procurement attempts after 2007.” It continues, “The Agency has not received additional information on this topic since the 2011 Annex.”

***ISIS Analysis:** Although it came to the conclusion, based on lack of additional indications, that Iran had halted its nuclear weapons related procurements after 2007, the IAEA did not obtain details from Iran about the past procurements' intended use. The IAEA found that Iran sought and obtained, using obfuscation techniques and concealing the end-user, goods related to the development of a nuclear explosive device, such as high speed cameras and switches. At least [one public case](#) of Iran acquiring two high speed cameras relevant to nuclear weapons development occurred in 2006-2007 when an individual was arrested and later convicted for exporting them from Germany. However, the IAEA notes a procurement of a high speed camera in the singular form. The IAEA also had information that private companies or contractors procured the goods rather than the AEOI or MODAFL. Iran denied a military nuclear use was intended for the high speed camera and denied that a private company ever sought the switches. These denials likely represent an effort to whitewash its nuclear weapons development related procurements. The question about post-2007 procurements should remain open.*

3) Nuclear Material Acquisition

IAEA Concerns:

- “Information available to the Agency prior to November 2011 indicated that the Gchine mine was a potential source of uranium for use in undeclared nuclear activities in the period 2000-2003. The information also indicated that preliminary activities, including the ‘green salt project’, were undertaken at an unknown location and were aimed at the production of uranium salts that would have been suitable either for conversion into material for uranium enrichment or into material for the direct reduction of uranium salts to pure uranium metal.” It continues, “Information contained in the alleged studies documentation links the uranium salts to be produced with warhead development.”

- “The Agency also had information from Member States that, although not used, kilogramme quantities of uranium metal were available to the AMAD Plan.”

IAEA Actions:

- “Iran provided the Agency with managed access to the Gchine mine in 2014 under the Framework for Cooperation and the JPA [Joint Plan of Action]. The Agency has assessed that the activities carried out at the site are consistent with Iran’s declarations provided in connection with the Framework for Cooperation and JPA and that, in any event, no substantial amount of nuclear material could have been produced in the Gchine mine before 2006.”
- “As previously reported, the Agency carried out a physical inventory verification (PIV) at the Jabr Ibn Hayan Multipurpose Research Laboratory (JHL) in August 2011 to verify, inter alia, the nuclear material, in the form of natural uranium metal, and process waste related to experiments to convert UF₄ into uranium metal that had been conducted at JHL in the period 1995-2000. As a result of the PIV, the Agency identified a possible discrepancy of several kilogrammes of natural uranium in the accountancy records of these experiments.”

IAEA Assessment:

- “The Agency assesses that the process design for the production of uranium salts was technically flawed and of low quality in comparison to what was available to Iran as part of its declared nuclear fuel cycle.”
- “The Agency re-evaluated this information in 2014 and assessed that the amount of natural uranium involved was within the uncertainties associated with nuclear material accountancy and related measurements.”

Overall IAEA Assessment on Concerns: “Based on all the information available to the Agency, including from the particular verification activities specified under the Framework for Cooperation (including the managed access to the Gchine mine) and the JPA, the Agency has not found indications of an undeclared nuclear fuel cycle in Iran, beyond those activities declared retrospectively by Iran. The Agency assesses that any quantity of nuclear material that may have been available to Iran under the AMAD Plan would have been within the uncertainties associated with nuclear material accountancy and related measurements.”

