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Assessing a Deal or Non-deal with Iran

The Critical Issue of Iran's Progress in Weapons Research, Development, and Production Capability

By Anthony H. Cordesman

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Request for comments:

This report is a draft that will be turned into an electronic book. Comments and suggested changes would be greatly appreciated. Please send any comments to Anthony H. Cordsman, Arleigh A. Burke Chair in Strategy, at acordesman@gmail.com.

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It now seems unlikely that the P5+1 countries of the United States, Russia, China, the United Kingdom, France, and Germany can reach a comprehensive agreement with Iran by the end of November. A final agreement remains a possibility, but it seems far more likely that if an agreement is not reached, the negotiations will be extended rather than abandoned all together. The question then arises as to how to judge the outcome of this set of negotiations, be it an actual agreement, an extension, or the collapse of the negotiations.

So far, most analyses of the negotiations have focused on the key features of Iran's various enrichment efforts and its ability to acquire fissile material. These include:

- The number of centrifuges,
- The development of more advanced centrifuges,
- The level of Uranium enrichment and the size of Iran's stockpiles,
- The potential use of the new reactor at Arak to produce Plutonium,
- How soon Iran could use any of these to get enough material to produce a nuclear device,
- The extent to which any agreement dealing with all of these issues is enforceable,
- How long an agreement will be in force, and
- The incentives to Iran for reaching an agreement, especially the extent to which UN, US, and EU sanctions will be lifted, and the timing of such action.

These are all important issues, but they are only part of the efforts aimed at ensuring Iran does not acquire nuclear weapons and discouraging other regional states to seek nuclear weapons. They also focus relatively narrowly on Iran's approach to the "break out" point in acquiring nuclear weapons, rather than its ability to actually produce and deploy nuclear weapons. Main studies focus on how soon Iran could get enough fissile material to produce one major fissile event, and not Iran's ability to actually produce a meaningful amount of nuclear bombs and missile warheads.

Looking Beyond Enrichment and Plutonium

It is important to remember that the primary goal of the negotiations is not to roll back Iranian enrichment technology, but rather to prevent Iran from actually producing and deploying nuclear weapons. Any agreement that convincingly prevents Iran from actually building and deploying nuclear weapons would meet the security needs of both the US and our regional allies. An agreement – or drawn-out negotiation process – that delays Iranian enrichment activity but allows Iran to conduct centrifuge development and complete the design of a nuclear weapon would not meet US security needs.

The collapse of negotiations – or the conclusion that Iran is simply stalling and seeking to break out of sanctions – raises a different set of issues. It would immediately raise the issue of how close Iran really is to developing, producing, and deploying nuclear weapons and a nuclear force. It would have to look beyond the issue of fissile material and consider three critical factors: the reaction time the US and its allies would have to use preventive strikes; create new defenses; and/or create a suitable deterrent.

The Issue is the Bomb

In all three cases, questions arise as to how far Iran has moved towards a bomb, whether it would need to carry out a major fissile test or tests, how much covert research and development activity it still needs, and how well the US and its allies can detect such actions and future covert fissile material production efforts – critical considerations in judging IAEA inspection and verification capabilities, as well.

These are all issues that the US has never publically addressed and that are critical in assessing an agreement: how far has Iran gotten in nuclear weapons design, how much necessary development work could it covertly do in spite of any agreement, and what is the US estimate of how long Iran would need to develop and deploy nuclear weapons versus simply produce fissile material?

Key IAEA Findings on Iran's Nuclear Weapons Efforts

Here, it is important to go back to the military annex to a critical IAEA report issued on November 8, 2011, that raised critical questions about about Iran's past weapons-related efforts which Iran has, so far, refused to address. This IAEA report was, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, and its weapons annex summarized the key issues surrounding Iran's actual efforts to develop a nuclear weapon – issues that have not formally surfaced in the public discussion of the P5+1 and Iran negotiations.[1]

The weapons-related sections of the military annex are provided in full detail as Annex A to this analysis. In summary, however, the IAEA report on Iran's weapons related activities: [2]

- Describes Iran's lack of cooperation with the IAEA regarding heavy water at the Iran Nuclear Research Reactor (IR-40) at Arak. Although the Agency was allowed access to the site on October 17, 2011, it has not been permitted access since then. According to Iran, operation of the IR-40 reactor is due to commence by the end of 2013. Although the Agency has not been permitted access to the Heavy Water Production Plant (HWPP) since August 17, 2011, satellite imagery has indicated that the HWPP appears to be in operation. Lastly, to date Iran has not allowed the Agency access to the heavy water stored at the Uranium Conversion Facility (UCF) to take samples.

- Provides a description of the IAEA's knowledge of the Uranium Conversion Facility (UCF) as of October 18, 2011. It reflects that Iran is continuing enrichment and heavy water production at the site in contravention of international demands and regulations. It indicates that as of October 18, 2011, the Agency observed the ongoing installation of the process equipment for the conversion of UF6 (uranium hexafluoride) enriched to 20% into U3O8 (triuranium octoxide).

    - Provides an introduction and summary of the possible military dimensions of Iran's nuclear program. Importantly, it indicates that Iran has not engaged the IAEA substantively regarding the military dimensions of its program since August 2008, and it stresses the following:

- Efforts, some successful, to procure nuclear related and dual-use equipment and materials by military-related individuals and entities.
- Efforts to develop undeclared pathways for the production of nuclear material.
- The acquisition of nuclear weapons development information and the documentation from a clandestine nuclear supply network.
- Work on the development of indigenous nuclear weapon design, including the testing of components.

