Analysis of IAEA Iran Verification and Monitoring Report - November 2022

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Background

- This report summarizes and assesses information in the International Atomic Energy Agency's (IAEA) quarterly report for November 10, 2022, *Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)*, including Iran's compliance with the Joint Comprehensive Plan of Action (JCPOA).

Findings

- Since the last IAEA report, Iran has surged the quantity of installed advanced centrifuges at its Natanz Fuel Enrichment Plant (FEP). It has added roughly 1740 new advanced centrifuges, consisting mostly of IR-2m and IR-4 centrifuges, making the current installed capacity over 50 percent larger than it was in August.
- This large increase in enrichment capacity poses immediate challenges. It reduces the time Iran would need to break out and produce several quantities of weapon-grade uranium (WGU) for nuclear weapons (see also below). This increase erodes further the value of a revived nuclear deal, since the JCPOA allows Iran to store advanced centrifuges, enabling Iran to further reduce breakout timelines for acquisition of weapon-grade uranium or more quickly build back its enrichment capacity in the event of another breakdown of the JCPOA.
- Iran's breakout time remains at zero because it has more than enough 60 percent enriched uranium, or highly enriched uranium (HEU), to directly fashion a nuclear explosive. Iran may prefer further enriching its 60 percent HEU up to 90 percent (or WGU) that is used in Iran's known nuclear weapons designs. In that case, it could produce enough for a nuclear weapon within a few weeks utilizing only a few advanced centrifuge cascades.
- Due to the current size of Iran's 60 percent, 20 percent, and 4.5 percent enriched uranium stocks, Iran can now produce enough WGU for four nuclear weapons in one month and make enough for a fifth weapon within the following month.
- Iran continues to learn important lessons in breaking out to nuclear weapons, including by experimenting with skipping typical enrichment steps as it enriches up to 60 percent uranium-235. It is starting from a level below 5 percent LEU and enriching directly to near

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60 percent in one step in two interconnected cascades, rather than using two steps in between, a slower process entailing the intermediate production of 20 percent enriched uranium. It has used temporary feed and withdrawal setups to produce HEU from near 20 percent enriched uranium feed. Iran is also enriching uranium in one IR-6 cascade modified to switch more easily from the production of near 5 percent enriched uranium to 20 percent enriched uranium. As such, Iran is experimenting with multi-step enrichment while seeking to shortcut the process.

- In essence, Iran has effectively broken out slowly by accumulating 60 percent enriched uranium. As of October 21, Iran had a stock of 62.3 kilograms (kg) (in uranium mass or U mass) of 60 percent enriched uranium in UF_6 form, or 92.2 kg (in hexafluoride mass or hex mass). Iran also has 2 kg of 60 percent HEU (U mass) in chemical forms other than UF_6.
- Iran keeps the majority (85 percent) of its stock of 60 percent HEU at the Esfahan site, where it maintains a capability to make enriched uranium metal. Although Iran has stated that it is using the HEU to make targets for irradiation in the Tehran Research Reactor (TRR), it has converted only a small fraction of its HEU into targets – about 2.1 kg – and has not converted more since March 2022.
- Iran's current production rate of 60 percent enriched uranium is 3.3 kg per month (U mass) centered on the use of two advanced production-scale centrifuge cascades, one containing IR-6 centrifuges and the other IR-4 centrifuges, and up to 5 percent low enriched uranium (LEU) as feed.
- For most of the reporting period, Iran was enriching uranium to 20 percent in both cascades of IR-6 centrifuges at the Fordow Fuel Enrichment Plant (FFEP). It is also operating six IR-1 cascades (three sets of two interconnected cascades) that were already producing 20 percent enriched uranium. For part of the reporting period, Iran was using the two IR-6 cascades to produce near 5 percent LEU from natural uranium to directly feed one of the three sets of IR-1 cascades for further enrichment up to 20 percent. The presence of advanced centrifuges at the FFEP enhances Iran's ability to break out using a declared but highly fortified facility.
- The average production rate of 20 percent enriched uranium at the FFEP was 26.8 kg (U mass) per month, or 39.6 kg (hex mass) per month.
- As of October 21, 2022, Iran had an IAEA-estimated stock of 386.49 kg of 20 percent enriched uranium (U mass and in the form of UF_6), equivalent to 571.73 kg (hex mass). Iran also has a stock of 30.8 kg (U mass) of 20 percent uranium in other chemical forms.
- At the Natanz FEP, Iran added up to ten cascades of advanced centrifuges during the last reporting period, for a total installed of 36 cascades of IR-1 centrifuges, 15 cascades of IR-2m centrifuges (up by nine), three cascades of IR-4 centrifuges (up by one), and three cascades of IR-6 centrifuges. Iran further announced it is planning to install an additional three IR-4 cascades and 18 cascades of a yet-unspecified type of centrifuge.
- Iran's current, total operating enrichment capability is estimated to be about 16,300 separative work units (SWU) per year, slightly lower than the 16,600 SWU per year at the end of the last reporting period, due to fewer IR-1 centrifuges enriching uranium at the FEP. As of the end of this reporting period, Iran was not yet using its fully installed enrichment capacity at the FEP, which, as noted above, has grown substantially.

- Average daily production of near 5 percent LEU at the FEP doubled, and for the first time since early 2021, Iran's near 5 percent LEU stock increased from one reporting period to the next, reaching 1030 kg (U mass).
- Despite the increase during this reporting period in the amount of uranium enriched between two and five percent, Iran has not prioritized its stockpiling during the last two years, at odds with its contention that its primary goal is to accumulate 4-5 percent enriched uranium for use in nuclear power reactor fuel. Instead, this stock has been used extensively to produce near 20 percent and 60 percent enriched uranium, far beyond any of Iran's civilian needs.
- Iran's overall reported stockpile of LEU decreased, due to a decrease in Iran's stock of up to 2 percent enriched uranium, much of which was used as feed in the production of near 5 percent LEU.
- The IAEA reports that it faces serious challenges in re-establishing continuity of knowledge about Iran's activities under a revived JCPOA, such as production of centrifuges and heavy water, due Iran's decision in February 2021 to deny the IAEA access to data from key monitoring and surveillance equipment. The IAEA details the rather tough remedial measures it will need to take in order to re-establish a centrifuge manufacturing baseline, including access to extensive records.
- The monitoring situation has been severely worsened by Iran's decision in June 2022 to remove all JCPOA-related monitoring and surveillance equipment, including video cameras. For more than five months, the IAEA has not had equipment installed to monitor Iran's activities at advanced centrifuge manufacturing sites, which have multiplied this year. It faces an additional surveillance gap at the former TESA Karaj centrifuge manufacturing facility from June 2021 until January 2022, when cameras were destroyed or removed following an attack on the facility. The absence of monitoring and surveillance equipment, particularly since June 2022, has caused the IAEA to doubt its ability to ascertain whether Iran has diverted or may divert advanced centrifuges.
- A risk is that Iran will accumulate a secret stock of advanced centrifuges, deployable in the future at a clandestine enrichment plant or during a breakout at declared sites. Another risk is that Iran will establish additional centrifuge manufacturing sites unknown to the IAEA. Iran is fully capable of moving manufacturing equipment to new undeclared sites, further complicating any future verification effort and contributing uncertainty about where Iran manufactures centrifuges.
- The IAEA concludes that "Iran's decision to remove all of the Agency's equipment previously installed in Iran for surveillance and monitoring activities in relation to the JCPOA has also had detrimental implications for the Agency's ability to provide assurance of the peaceful nature of Iran's nuclear programme."
- Combined with Iran's refusal to resolve outstanding safeguards violations, the IAEA has a significantly reduced ability to monitor Iran's complex and growing nuclear program, which notably has unresolved nuclear weapons dimensions. The IAEA's ability to detect diversion of nuclear materials, equipment, and other capabilities to undeclared facilities remains greatly diminished.