ISIS Analysis: *It is a positive development that the IAEA could find no indications of the diversion of a significant amount of nuclear material to a nuclear weapons program. However, as discussed above, the IAEA appears not to have investigated, or at least did not feel the need to mention, past, covert enrichment efforts, such as those previously carried out by the Physics Research Center in Iran. It is positive that it could determine that the uranium salts project likely failed and naturally concluded, that the amount of uranium metal used by Iran during the AMAD Plan could be accounted for, and that no additional material appears to have been used. However, the IAEA appears to have maintained its position that the Gchine mine, the Green Salt Project, and the availability of uranium metal are all linked to a nuclear weapons effort that was operating in secret and parallel to a civilian nuclear program. This finding in particular highlights that the pressure brought on Iran in 2003 by the international community disrupted a broad based nuclear weapons effort that was not yet in a position to produce the nuclear explosive materials necessary to actually build nuclear weapons. Given the lack of cooperation by Iran of the intent of these various efforts, the IAEA and Member States will need to remain vigilant in pursuing evidence about the existence of prior undeclared fuel cycle activities conducted by the military.*

4) Nuclear Components for an Explosive Device

IAEA Concerns: “Information available to the Agency prior to November 2011 indicated that, in the early 1990s, Iran may have received design information for a nuclear explosive device from a clandestine nuclear supply network. Iran provided the Agency with a copy of a one-page handwritten document said to be an offer from this nuclear supply network relating to centrifuge enrichment technology. During discussions with Iran in 2005, the Agency identified a 15-page document relating to the conversion of uranium compounds into uranium metal (‘uranium metal document’) and the production of hemispherical enriched uranium metallic components. Information available to the Agency prior to November 2011 also indicated that Iran had made progress with preparatory work aimed at developing a chemical process to reduce a uranium fluoride compound (UF₄) to uranium metal, using lead oxide as a surrogate material. Additionally, information indicated that Iran conducted preparatory work, not involving nuclear material, for the fabrication of uranium components for a nuclear explosive device.”

Iranian Response: “During discussions in September 2015 under the Road-map, Iran informed the Agency that it had not conducted metallurgical work specifically designed for nuclear devices, and was not willing to discuss any similar activities that did not have such an application.”

IAEA Assessment: “Based on all the information available to it, the Agency has found no indications of Iran having conducted activities which can be directly traced to the ‘uranium metal document’ or to design information for a nuclear explosive device from the clandestine nuclear supply network.”

ISIS Analysis: The IAEA appears to refer to nuclear weapons design information allegedly provided to Iran by the Pakistani A.Q. Khan proliferation network, and to a uranium metal document that would inform efforts to produce hemispherical enriched uranium metallic components for a nuclear explosive device. It is positive that the IAEA could conclude that no evidence exists of continued efforts on these projects. However, Iran’s denials cannot be considered cooperation in the face of IAEA and other countries’ evidence that Iran had acquired the information and possibly used it in its nuclear weapons efforts. The IAEA not finding indicators of direct use is not surprising, possibly given the level of Iranian deceit and the lack of cooperation. In this circumstance, finding such indicators would have been extraordinary. Not finding them is potentially more a sign of Iran’s successful efforts to cover up its nuclear weapons efforts rather than a measure that such efforts did not exist.

5) Detonator Development

IAEA Concern: “The development of safe, fast-acting detonators, and equipment suitable for firing the detonators, is an integral part of a programme to develop an implosion-type nuclear explosive device. Prior to November 2011, the Agency had information indicating that Iran, in 2002-2003, developed exploding bridgewire (EBW) detonators and a high voltage firing capability which, in combination, enabled several detonators to be fired with less than microsecond simultaneity.”

Iranian Response: “During meetings in 2014 under the Framework for Cooperation, Iran provided information to the Agency which indicated that, in December 2000, Iran’s Ministry of Defence decided to improve safety requirements for certain operations involving conventional explosives by developing safer detonators. Iran stated that preliminary work on EBW detonators was undertaken by an industrial group connected to the Ministry of Defence, after which, in 2002, it started further work which culminated in the successful development of EBW detonators. Iran showed the Agency a video of

experimental activities being carried out, which Iran stated were linked to its aerospace industry. The Agency notes that Iran has not provided an explanation for the activities the information indicates that it undertook during 2000-2003.”

“Iran stated that the rationale for developing EBW detonators was to help prevent explosive accidents and, during the meeting under the Framework for Cooperation on 20 May 2014, provided the Agency with a list of five such accidents. The Agency determined this information to be inconsistent with the timeframe and unrelated to the detonator development programme. At the meeting under the Roadmap on 15 October 2015, Iran provided the Agency with a table listing another six accidents. The Agency notes that, although each of these was stated to have occurred in the correct timeframe and to have related to explosive accidents, at least one did not appear to be related to a detonator.”

“In the same meeting of 20 May 2014, Iran further informed the Agency that, around 2007, its oil and gas industry had identified a requirement for EBW detonators for the development of deep borehole severing devices. To support this claim, Iran presented information to the Agency, including the results of a limited number of tests in which detonators were fired with sub-microsecond simultaneity. Iran informed the Agency that in 2008, owing to concern over the interest expressed by the Agency in Iran’s development of EBW detonators, the oil and gas industry’s requirement was suspended. Work on single EBW detonators for applications in the oil and gas industry commenced in 2013. As previously reported by the Agency, such an application is not inconsistent with specialized industry practices.”

IAEA Assessment: “The Agency assesses that EBW detonators developed by Iran have characteristics relevant to a nuclear explosive device. The Agency acknowledges that there is a growing use of EBW detonators for civilian and conventional military purposes.”

***ISIS Analysis:** Iran’s explanations of the uses for EBW detonators often lacked credibility due to the incorrect time frame described and the use Iran offered that did not explain evidence of work relating to the nuclear weapons effort. The IAEA notes that Iran did not explain its work during the period 2000-2003 on EBW detonators. Overall, the IAEA broke no significant ground in gaining Iranian explanations for its work on EBW detonators. Interestingly, the IAEA used its characterization of “not inconsistent” with specialized industry practices, which as Olli Heinonen has explained should be interpreted as meaning that the explanation about non-nuclear industrial is consistent, i.e. not containing any noticeable inconsistencies, but it is not viewed as the whole story, namely Iran’s statements about the EBW are not complete.*

6) Initiation of High Explosives and Associated Experiments

IAEA Concerns: The IAEA had information indicating that “Iran had available to it design information on the explosives technology known as multipoint initiation (MPI) and it had used this for the initiation of high explosives in hemispherical geometry.” The information also indicated that Iran “had developed a hemispherical MPI system and conducted at least one large scale experiment in 2003, details of which were technically consistent, both internally and with publications authored by a certain ‘foreign expert.’”⁵ The IAEA reassessed that “this experiment was conducted at a location called “Marivan”, and not conducted in “the region of” Marivan.” The IAEA “received additional information from Member States regarding the conduct by Iran, in the early 2000s, of small scale experiments aimed at validating

⁵ Identified by ISIS as Vyacheslav Danilenko, who had knowledge of both MPI technology and experimental diagnostics and worked for much of his career in the Soviet nuclear weapons program.

the initiation of high explosives, associated instrumentation, and the implementation of safety standards at various test locations in Iran.” It stated, “Information available to the Agency in 2011 also indicated that Iran could have benefitted from the aforementioned foreign expert, who had knowledge of both MPI technology and experimental diagnostics and had worked for much of his career in the nuclear weapon programme in his country of origin. The foreign expert’s presence in Iran in the period 1996-2001 has been confirmed by Iran.”

Iranian Response: In August and September 2015, Iran informed the Agency that since the mid-1990s it had a conventional military requirement for the development of MPI technology but added that the ‘operationalization’ of the project had begun only in 2007. Iran’s submission showed how the concept of a ring wave generator was derived from the design featured in information Iran had provided to the Agency in 2008, and was apparently developed to optimize the performance of conventional munitions. Iran then showed the Agency examples of the ring wave generator, including some that had been filled with explosives and fired. Iran stated that the testing had been of an empirical nature to determine the performance of the explosive system.