Part 1: Enriched Uranium Stocks

At the Natanz FEP, Iran produced approximately 1248.4 kg of UF_6 enriched up to 5 percent U-235 during the reporting period, which spanned 61 days from August 21, 2022 to October 21, 2022. The report discusses this amount as kilograms of UF_6 in units of UF_6 mass, which the authors refer to as hex mass. The total uranium mass would be 843.9 kilograms, for a monthly average production rate of 415 kg U mass and a daily average production rate of 13.8 kg U mass.[2] These average production rates doubled from 202.8 kg U mass per month or 6.8 kg U mass per day during the previous reporting period, consistent with the large amount of 2 percent LEU reportedly used as feed instead of natural uranium, which allows for the quicker production of 5 percent LEU. Of the 2011.4 kg near 2 percent LEU (hex mass) used as feed, 151.6 kg (hex mass) were dumped, representing 7.5 percent of the feed.

At the FFEP, from August 21, 2022 to October 21, 2022, Iran produced 80.7 kg of UF_6 (hex mass) enriched up to 20 percent enriched uranium, or 54.6 kg U mass. It produced 513.8 kg of UF_6 hex mass (or 347.3 kg U mass) of up to 2 percent enriched uranium in tails. The daily average production rate of 20 percent enriched uranium at the FFEP decreased slightly to 1.3 kg (hex mass) or 0.89 kg (U mass) from the previous reporting period, where it was 1.4 kg (hex mass) or 0.96 kg (U mass). At this rate, Iran could produce 39.6 kg of near 20 percent enriched uranium per month (hex mass) or 26.8 kg (U mass) per month. Annually, Iran could produce 483 kg (hex mass) or 326 kg (U mass).

At the Pilot Fuel Enrichment Plant (PFEP), Iran produced 2 percent enriched uranium, up to 5 percent enriched uranium, and up to 60 percent enriched uranium stock during the reporting period. Between August 21 and October 21, 2022, the PFEP produced 9.9 kg (hex mass) of near 60 percent enriched uranium (equivalent to 6.7 kg (U mass); 120.9 kg (hex mass) of up to 5 percent LEU (81.7 kg U mass); and 345.4 kg (hex mass) of uranium enriched up to 2 percent U-235 (233.4 kg U mass).

The 60 percent enriched uranium production rate during this reporting period was 9.9 kg (hex mass) or 6.7 kg (U mass) over 61 days, resulting in a monthly average production rate of 4.9 kg (hex mass) or 3.3 kg (U mass), or a daily average production rate of 0.16 kg (hex mass) or 0.11 kg (U mass). This rate is slightly below the previous reporting period's monthly average production rate, which was 5.7 kg (hex mass) or 3.9 kg (U mass). Annually, using only the two advanced production-scale centrifuge cascades at the PFEP, Iran could produce 59.2 kg (hex mass) or 40 kg (U mass) of 60 percent enriched uranium.

Of the 2 percent LEU, Iran produced 138.6 kg (hex mass) (or 93.7 kg U mass) in PFEP lines 1, 2, and 3 and 206.8 kilograms (hex mass) (or 139.7 kg U mass) enriched up to 2 percent as tails in line 5.

[2] That production values are reported in uranium hexafluoride mass can be discerned only by comparing the production values to the differences in stockpile from one reporting period to the next. The differences in stockpile are consistently two-thirds of the given produced quantity, showing that the former is in uranium mass and the latter is in uranium hexafluoride mass.

Due to reduced monitoring measures, the IAEA can only verify the amount of LEU removed from the process as a product and not the amount that is still in process, but it is able to reliably estimate total amounts.

Estimates of additional amounts of LEU in oxides and intermediate products, fuel assemblies and rods, and scrap, add up to 350.6 kg (U mass), an amount larger than during the previous reporting period. The report specifies that out of the 350.6 kg enriched to unspecified levels (U mass), 30.8 kg are up to 20 percent LEU and 2 kg are up to 60 percent HEU. Of the 30.8 kg (U mass) near 20 percent enriched uranium, 28.9 kg (U mass) are specified to be in the form of fuel assemblies. A footnote indicates that it is up by 1.1 kg (U mass) from the last reporting period due to additional fabrication of plates and mini-plates. Thus, it appears that 2.7 kg (U mass) of near 20 percent enriched uranium contained in partially fabricated TRR fuel items imported from Russia during this reporting period are not added to this 20 percent sub-stock and therefore are not included in the overall near 20 percent enriched uranium stock.