Iran stated that it had not defined a specification for the functioning of the ring wave generator and it had undertaken only limited diagnostic measurements. In addition, it specified that it had investigated MPI technology in a cylindrical geometry for an unspecified conventional military purpose, but reiterated that no work had been conducted with MPI technology in (hemi) spherical geometry.

Iran confirmed the abovementioned foreign expert’s presence in Iran between 1996 and 2001, although it stated as it has before that his activities were related to the production of nanodiamonds.

IAEA Assessment: The Agency assessed that the MPI technology developed by Iran has characteristics relevant to a nuclear explosive device, as well as to a small number of alternative applications. The IAEA assessed that details of the 2003 experiment were “technically consistent, both internally and with publications authored by a certain ‘foreign expert.’” The IAEA reassessed that this experiment was conducted at a location called “Marivan” (not in “the region of” Marivan, as it had previously reported). The location of the site Marivan was not given.

***ISIS Analysis:** The IAEA seemed to concretely assess that Iran had undertaken the 2003 experiment of a hemispherical MPI system and re-confirmed the exact location in which it took place. In relation to the overall development of MPI technology, although it recognized alternative applications, it specified that they are “few.” This, in conjunction with the amount of information it had at its disposal, can be interpreted as not accepting Iran’s vague and unspecified explanations for the use of MPI technology. The fact that Iran gave an unspecified conventional military justification for the use of this technology is an indication of its lack of credibility. Overall, the IAEA broke no significant ground in gaining Iranian explanations for its work on MPI technology. The only significant information received while investigating this issue was the Iranian confirmation of Danilenko’s presence in Iran in the period 1996 to 2001.*

7) Hydrodynamic Experiments

IAEA Concern: In early 2012, the IAEA requested access to a specific site within the Parchin Military Complex because it possessed information indicating that Iran had “manufactured simulated components for a nuclear explosive device from high density materials, and that these may have included features relevant to the dynamic compressive testing of the components, i.e. hydrodynamic

testing.” This testing involves high speed diagnostic equipment to monitor the symmetry of the compressive shock of the simulated core of a nuclear explosive device. The IAEA’s information indicated that Iran had installed the chamber and then built the building around it which was in use until late 2003. Despite repeated requests by the IAEA and its Board of Governors, Iran denied IAEA inspectors access to this specific site and instead undertook substantial reconstruction and site modifications.

IAEA Action: Until September 2015, the IAEA had only been able to monitor activities at the site using satellite imagery. Under the Roadmap, the IAEA and Iran worked out a controversial arrangement that allowed for environmental samples to be taken in the main suspect building and direct visual observation through a ceremonial visit by the Director General and Deputy Director General for Safeguards.⁶

IAEA Assessment:

- Notwithstanding Iran’s attempt to contest the IAEA’s imagery-derived analysis by providing Iranian aerial photography, the Agency used new imagery from various sources to reinforce its previous assessment that **a large cylindrical-shaped object was made and installed at the site in the summer of 2000.**
- The IAEA stated that additional information indicates that **this cylinder matched the parameters of an explosives firing chamber featured in publications of a foreign expert.** In the past, the IAEA had developed evidence that a former Soviet nuclear weapons expert aided in the development of a high-explosive testing chamber inside the building and possibly provided help in using sophisticated diagnostic equipment for testing the spherical symmetry of high explosive shaped charges.⁷ The chamber dimensions featured in publications of the foreign expert match

⁶ For more information on problematic issues relating to the visit and environmental sampling process see David Albright, Olli Heinonen, and Serena Kelleher-Vergantini, “IAEA Visit to the Parchin Site,” September 22, 2015, http://isis-online.org/uploads/isis-reports/documents/IAEA_Visit_to_the_Parchin_Site_September_22_2015_Final_1.pdf.