Of its near 5 percent LEU stock, Iran fed 590.7 kg hex mass (or 399.3 kg U mass) into the cascades at Fordow, for an average feed rate of about 9.7 kg per day hex mass, or 6.5 kg U mass, similar to the previous reporting period. This feed rate is consistent with the IAEA reporting – and similar to the previous reporting period – that for much of the time, Iran was feeding all six IR-1 cascades and both IR-6 cascades with 5 percent enriched uranium to make 20 percent, and for some of the reporting period, fed the IR-6 cascades with natural uranium to produce the direct feed for one tandem IR-1 cascade. Iran dumped 27.2 kg near 5 percent LEU feed at the FFEP (hex mass), or about 18.4 kg in uranium mass, almost 5 percent of the total feed. It also fed 337.6 kg of near 5 percent hex mass (228 kg U mass) into PFEP R&D lines 4, 5, and 6, for a daily average feed rate of 5.5 kg (hex mass) or 3.7 kg U mass per day, less than during the previous reporting period.
Based on this information, Iran's new stockpile of near 5 percent LEU in uranium mass should be the sum of 713.9 kg U mass from the last reporting period, 843.9 kg from the FEP, and 81.7 kg from the PFEP, with the feed of 627.3 kg subtracted, resulting in 1012.2 kg. Adding back the 18.4 kg (U mass) feed dumped at the FFEP, this total becomes 1030.9 kg, close to the 1029.9 kg U mass of near 5 percent LEU in UF_6 form that the IAEA reported, with the caveat that the IAEA did not report how much near 5 percent LEU exists in forms other than UF_6.

The net overall enriched uranium stock, including all levels of enrichment and all chemical forms, decreased by 267.2 kg from 3940.9 kg U mass to 3673.7 kg (see Table 1), a notable change from previous reporting periods' increases. This appears to reflect Iran's priority to build up its higher enriched uranium stocks rather than its 2 percent enriched uranium stock. For the first time since February 2021, the near 5 percent LEU stock in the form of UF_6 increased by 316 kg, while Iran kept its production of 20 percent and 60 percent enriched uranium steady; both processes use large amounts of 5 percent LEU as feedstock. Iran's near 2 percent LEU stock decreased by 675.4 kg from 2519.9 kg to 1844.5 kg (U mass). The near 20 percent enriched uranium stock increased by 54.5 kg, from 331.9 kg to 386.4 kg (U mass), and the near 60 percent enriched uranium stock increased by 6.7 kg from 55.6 kg to 62.3 (U mass).

Iran continued to use a combination of R&D lines 4, 5, and 6 to feed 5 percent LEU into the interconnected cascades in lines 4 and 6 to produce 60 percent enriched uranium, while feeding the tails into line 5 to produce 5 percent LEU. During this reporting period, spanning August 21 to October 21, 2022, of the 337.6 kg (hex mass) of 5 percent LEU fed into lines 4 and 6, Iran turned 9.9 kg (2.9 percent) into 60 percent enriched uranium, 120.9 kg back into 5 percent enriched uranium (35.8 percent), and 206.8 kg (61.2 percent) remained as tails enriched up to 2 percent.

Table 1. Enriched Uranium Quantities,* including less than 5 %, up to 20 %, and up to 60 % enriched uranium (all quantities in uranium mass)

Chemical Form	November 6, 2021	March 3, 2022	May 15, 2022	August 21, 2022	October 22, 2022
UF_6 (kg)	2313.4	2883.2	3809.3	3621.3	3323.1
Uranium oxides and their intermediate products (kg)	125.4	249.5	238.9	252.3	241.6
Uranium in fuel assemblies and rods (kg)	35.4	37.8	48.1	48.2	49.3
Uranium in liquid and solid scrap (kg)	15.5	26.6	30.6	19.1	59.7
Enrichment Level Subtotals (in UF_6 form)					
Uranium enriched up to 5 percent (kg) but more than 2 percent	1622.3	1277.9	1055.9	713.9	1029.9
Uranium enriched up to 2 percent (kg)	559.6	1390	2154.4	2519.9	1844.5
Uranium enriched up to 20 percent (kg)	113.8	182.1	238.4	331.9	386.4
Uranium enriched up to 60 percent (kg)	17.7	33.2	43.1	55.6	62.3
Enrichment Subtotals (not in UF_6 form)					
Uranium in chemical forms other than UF_6 with unspecified enrichment level (kg) (including 30.8 kg up to 20 % LEU and 2 kg up to 60 % HEU)	176.3	313.9	317.6	319.6	350.6
Totals of Enriched Uranium in UF_6, <5 % (kg)	2181.9	2667.9	3210.3	3233.8	2874.4
Totals of Enriched Uranium in UF_6, including near 20 % and near 60 % (kg)	2313.4	2883.2	3491.8	3621.3	3323.1
Totals of Enriched Uranium in all chemical forms , <5 % <20 % and <60 % enriched	**2489.7**	**3197.1**	**3809.4**	**3940.9**	**3673.7**

*These totals do not include undisclosed stocks of enriched uranium exempted by the JCPOA Joint Commission.

Part 2: Enrichment capacity

Natanz Fuel Enrichment Plant

Installed Centrifuges. As of November 1, 2022, Iran had installed at the Natanz FEP 36 cascades of IR-1 centrifuges, 15 cascades of IR-2m centrifuges, three cascades of IR-4 centrifuges, and three cascades of IR-6 centrifuges. Since the last IAEA reporting in August 2022, Iran has installed nine IR-2m centrifuge cascades and completed installation of the third cascade of IR-4 centrifuges. It now has an estimated total of 3654 advanced centrifuges installed at the FEP, of which 2610 are IR-2m centrifuges.

These values represent a tremendous boost in the number of installed advanced centrifuge cascades compared to the previous reporting period.[3] This impacts the breakout calculation discussed below and would also affect the breakout timelines under a revived JCPOA, because under the deal, Iran can mothball its installed centrifuges, allowing them to be quickly redeployed in a breakout.

Iran has plans to install an additional three cascades of IR-4 centrifuges, but their installation had yet to begin. Iran also announced plans in August 2022 to install the "infrastructure" for up to 18 additional cascades of an unspecified type, and as of November 1 it had started installing sub-headers for six of the 18 cascades. As of November 1, 2022, the IAEA indicated that installation of sub-headers for six of the 18 cascades had begun.

The IAEA also reported that four IR-1 cascades out of the 30 IR-1 centrifuge cascades installed under the JCPOA were reconfigured to include 10 additional centrifuges.

Enriching Centrifuges. As of November 1, 2022, the IAEA reports that in total, 34 cascades of IR-1 centrifuges, six cascades of IR-2m centrifuges, two cascades of IR-4 centrifuges, and three cascades of IR-6 centrifuges were being fed with natural UF_6 and UF_6 enriched up to 2 percent to produce UF_6 enriched up to 5 percent. During the previous reporting period, 36 IR-1 cascades, six IR-2m cascades, two IR-4 cascades, and three IR-6 cascades were being fed with natural UF_6. The quantity of IR-1 or IR-2m centrifuges Iran withdrew from JCPOA-mandated storage is not available for this reporting period because of Iran's refusal since February 2021 to provide the IAEA with access to the data and recordings collected by agency equipment, and since June 2022, to continue collecting the data. In general, it is unclear whether the newly installed IR-1 and IR-2m cascades contain newly produced machines or those from storage.

[3] David Albright, Sarah Burkhard, and Spencer Faragasso, "Iran's Vastly Increased Advanced Centrifuge Deployment at Natanz Underground Facility," *Institute for Science and International Security*, October 25, 2022, https://isis-online.org/isis-reports/detail/irans-vastly-increased-advanced-centrifuge-deployment-at-natanz-underground.

Fordow Fuel Enrichment Plant

At the FFEP, Iran currently has 1044 IR-1 centrifuges installed in three sets of interconnected cascades, two cascades of 166 IR-6 centrifuges, and one IR-1 centrifuge in a separate position. Iran has not announced any new plans to deploy additional centrifuges at the FFEP.

Iran continues to use the three sets of two interconnected IR-1 cascades to produce 20 percent enriched uranium from up to 5 percent LEU. For part of the reporting period, the two IR-6 centrifuge cascades also produced 20 percent enriched uranium from 5 percent LEU. The IAEA confirmed that on October 2, 2022, Iran switched methods and has been using the two cascades of IR-6 centrifuges to produce UF_6 enriched up to 5 percent from natural uranium feed, which is then fed into one set of IR-1 cascades to produce UF_6 enriched up to 20 percent enriched uranium. According to the report, both IR-6 cascades switched methods, although one of the IR-6 cascades has a fixed configuration and the other one has modified subheaders, which eases changes in the cascade's operational configuration.

The near five percent LEU produced by the IR-6 centrifuges could also be collected using a separate product withdrawal line. On August 31, Iran provided the IAEA with an updated DIQ, indicating it planned to install a new product withdrawal line to allow for separate collection of 5 percent LEU made by the two IR-6 cascades and being fed with natural UF_6. On September 5, the IAEA verified that the new product withdrawal line had been installed. However, the November 2022 report does not report usage of the product withdrawal line and does not report any accumulation of 5 percent LEU at the FFEP.

The one IR-1 centrifuge remained installed in a separate position and was not being fed with uranium hexafluoride.

Pilot Fuel Enrichment Plant

Since the previous report, Iran has not progressed with plans to transfer its enrichment research and development activities to a segregated area of Building A1000 at the FEP, to create a new area of the PFEP. On November 1, the IAEA verified that in preparation for the planned installation of a new feed and withdrawal area for the new enrichment R&D activities, Iran continued to remove infrastructure and equipment previously used for the same purpose at the FEP.

Iran earlier completed the installation of sub-headers for 18 cascades in this new area, a threefold increase from the six lines in the above ground PFEP. On November 2, 2022, the IAEA verified that Iran had made no progress in the installation of infrastructure for these 18 cascades during the reporting period. It reported similar findings in previous and current reports. The report does not provide an anticipated start date for this new area. Given its three-fold greater size, one must ask if this area could be devoted to production-scale enrichment in case of a surge in enriched uranium production or a breakout.

60 Percent Enriched Uranium Production in Lines 4, 5, and 6. The IAEA reported no changes to the deployment of centrifuges in production lines 4, 5, and 6. Iran continued to use lines 4, 5, and 6 for the production of 60 percent enriched uranium and re-enrichment of tails to 5 percent, principally in a variety of cascade arrangements of IR-4 and IR-6 centrifuges. Since 60 percent production started on April 17, 2021, Iran has changed the mode of production several times, several of which were described in previous IAEA reports.

On November 2, 2022, the IAEA verified that Iran was continuing to feed up to 5 percent LEU into the two interconnected cascades in lines 4 and 6, comprising up to 164 IR-4 and up to 164 IR-6 centrifuges, respectively, and producing up to 60 percent enriched uranium. The tails from these two cascades were fed into cascades of IR-5 and IR-6s centrifuges in line 5 to produce up to 5 percent enriched uranium. The assay of the tails is likely about 2-3 percent.

The IR-4 cascade in line 4 and the IR-6 cascade in line 6 have similar estimated production-scale enrichment outputs of about 600 SWU per year each, where the enrichment outputs for these two centrifuge types in a production-scale cascade are taken from separate Institute reports.[4] The IR-6 centrifuge cascade has a production-scale enrichment output that is lower than expected. The two lines together have an estimated output of 1200 SWU per year, or the equivalent of about 1330 IR-1 centrifuges.

Lines 2 and 3. On November 2, 2022, the IAEA verified that lines 2 and 3 continued to accumulate uranium enriched up to 2 percent through feeding of natural UF_6. The IAEA verified that Iran had been using for this purpose small and intermediate cascades of up to: 13 IR-2m centrifuges; 19 IR-4 centrifuges and six IR-4 centrifuges; six IR-5 centrifuges; ten IR-6 centrifuges, and 19 IR-6 centrifuges. Iran has removed the ten IR-s centrifuges that had been installed in lines 2 and 3 since at least June 2020. The IR-s is a shorter centrifuge with a relatively high theoretical enrichment output, which suggests that it uses a carbon fiber rotor tube and is designed to operate at higher speeds than other Iranian advanced centrifuges, as discussed in an earlier Institute report.[5] Perhaps, Iran acquired enough information from the multi-year testing period or just as likely, a problem was encountered. Iran has had difficulty operating centrifuges at high speeds and the centrifuges may have broken and not been replaced.

The following single centrifuges were being tested with natural UF_6 but were not accumulating enriched uranium: five IR-2m centrifuges, two IR-4 centrifuges; three IR-5 centrifuges; one IR-6

[4] David Albright, Sarah Burkhard, and Spencer Faragasso, "A Comprehensive Survey of Iran's Advanced Centrifuges," *Institute for Science and International Security*, December 2, 2021, https://isis-online.org/isis-reports/detail/a-comprehensive-survey-of-irans-advanced-centrifuges. The enrichment output for the IR-6 is further adjusted based on: David Albright and Sarah Burkhard, "The IR-6 Centrifuge Needs Further Development," *Institute for Science and International Security,* September 9, 2022, https://isis-online.org/isis-reports/detail/the-ir-6-centrifuge-needs-further-development/

[5] David Albright, Sarah Burkhard, and Spencer Faragasso, "A Comprehensive Survey of Iran's Advanced Centrifuges," *Institute for Science and International Security*, December 2, 2021, https://isis-online.org/isis-reports/detail/a-comprehensive-survey-of-irans-advanced-centrifuges .

centrifuge; one IR-6s centrifuge; one IR-7 centrifuge; one IR-8 centrifuge; one IR-8B centrifuge; and one IR-9 centrifuge.