⁷ See David Albright and Robert Avagyan, *Revisiting Danilenko and the Explosive Chamber at Parchin: A Review Based on Open Sources*, ISIS Report, September 17, 2012, <http://isis-online.org/isis-reports/detail/revisiting-danilenko-and-the-explosive-chamber-at-parchin-a-review-based-on/8>, and Mark Gorwitz, *Revisiting Vyacheslav Danilenko: His Origins in the Soviet Nuclear Weapons Complex*, ISIS Report, September 17, 2012, http://isis-online.org/uploads/isis-reports/documents/Gorwitz_Revisiting_Vyacheslav_Danilenko_17Sept2012.pdf. An excerpt from the former ISIS report follows:

*Danilenko’s writings describe a chamber that he designed in 1999 and 2000 that is strikingly similar to the one at Parchin. According to Olli Heinonen, a senior fellow at the Belfer Center at Harvard University and former Deputy Director General of IAEA, the IAEA obtained a photo of the chamber installed at Parchin that was built by the Iranian company Azar AB Industries. The Associated Press obtained a description and drawing of the chamber built for the Parchin site from a country tracking Iran’s nuclear program. The drawing was based on information from a person who had seen the chamber at the Parchin site. Based on this information, the IAEA concluded that the chamber at Parchin is akin to one designed by Danilenko and described in his 2003 book, titled *Sintez i Spekanie Almaza Vzryvom (Explosive Synthesis and Sintering of Diamonds)*, which a European intelligence agency said he wrote based on the lectures he delivered in Iran. In his book, parts of which ISIS has translated from Russian, he states that in 1999-2000, he designed a cylindrical chamber of 4.6 x 19 m² with a volume of 315 m³ capable of withstanding multiple explosions of devices up to 70 kg. The chamber’s air-water system is pictured in figure 3.3 (figure 1 in this report). The external part of the central section of a length of 9 meters is strengthened with a reinforced concrete square section of 7.6 x 7.6 m² and a mass of 700 tonnes. Before an explosion, the chamber can be showered with water, and a vacuum can be created.⁸ These dimensions and characteristics of this chamber are similar to those of the Parchin chamber described by the media.⁹*

the dimensions of the foundation that is visible in a GeoEye satellite image of the site from March 2000 (see figure 1).

- The visual observation allowed the Agency to assess that as of September 20, 2015, **the cylinder or any associated equipment was no longer present inside the building, and recent signs of internal refurbishment, such as a floor with an unusual cross-section and an incomplete ventilation system, were visible.**
- **Although Iran argued that the building of interest had always been used as a storage for chemical material for the production of explosives, this purpose is not supported by the results of the analysis of the environmental samples,** which did not detect any explosive compounds or precursors required for the storage of chemical explosives. In addition, the presence of a protective berm on only one side of the building, instead of all four, would argue against such use. Moreover, satellite imagery from 2000, during the construction of the main suspect building, shows an adjacent building more suitable for storing high explosives (see figure 1). This building may still be at the site, although it would now be buried.⁸
- **Environmental sampling did identify two particles that appear to be “chemically man-made particles of natural uranium.”** However, the number of particles with this composition is not enough to assert the use of nuclear material at the site;
- The IAEA stated that **extensive activities undertaken by Iran since February 2012 seriously undermined its ability to conduct effective verification at this site.**

(The footnotes from the excerpt can be found in original report.)

⁸ It is worth noting that the layout of this site is not random, but follows a clear logic. It is very likely that the building to the left of the main building (foundation visible in figure 1) was used to store high explosives that were then prepared in a small building nearby (that was later demolished and rebuilt). The assembled device was tested in the test chamber. The building holding the control diagnostics was on the other side of the berm from the chamber building. Additionally, there is one more relatively large building at the north end of the site that was built into the hillside after the chamber building was constructed and extensively modified by Iran after the IAEA asked to visit the site. Although the exact purpose of this building is unknown, it is believed to be a research and development test hall linked to the main building.