In 2021, Iran implemented a new mode of operation in line 2, feeding either 5 or near 20 percent enriched uranium into single advanced centrifuges, intermediate cascades of 10 advanced centrifuges, and intermediate cascades of 20 advanced centrifuges. For part of last year, only near 20 percent enriched uranium was used as feed, marking the first time Iran started feeding a cascade with uranium enriched higher than 5 percent at any of its enrichment plants. Although the product and tails streams were re-combined, with no product collected, the experience gained from this procedure was likely important, particularly in the production of HEU in key advanced centrifuges when using near 20 percent enriched uranium feedstock. It is possible, and perhaps the objective, that Iran achieved an enrichment level of 90 percent and measured it, prior to remixing with the tails, a measurement likely unavailable to the IAEA. In any case, Iran gained irreversible knowledge in the setup and use of feed equipment designed for smaller quantities and higher enriched uranium levels.

The IAEA reported that as of November 17, 2021, Iran had stopped feeding near 20 percent enriched uranium into line 2. It added that Iran had removed the associated temporary feed and withdrawal setup, a setup likely required because of the smaller quantities of enriched uranium and concerns about criticality of HEU product. The IAEA did not state where this setup is stored or how many such setups exist. These setups could be critically important in a breakout and allow for a more rapid conversion from producing LEU to producing HEU. As such, their use in line 2 represents the use of additional equipment and experience gained relevant to breakout.

Line 1. Iran was feeding natural UF_6 into an intermediate cascade of 18 IR-1 centrifuges and an intermediate cascade of 53 IR-2m centrifuges in line 1 to produce uranium enriched up to 2 percent U-235.

Capacity of Centrifuges Enriching Uranium

Table 2 lists the estimated enrichment capacity by facility for those centrifuges that are currently enriching (not including installed but not yet enriching), leading to a total of 16,270 SWU per year, or the equivalent of 18,078 IR-1 centrifuges. This total number of enriching centrifuges is slightly lower than the previous reporting period's 16,586 SWU per year, because Iran was not enriching uranium in two IR-1 cascades at the FEP.

In contrast, including the installed but not yet enriching centrifuges results in an enrichment capacity of 24,530 SWU per year.

Of note, centrifuge quantities for PFEP line 5 are taken from the November 2021 report, as they are not specified in more recent reports. The total enrichment capacity used in breakout calculations is different since it also includes currently installed centrifuges. This difference is especially significant at the moment, because Iran has ten additional advanced centrifuge cascades installed, which it was not using to enrich during the latest reporting period, but these increase

Iran's installed enrichment capacity dramatically. Also, the advanced centrifuges in the PFEP, except production-scale advanced cascades, would likely not contribute meaningfully to the quick production of enough WGU for a nuclear explosive, starting with up to five percent or near 20 percent enriched uranium.

Table 2. Quantity of enriching centrifuges and enrichment capacity

	Number of enriching centrifuges	Enrichment capacity in SWU/yr	IR-1 equivalent
Natanz	7668	12160	13511
Fordow	1376	2135	2372
Natanz PFEP*	531	1976	2195
Lines 2 & 3	See text		
Lines 1, 4, 5, 6	See text		
Total	**9575**	**16270**	**18078**

*The values for lines 1, 2, 3, and 5 of the PFEP are rough estimates based on the use of estimated and measured values for the separative output of these centrifuges in cascades, as drawn from IAEA and Iranian information.

Practicing Breakout by Producing Highly Enriched Uranium

During this reporting period, Iran continued to produce 60 percent enriched uranium, or HEU, and its stock amounts to well over one significant quantity of HEU. Thus, Iran continues to have enough nuclear explosive material to have assurance it can directly fashion a nuclear explosive device.

Sixty percent enrichment is a level associated with a key step in the traditional A.Q. Khan stepwise process of climbing from natural uranium to 90 percent enriched uranium, or WGU. But 60 percent enriched uranium can be used directly in nuclear weapons. About 40 kg (U mass) is more than enough to make a nuclear explosive, compared to 25 kg (U mass) of 90 percent enriched uranium the Institute uses as sufficient for Iran to manufacture a nuclear explosive.

Moreover, the way Iran has proceeded to enrich up to 60 percent in one step, starting from near 5 percent enriched material, is innovative, suggesting Iran gained valuable experience in producing HEU, and by extension, even WGU. It is practicing breakout under a civilian cover and also learning to reduce the number of steps that it would need to go from natural uranium to WGU.

Iran may have applied this one-step process to the production of small quantities of WGU from near 20 percent enriched uranium, despite not collecting this product. In November 2021, Iran fed an unspecified amount of its near 20 percent enriched uranium stock into a variety of advanced centrifuges at the PFEP. Since Iran was not accumulating enriched uranium, and was instead combining the product and tails, the levels of enriched uranium achieved are not included in the report and may also not be known to the IAEA. The levels reached may include 90 percent, or weapon-grade.

Although Iran's process of creating 60 percent enriched uranium is far from ideal, the Iranian process has demonstrated certain advantages, including being within its technical reach and recycling the tails down to the level of near two percent enriched or even natural uranium, while producing 5, 20, and 60 percent enriched uranium. More importantly, it is practicing multi-step enrichment arrangements that are key to breaking out. Moreover, the Iranians are experimenting with transferring enriched UF_6 as a gas from one step to the next, instead of having to solidify the intermediate product gas and turn it back into a gas in the next step. This experimentation continues at Fordow with the production of near 20 percent enriched uranium from natural uranium, utilizing IR-6 cascades to make the less than 5 percent enriched uranium where a tandem pair of IR-1 cascades receive the product gas from the IR-6 cascades and enrich it further to near 20 percent enriched uranium. All this experimentation is leading Iran to be more capable of breaking out, if the leadership orders production of WGU or moves toward the construction of nuclear weapons. Meanwhile, Iran continues to accumulate 60 percent HEU, which can be used directly in a nuclear explosive or further enriched quickly to weapon-grade in relatively few advanced centrifuges. After all, 60 percent enriched uranium is 99 percent of the way to WGU.