Figure 1. GeoEye satellite imagery showing the foundation where Iran allegedly placed a high explosive test chamber later in the year 2000. This image also shows the foundation of a building possibly used as a high explosives storage.

ISIS Analysis: *The IAEA did not draw full conclusions about what occurred at the Parchin site given Iran’s limited cooperation and continued denials and obfuscation. Its evidence relating to past nuclear weapons related high explosives testing, help from a foreign expert, and sanitization of those efforts was not addressed by Iran. Although the IAEA was able to confirm that the measurements of the explosive chamber featured in publications of the foreign expert actually matched the size of the foundation at Parchin, overall it was only able to determine that the evidence does not support Iran’s claim that the building of interest was used as storage for chemical explosives. Although the results of the limited environmental samples taken by Iran under the IAEA’s direction identified two particles that appeared to be “chemically man-made particles of natural uranium” the IAEA did not make a definitive conclusion about the use of nuclear material at the site. But these samples could be evidence supporting the allegation that Iran conducted high explosive work on a uranium deuteride neutron initiator at Parchin. Iran’s extensive sanitization activities since 2012 have seriously interfered in the IAEA’s ability to draw conclusions, particularly without a more rigorous investigation about what occurred there.*

Since Iran did not seriously cooperate with the investigation, including detailing what actually occurred at the site, and in light of the IAEA’s discovery of uranium particles, the IAEA’s investigation of Parchin should continue. It should be granted a mandate from the Board of Governors in its upcoming resolution stating its authority to conduct additional visits to Parchin, take additional, in-

person samples, and interview persons of interest it identifies as having worked on past efforts. The IAEA should also visit the building at the north end of the site that is built into the hillside and was also extensively modified by Iran. This building is believed to be a research and development hall related to activities in the main building.⁹

The Parchin file can in no way be considered closed. It should remain open and the IAEA should continue its investigation into the activities that took place at the site.

8) Modelling and Calculations

IAEA Concerns: The IAEA's information indicated that, "...prior to 2004 and between 2005 and 2009, Iran had undertaken computer modelling studies of various component arrangements, which were only specific to nuclear explosive configurations based on implosion technology. Open source information also indicated that Iran had conducted additional studies relating to high explosives modelling, which the Agency also considered significant in the context of both hydrodynamic simulation and code development studies. The modelling described above has a number of possible applications, some of which are exclusively for a nuclear explosive device." Additional information was also received by the IAEA "from a Member State regarding a project in 2009 to determine equations of state for materials of concern."

IAEA Action: In October 2014, the Agency discussed several of these issues with Iran, including issues referring to relevant Iranian open source publications.

Iranian Response:

- With regard to the open source publications related to neutronic calculations, Iran explained that they were based on past and present thesis work for a doctoral degree. In April 2015, Iran showed this thesis (in Farsi) to the Agency for examination and provided the name of the doctoral candidate.
- With regard to the modelling of nuclear explosive device configurations, Iran stated that such studies had never taken place in Iran.
- With reference to the modelling studies on high explosives, in August 2015, Iran linked the applicability of hydrodynamic modelling to conventional military applications and stated that such applications were of no relevance to the IAEA's concern. Subsequently, Iran told the IAEA it was not in a position to discuss such applications, given the "strong conventional military dimensions associated with this work."

IAEA Assessment: Based on all the information available, the IAEA assessed that Iran conducted computer modelling of a nuclear explosive device prior to 2004 and between 2005 and 2009. The IAEA also highlighted similarities between the Iranian open source publications relating to high explosives modelling and information it had received from Member States, in terms of textual matches, and certain dimensional and other parameters used. The IAEA notes, however, the incomplete and fragmented nature of those calculations. The IAEA also notes the applicability of some hydrodynamic modelling to conventional military explosive devices.

⁹ To view additional imagery of this building please consult ISIS's Iran Imagery Brief Page: <http://isis-online.org/isis-reports/imagery/category/iran/>.