Transfer of 60 Percent HEU from Natanz to Esfahan

During previous reporting periods, Iran transferred 60 percent HEU hexafluoride from the Natanz site to the Fuel Plate Fabrication Plant (FPFP), which it declared to be for the production of HEU targets for the TRR. In January 2022, Iran transferred 23.3 kg (U mass) of 60 percent material to the FPFP. On April 19, 2022, the IAEA verified the receipt of an additional quantity of 15.3 kg (U mass) 60 percent HEU, bringing the total to 38.6 kg (U mass). On September 11, 2022, the IAEA verified the receipt of 16.5 kg (U mass) of 60 percent enriched uranium, bringing the total to 55.1 kg. On October 24, 2022, the IAEA verified the presence of a total of 53 kg (U mass) 60 percent HEU at the "storage area" of FPFP. The difference of about 2 kg matches the amount of 60 percent HEU reported to be in forms other than uranium hexafluoride, specified to contain 1.6 kg (U mass) in mini-plates (produced and irradiated in the TRR in March 2022) and 0.4 kg (U mass) in liquid and solid scrap. Given a total stock of 62.3 kg (U mass), about 85 percent of this stock was at Esfahan at the end of the last reporting period. Given that Esfahan holds Iran's capabilities to turn enriched uranium hexafluoride into metal, this transfer raises additional proliferation concerns.[6] No additional transfer or production of mini-plates (targets) has been reported since.

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[6] David Albright, Sarah Burkhard, and Andrea Stricker, "Analysis of IAEA Iran Verification and Monitoring Report - May 2022," *Institute for Science and International Security*, June 6, 2022, https://isis-online.org/isis-reports/detail/analysis-of-iaea-iran-verification-and-monitoring-report-may-2022/8.

Part 3: Current Breakout Estimates

During this reporting period, Iran's installed centrifuge capacity has grown substantially due to the installation of additional IR-2m cascades. This shortens breakout timelines, in particular speeding up the production of successive quantities of weapon-grade uranium, all of which depends on initial installed centrifuge enrichment capacity as well as enriched uranium stocks.

Iran's breakout timeline remains at zero. It has significantly more than enough 60 percent enriched uranium or HEU to be assured it could directly fashion a nuclear explosive.[7] If Iran wanted to further enrich its 60 percent HEU up to weapon-grade, it could do so within weeks utilizing only a few of its advanced centrifuge cascades.[8]

In parallel to further enriching 60 percent material, Iran could further enrich its near 20 percent enriched uranium stock to weapon-grade uranium. Using the Institute breakout calculator, and assuming a setup time of two weeks, Iran is estimated to be able to accumulate, in one month, enough weapon-grade uranium for four nuclear weapons from these two enriched uranium feed stocks.

A few weeks later, about 1.7 months after starting breakout, Iran could accumulate enough additional weapons-grade uranium from its feedstock of less than five and above two percent (taken as 4.5 percent) enriched uranium for a fifth quantity of weapon-grade uranium. Iran could produce enough WGU for a sixth nuclear weapon by the end of the third month.

When Iran ended its crash nuclear weapons program in 2003, called the Amad Plan, its biggest bottleneck was its lack of WGU; it still needed at least a few more years to accumulate enough WGU for a nuclear weapon.[9] Under intense international pressure, Iran decided in 2003 to downsize and better camouflage its nuclear weapons effort, while pushing to establish a robust capability to enrich uranium. Today, that decision has borne fruit. While it could only aim for enough nuclear explosive material for five nuclear weapons in 2003, today it can have enough for those five weapons in less than two months. With its residual and covert nuclear weaponization capabilities, Iran could test a nuclear explosive underground or deploy a crude nuclear weapon within several months – certainly within six months – and deploy nuclear weapons on ballistic missiles within a year or two.

The Institute's breakout calculator is used to estimate the worst-case breakout time, as in previous reports. The methodology is described in earlier Institute reports. The production of WGU from

[7] According to the IAEA, Iran has 62.3 kg of 60 percent enriched uranium (uranium mass) in the form of uranium hexafluoride, more than one significant quantity, which the IAEA defines as the "approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive cannot be excluded."

[8] For background, see David Albright and Sarah Burkhard: "Entering Dangerous, Uncharted Waters: Iran's 60 Percent Highly Enriched Uranium," *Institute for Science and International Security,* April 11, 2022, https://isis-online.org/isis-reports/detail/entering-uncharted-waters-irans-60-percent-highly-enriched-uranium.

[9] David Albright with Sarah Burkhard and the Good ISIS Team, *Iran's Perilous Pursuit of Nuclear Weapons* (Washington, DC: Institute for Science and International Security Press, 2021).

the 4.5, 20, and 60 percent enriched uranium stocks significantly reduces the timeline for the production of multiple quantities of 25 kg of WGU (U mass). The authors' benchmark reflects a reasonable, assured quantity of WGU for a variety of nuclear weapon designs available to Iran and the creation of a pipeline for production of multiple WGU cores. As before, the total enrichment contribution from small cascades of advanced centrifuges installed at the PFEP is not included, as their use in a breakout would be complicated and likely would not contribute significantly to reducing breakout timelines. However, the production-scale cascades of IR-4 and IR-6 centrifuges in lines 4 and 6, respectively, are an exception. In the breakout calculations, as discussed above, Iran's stock of 60 percent enriched uranium is further enriched to weapon-grade in these two cascades, which are already modified to produce highly enriched uranium. These two cascades are then ignored in any further effort to enrich five or near 20 percent enriched uranium to WGU after the 60 percent HEU stock is depleted, estimated as requiring less than one month. Any production of WGU in the PFEP would proceed in parallel to the further, stepwise enrichment of 4.5 percent and near 20 percent enriched uranium to WGU at the FEP and FFEP. Stocks of less than 2 percent enriched uranium are not used, since to do so would require additional modifications of the cascades to handle lower enrichments, likely significantly slowing or contributing only slightly, rather than speeding up, breakout timelines. Lastly, only enriched uranium hexafluoride stocks are used; Iran's chemical conversion of other stocks is assessed as too time consuming, and involving too little material, to significantly affect the breakout estimate.

The breakout timelines are credible, worst-case estimates, likely representing the shortest timelines to breakout, with longer timelines possible. Uncertainties include ongoing ones, such as the exact enrichment level of the uranium stock enriched between 2 and 5 percent and operational efficiencies of the advanced centrifuges, particularly the IR-4 and IR-6 cascades, although the calculations use a significantly lower estimated enrichment output for the IR-6 cascades than expected.

Part 4: Centrifuge Assembly, Manufacturing, Mechanical Testing, and Component Inventory

Iran has augmented centrifuge manufacturing and mechanical testing activities in violation of the JCPOA, while halting IAEA monitoring. Without any monitoring in place, the IAEA is uncertain about the total quantities of centrifuges Iran has manufactured during the last five months (see Part 7).