ISIS Analysis: *The IAEA concludes that Iran conducted computer modelling of a nuclear explosive device not only prior to 2004, but also between 2005 and 2009. It also points out that the modeling was incomplete and fragmentary in nature. Although it acknowledges that some of the work is applicable to conventional military explosives, that explanation does not explain all of these modelling efforts.*

Iran's cooperation on this issue was minimal, at best. Not only did it deny any activities related to modelling of nuclear explosive device configurations and use a conventional military application as a justification, it went one step further by refusing to discuss some applications with the IAEA because of a "strong conventional military dimensions associated with this work."

Overall, the IAEA broke no significant ground in gaining Iranian explanations for its work on modelling studies of various component arrangements specific to nuclear explosive configurations based on implosion technology.

9) Neutron Initiator

IAEA Concerns: The IAEA had received information indicating that "Iran considered practical measures to ensure the neutron initiation of an implosion-type nuclear explosive device by experimenting with materials and configurations which could generate neutrons under shock compression."

Before the implementation of the Roadmap, the IAEA had "assessed that one of the indicators of the manufacture of shock-driven neutron sources was weaker than previously considered." However, new information (prior to November 2011) "indicated that Iran may have continued engaging in such activities after 2004," and that, "from around 2006 onwards, Iran embarked on a four-year programme on the validation of shock-driven neutron source design, including through the use of non-nuclear material to avoid contamination."

Iranian Response: In August 2015, Iran submitted to the IAEA information on general neutron generation studies and identified relevant non-Iranian open source publications. It confirmed that research had been undertaken at an institution in Iran where plasma focus equipment was used to generate short neutron pulses and to develop and test suitable detectors. During a visit at an institution, Iran showed the IAEA neutron research capabilities. However, in September 2015, Iran stated that it had carried out no activity, practical or theoretical, related to shock-driven neutron sources.

IAEA Assessment: None stated.

ISIS Analysis: *Iran provided no cooperation or information to solve this PMD-related issue.*

In 2009, the Times of London provided ISIS with a Farsi language document that appeared to be a study on the development of uranium deuteride neutron initiators. The document apparently originated from the FEDAT (Field of Expansion and Deployment of Advanced Technologies), an organization under the Ministry of Defense which was part of Iran's "clandestine nuclear sector."¹⁰ While it was not possible at that time to confirm the broader significance of the document in relation to Iran's nuclear intentions in 2009, it contributed to concerns that Iran was continuing its military

¹⁰ See "New Document Reopens Question on Whether Iran's Nuclear Weaponization Work Continued Past 2003," ISIS Report, December 14, 2009, http://www.isisnucleariran.org/assets/pdf/Neutron_Initiator_14Dec2009.pdf

nuclear activities. However, based on the IAEA's efforts, the information in the document remains credible.

Much more Iranian cooperation is needed in order to determine whether such research continued beyond 2003. This issue remains unresolved.

10) Conducting a Test

IAEA Concerns: The IAEA had information indicating that between 2002 and 2003, "Iran may have planned and undertaken preparatory experimentation relevant to testing a nuclear explosive device." In addition, information indicated that Iran had "conducted a number of practical tests to see whether its EBW detonator firing component would function satisfactorily over a long distance between the firing point and a test device located down a deep shaft" and "from the alleged studies documentation," it was indicated that "Iran was in possession of documentation identified as being relevant to explosive safety arrangements inherent to the testing of a nuclear explosive device."

Iranian Response: None.

IAEA Assessment: The IAEA did not receive additional information on this area since the 2011 Annex.

ISIS Analysis: Iran provided no cooperation or information to resolve this PMD-related issue. This issue remains unresolved.