Since February 2021, Iran has not provided declarations about its production and inventory of centrifuge rotor tubes, bellows, and rotor assemblies or allowed IAEA verification, as specified in the JCPOA (see also Part 7). The IAEA has also been unable to access the data and recordings collected by its surveillance equipment up until June 2022, installed to monitor the manufacturing of rotor tubes and bellows, and consequently has had no ability to take inventory. However, it has hope that it will eventually gain access to those data.

From June 9 to 11, 2022, Iran removed all such surveillance equipment, meaning that centrifuges manufactured after these dates were unmonitored, causing a high degree of uncertainty about the quantities manufactured, the location of their manufacture, and their current location. In particular, according to the November 2022 IAEA report, since June, the IAEA has been "unable to verify whether Iran has produced any IR-1 centrifuges, including IR-1 centrifuge rotor tubes, bellows or rotor assemblies to replace those that have been damaged or failed and has no information on the inventory of rotor tubes, bellows and rotor assemblies relevant to any type of Iranian centrifuge." Particularly concerning, the IAEA does not know how many advanced centrifuges Iran has made in the last five months, beyond those deployed at the three centrifuge plants.

There are indications that Iran has increased its production of centrifuges during this reporting period. On August 29, 2022, at Iran's request, the IAEA removed seals that had been attached in December 2021 to a flow-forming machine that had been used for the manufacture of centrifuge components in the past. This machine may have been at the TESA Karaj centrifuge manufacturing facility and subsequently moved to a new site due to that plant's closure.

A risk is that Iran will accumulate a secret stock of advanced centrifuges, deployable in the future at a clandestine enrichment plant or during a breakout at declared sites. Another risk is that Iran will establish additional centrifuge manufacturing sites unknown to the IAEA. During the first six months of 2022, Iran established two new sites for manufacturing rotor tubes and bellows at Esfahan and Natanz, both currently without any monitoring equipment. Iran is fully capable of moving manufacturing equipment to new undeclared sites, further complicating any future verification effort and contributing to uncertainty about where Iran manufactures centrifuges.

As noted in earlier reports, Iran continues building a larger, permanent advanced centrifuge assembly facility under a nearby mountain to the south of the Natanz enrichment plants.[10] The facility will replace the above-ground Iran Centrifuge Assembly Center (ICAC), destroyed in an attack in July 2020. The Institute assesses that this tunnel complex is likely to be more deeply buried than the Fordow enrichment plant and contain significant floor space.[11] However, construction progress has been slower than planned, and the facility is not expected to open this year or possibly even next year.

Part 5: Enriched uranium metal production remains halted

During the last four reporting periods, Iran has not produced any uranium metal at the FPFP. On February 28, 2022, the IAEA verified that Iran had converted a remaining 900 grams of uranium in the form of uranium tetrafluoride (UF_4) enriched up to 20 percent, previously intended for

[10] David Albright, Sarah Burkhard, and John Hannah, "Iran's Natanz Tunnel Complex: Deeper, Larger than Expected," *Institute for Science and International Security*, January 13, 2022, https://isis-online.org/isis-reports/detail/irans-natanz-tunnel-complex-deeper-larger-than-expected/8.

[11] David Albright and Sarah Burkhard, "Imagery Update: Iran Continues to Harden its New Natanz Tunnel Complex," *Institute for Science and International Security*, May 5, 2022, https://isis-online.org/isis-reports/detail/imagery-update-iran-continues-to-harden-its-new-natanz-tunnel-complex-2022.

production of uranium metal, into U_3O_8. However, its capability to produce uranium metal remains intact.

As of August 22, 2022, the IAEA verified a total of 192 kg (U mass) near 20 percent enriched uranium in the form of UF_6 at the FPFP storage area, in addition to the 60 percent enriched uranium hexafluoride discussed above.

In December 2020, Iran informed the IAEA that it would begin producing uranium metal, including uranium metal enriched up to 20 percent, in violation of its JCPOA commitments. Iran is using the uranium metal in civil applications, including to produce experimental fuel rods for the TRR. However, Iran has no pressing need to develop this fuel or to use this material for other civilian activities, lending weight to concern that Iran is installing the wherewithal to make uranium metal to increase its nuclear weapons capabilities and is producing it as a way to practice the manufacture of enriched uranium metal components of nuclear weapons. Prior to 2003, under the Amad Plan, Iran was constructing both pilot and large-scale uranium metallurgy facilities to make nuclear cores and was practicing with surrogate materials for WGU.[12]

On February 2, 2021, Iran began producing uranium metal using natural uranium in a laboratory experiment at the Esfahan FPFP. As of August 14, 2021, the IAEA verified that Iran had begun producing enriched uranium metal from 20 percent enriched UF_6. It produced 200 grams of enriched uranium metal, starting with 257 grams of enriched uranium in tetrafluoride form. Iran stated the enriched uranium metal is for use in silicide fuel for the TRR. Iran produced "two batches of uranium silicide" containing 0.43 kg of uranium enriched to 20 percent. Assuming this is in uranium mass, the uranium silicide contains twice the amount of metal that was reported previously (430 grams compared to 200 grams). On November 2, 2021, the IAEA verified that Iran had "manufactured two fuel plates using uranium silicide." Subsequently, the two fuel plates were inserted into the TRR and on October 22, 2022, the IAEA observed that they were still being irradiated.

On February 21, 2022, the IAEA verified that the installation of equipment for the first stage of production of enriched UF_4 from enriched UF_6 at the FPFP, while almost complete, had progressed only slightly. The IAEA noted that on May 17, 2022, installation had been completed but had yet to undergo testing, and the IAEA observed the same as of October 11, 2022. No progress was observed on the remaining two stages of the process during this reporting period.

At the nearby Uranium Conversion Facility (UCF) at Esfahan, in November 2021, Iran had finished installing equipment for producing uranium metal, and the facility has been ready to operate with depleted or natural uranium since. On October 23, 2022, the IAEA verified that no nuclear material had been introduced into the production area.

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[12] *Iran's Perilous Pursuit of Nuclear Weapons*; David Albright, Sarah Burkhard, and Frank Pabian, "Shahid Mahallati: 'Temporary' Plant for Manufacturing Nuclear Weapon Cores," *Institute for Science and International Security*, April 8, 2020, https://isis-online.org/isis-reports/detail/shahid-mahallati-temporary-plant-for-manufacturing-nuclear-weapon-cores/8.

Part 6: Heavy water and Arak reactor

The IAEA reports that since February 2021, due to Iran's reductions in agency monitoring, it has not been able to ascertain the status of Iran's Heavy Water Production Plant (HWPP) nor the production and inventory of heavy water. Since June 11, 2022, when Iran removed Flow-rate Unattended Monitoring (FLUM) equipment at the HWPP, the IAEA has had no monitoring capabilities. Based on commercial satellite imagery, the IAEA included in its November 2022 report its assessment that the HWPP is once again operational after parts were shut down for major maintenance over the summer.

The IAEA reports that, as of October 25, 2022, Iran had not pursued construction of the Arak heavy water research reactor (IR-40 reactor), now called the Khondab Heavy Water Research Reactor (KHRR), based on its original design. Iran also had not produced or tested natural uranium pellets, fuel pins, or fuel assemblies for the reactor as originally designed. However, questions remain about the irreversibility of technical modifications carried out to date by Iran's partners in the JCPOA Arak reactor working group. Moreover, a wide range of "civil construction works" on all floors of the reactor were ongoing, including the completion of piping for the primary cooling system and connection to heat exchangers. The IAEA observed no further progress on the construction of a control room for the refueling machine.

Part 7: Additional Protocol & JCPOA monitoring

Iran stopped implementing the Additional Protocol (AP) to its comprehensive safeguards agreement (CSA) and the JCPOA's additional monitoring arrangements on February 23, 2021, when it also stopped implementing modified Code 3.1 to the CSA. Iran agreed to continue operating IAEA monitoring and surveillance equipment installed for JCPOA monitoring purposes, but it would keep the footage and data in its custody until it received sanctions relief. These data would continue to be collected and stored "with the aim of enabling the Agency to recover and re-establish the necessary continuity of knowledge" at the affected nuclear sites. On June 8, 2022, following IAEA board censure of its failure to cooperate on the IAEA's separate safeguards probe, Iran notified the IAEA that it would remove the IAEA's JCPOA-related monitoring and surveillance equipment. From June 9 to 11, the IAEA removed, in total, 27 surveillance cameras, the on-line enrichment monitor (OLEM) at the FEP, and the FLUM equipment installed at the HWPP. The equipment was placed in storage under IAEA seal. The IAEA notes, "the Agency's verification and monitoring activities have been seriously affected as a result of Iran's decision to stop the implementation of its nuclear-related commitments under the JCPOA, including the Additional Protocol."

Due to Iran's refusal to implement the AP, the IAEA can no longer carry out daily visits to Iran's enrichment facilities, receive updated declarations, or conduct "complementary access" to sites. It has not "had access to data gathered by on-line enrichment monitors and electronic seals, or access to recordings registered by its installed measurement devices." In addition to the centrifuge manufacturing limitations described in part 4, the IAEA also no longer receives data and recordings of test stands for conducting quality control tests of advanced centrifuge rotor assemblies, prior to their installation at Natanz and Fordow enrichment plants. It also no longer has information about Iran's production of uranium ore concentrate (UOC) or its transfer to the Esfahan facility for conversion, or about UOC obtained from any other source. Annex I to the IAEA report describes these and other reduced provisions, many of which fall under JCPOA enhanced monitoring provisions.

The IAEA also reports that it cannot verify Iran's JCPOA commitments under Sections D, E, S, and T. The Section T commitments relate to prohibited nuclear weapons development activities.

During the reporting period, the IAEA did not attend any meetings of the Procurement Working Group of the JCPOA Joint Commission, which oversees Iran's imports of nuclear-related equipment. Tehran is likely not complying with the JCPOA's procurement channel provisions, given evidence of illicit procurements.[13]

February 2021 Agreement Collapse and Issues with Re-establishing Continuity of Knowledge

Between February 21, 2021 and June 8, 2022, as described, the IAEA and Iran had agreed that Iran would continue to collect safeguards information on agency monitoring and surveillance equipment per the terms of the JCPOA. This would allow the IAEA to "recover and re-establish the necessary continuity of knowledge." Following Iran's removal of IAEA monitoring equipment, the IAEA "has not been able to perform JCPOA verification and monitoring activities in relation to the production and inventory of centrifuges, rotors and bellows, heavy water and uranium ore concentrate (UOC) for almost two years, including some five months when the surveillance and monitoring equipment were not installed." The IAEA stated this lack of verification and monitoring would severely affect its ability to reestablish accurate baselines in the future:

> *This would have a significant impact on the Agency's ability to recover and re-establish the necessary continuity of knowledge in the event of a full resumption of implementation by Iran of its nuclear-related commitments under the JCPOA. Therefore, any future baseline for the above-mentioned JCPOA verification and monitoring activities would take a considerable time to establish and would have a degree of uncertainty. The longer the current situation persists the greater such uncertainty becomes.*

[13] The alleged illicit procurements occurred from 2018 to 2020, raising the possibility that Iran has not been complying all along with the JCPOA procurement channel provisions. See: Spencer Faragasso and Sarah Burkhard, "Iranian Illicit Procurement Scheme to Acquire Controlled Spectrometry Systems Busted," *Institute for Science and International Security*, September 14, 2021, https://isis-online.org/isis-reports/detail/iranian-illicit-procurement-scheme-to-acquire-controlled-spectrometers. Another set of illicit procurements occurred from 2015 to 2018. See: Simon Mairson and Valerie Lincy, "U.S. Targets Procurement Network Supplying Machine Tools to Iran," *Wisconsin Project on Nuclear Arms Control*, October 21, 2019, https://www.wisconsinproject.org/u-s-targets-procurement-network-supplying-machine-tools-to-iran/.

With regard to activities occurring between February 21, 2021 and June 8, 2022, the IAEA could confirm the integrity, comprehensiveness, and accuracy of the data recorded by its surveillance equipment by comparing the data to the declarations provided by Iran. The IAEA added that Iran would need to provide it with all related records, the consistency of which the IAEA would then need to confirm through the application of additional safeguards measures, including those available under the AP.

However, the IAEA would face severe challenges in verifying Iran's declared inventories after June 11, 2022, when the monitoring and surveillance equipment was removed. According to the November 2022 report, the IAEA will "face considerable challenges to confirm the consistency of Iran's declared inventory of heavy water, UOC and centrifuges for the period – currently five months – in which the surveillance and monitoring equipment were not installed."

The IAEA believes that with time, it would be able to establish a new baseline for future verification and monitoring activities. However, "because of the absence of continuous surveillance and monitoring of Iran's JCPOA-related activities since June 2022, the Agency would not be able to exclude the possibility that the subsequent levels of activities were significantly different to those previously observed by the Agency at the declared locations." The IAEA concludes, "Iran's decision to remove all of the Agency's equipment previously installed in Iran for surveillance and monitoring activities in relation to the JCPOA has [had] detrimental implications for the Agency's ability to provide assurance of the peaceful nature of Iran's nuclear programme."