11) Integration into a Missile Delivery Vehicle

IAEA Concern: The IAEA received extensive amounts of information (within the alleged studies documentation) indicating that "in 2002-2003" Iran had engaged in "detailed project work to examine how to integrate a new spherical payload into the existing payload chamber of the re-entry vehicle for the Shahab 3 missile." The objective was to ensure that "the payload would survive the severe launch and re-entry environments, and remain functional until it reached its target." The information, which was mostly engineering studies, included practical, theoretical and design considerations, and took place in a number of workshops located near the old Tehran international airport, where components and mock-up model parts were made. Details of these efforts have been "recorded in reports."

IAEA Action: In the course of Roadmap implementation, the IAEA requested visits to the workshops. It had originally determined the locations of these workshops from analyzing the data in the acquired documentation. Iran denied its requests to visit these workshops in 2008.

Iranian Response: "On 30 September 2015, Iran showed the Agency a short video of each of the three workshops." Iran stated that two of the videos were filmed inside the two operating workshops. Iran stated that the third workshop was no longer operating and provided the IAEA with a video of it filmed from outside. "On 15 October 2015, the Agency was invited to visit the two operational workshops."

IAEA Assessment: "From these videos and visits, the Agency has verified that the workshops are those described in the alleged studies documentation. Further, the workshop's features and capabilities are consistent with those described in the alleged studies documentation. The Agency has verified the existence in Iran of two of the workshops referred to in the alleged studies documentation, but has not received any other information on this area since the 2011 Annex."

ISIS analysis: *The IAEA did not provide any information about the results of its visits to workshops relating to design work for the payload for a re-entry vehicle of a nuclear capable missile. However, the identification of these workshops is significant confirmation of the information in the acquired documentation and adds to the credibility of the documentation. By using this information, the IAEA successfully identified existing and non-declared facilities associated with the manufacture of a missile re-entry vehicle. Iran, however, needs to provide more information and cooperation, including in relation to the third workshop for which it only provided an external video and no access to inspectors.*

12) Fuzing, Arming, and Firing System

IAEA Concerns: The documents from the alleged studies documentation (mentioned above) also referred to the development of a prototype firing system for a heavy spherical payload (interpreted by the IAEA as a nuclear warhead) to be placed inside its Shahab 3 missile reentry vehicle. More specifically, the information indicated that “Iran considered a number of technical options for a fuzing, arming and firing system that would ensure that the new Shahab 3 missile spherical payload would remain safe until the re-entry vehicle reached its designated target, and that the payload would then function correctly.”

Iranian Response: None.

IAEA Assessment: It states only, “The Agency has not received additional information on this topic since the 2011 Annex.”

ISIS Analysis: *Iran provided no cooperation or information to solve this PMD-related issue. This issue remains unresolved.*

Conclusion

The IAEA’s report closes the investigation set forth by the Roadmap. It should not be considered a report that closes the overall PMD file. It is important that the investigation into many of the issues contained in the overall PMD file continues. To that end, the upcoming IAEA Board of Governors resolution should direct the IAEA to continue its investigation into the possible military dimensions of Iran’s nuclear program.

Whether Iran has actually closed down all of its nuclear weapons related activities, let alone dismantled and destroyed all aspects of that work, is uncertain given its poor level of cooperation with the IAEA, including the absence of any admission of its past efforts and denial of the facts and findings in the report. Some of its activities may continue in highly secret facilities or its nuclear weapon accomplishments are retained for later use. Absence of IAEA assurance about this, due to the lack of Iran’s full disclosure about its PMD activities, is further reason that the IAEA’s investigation must continue.

Lack of full knowledge of Iran’s nuclear weapons related activities will hamper verification efforts relating to the JCPOA and the IAEA’s effort to reach a broader conclusion. Sanctions relief under the JCPOA Implementation Day should be conditioned on some amount of additional cooperation from Iran on this investigation. Allowing the possible military dimensions investigation to close would set a poor nonproliferation precedent well into the future. We strongly urge the IAEA Board of Governors to direct a continuation of the investigation.