This section of the report also states that the Agency has "serious concerns regarding possible military dimensions to Iran's nuclear program." It: [3]

- Provides a historical overview of the possible military dimensions of Iran's nuclear program. It reveals that the IAEA discovered that Iran's program has roots going back nearly 40 years, and that it has had ongoing undeclared R&D program for nuclear testing, experimentation, uranium conversion, enrichment, fabrication, and irradiation activities, including the separation of plutonium. Moreover, it reports that Iran admitted to engaging in undeclared activities at clandestine locations, and procured nuclear material via a clandestine supply network.
- Reflects what the IAEA believes to be the structure of Iran's nuclear production, which is thought to involve the participation of a number of research centers, government bodies, universities, and committees, all of which operate under the Ministry of Defense Armed Forces Logistics (MODAFL). Moreover, it indicates that the program's nuclear activity was consolidated under the AMAD Plan in the late 1990s and early 2000s, although it was halted in 2003.
- Provides the IAEA's knowledge of Iran's nuclear procurement activities relevant to nuclear weapons production, many of which were allegedly undertaken by private front companies. For instance, Kimia Maadan, a private Iranian company, was a company for chemical engineering operations under the AMAD Plan, while also being used to help with procurement for the Atomic Energy Organization of Iran (AEOI).

  Among the equipment procured relevant to nuclear weapons production include high-speed electronic switches and spark gaps (useful for triggering and firing detonators); high-speed cameras (useful in experimental diagnostics); neutron sources (useful for calibrating neutron measuring equipment); radiation detection and measuring equipment (useful in a nuclear material production environment); and training courses on topics relevant to nuclear explosives development (such as neutron cross section calculations and shock wave interactions/hydrodynamics).
- Describes the IAEA's knowledge of Iran's attempts to acquire nuclear material relevant to nuclear weapons production. It also emphasizes that Iran only declared a number of facilities once the IAEA was made aware of their existence by sources other than Iran. Taken with Iran's additional past efforts to conceal nuclear activity, this reality creates more concern about the possible existence of further undeclared nuclear facilities, material, and activities in Iran.
- Provides the IAEA's analysis of Iran's alleged ongoing efforts to acquire nuclear components for use in an explosive device. It reiterates that Iran received documents that describe the processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components, which are integral in the production of a rudimentary fission device. Additionally, the Agency indicates that during a 2007 interview with a member of Iran's clandestine supply network, it was told that Iran had been provided with nuclear explosive design information. Lastly, this portion of the report stresses that the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004.
- Discusses the IAEA's knowledge of Iran's R&D into and acquisition of "safe, fast-acting detonators, and equipment suitable for firing the detonators," an integral component to constructing an implosion type nuclear device. It indicates that the Agency discovered that Iran had developed fast-

functioning detonators known as "exploding bridgewire detonators" (EBWs) during the period 2002-2003 as safe alternatives to previous detonator technology it had developed. Moreover, in 2008, Iran told the Agency that before the period 2002-2004, it had already achieved EBW technology. It also provided the Agency with a short, undated document in Persian, which was understood to be the specifications for a detonator development program, and a document from a foreign source that showed the example of a civilian application in which detonators fired simultaneously. Iran, however, has not explained its own need or application for such detonators.

- Describes development of a multipoint initiation system, which is used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density. As such, it is a vital component of a fission weapon. According to the Agency, Iran has had access to information on the design concept of a multipoint initiation system that can be used to initiate a high explosive charge over its surface effectively and simultaneously. This information was reportedly supplied to the IAEA by a Member State.
- Discusses Iran's efforts to evaluate the theoretical design of an implosion device using computer simulations, as well as high explosive tests referred to as "hydrodynamic experiments" in which fissile and nuclear components may be replaced with surrogate materials. According to information provided, Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten. Such experiments have also been linked to experiments involving the use of high-speed diagnostic equipment, including flash X-ray, to monitor the symmetry of the compressive shock of the simulated core of an explosive device. Such experiments would have little, if any, civilian application, and represent a serious source of concern regarding the potential weaponization of Iran's nuclear program.
- Provides an overview of the IAEA's knowledge of Iran's studies that focus on modeling of spheres, components, and neutronic behavior indicating investigation into a nuclear warhead. Moreover, the Cordesman/Gold Iran & The Gulf Military Balance 18.7.13AHC 80 Agency has acquired information that indicates Iran has conducted studies and done calculations relating to the state of criticality of a solid sphere of uranium being compressed by high explosives. Such efforts provide an additional indication of the potential weaponization of Iran's nuclear program.
- Discusses Iran's research and development into neutron initiators, which, "if placed in the center of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction." Iran has yet to explain its objectives and capabilities in this field.
- Discusses what the IAEA perceives as Iran's efforts to "have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device." It also indicates that these efforts directly reflect those undertaken by declared nuclear-weapon states. These indicators could perhaps point to a potential Iranian nuclear weapons test in the future.
- Reflects what the IAEA perceives as a structured Iranian program to carry out "engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile." Such explorations into warhead development provide a key indicator that Iran's program is military in nature.
- Describes Iran's efforts at developing "a prototype firing system that would enable the payload [a nuclear warhead on a Shahab 3 missile] to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground." It presents further indication that Iran is at least considering the possibility of installing nuclear warheads on its existing arsenal of Shahab 3 missiles.
- **P**rovides an overview of the different bodies and projects that constitute the Iranian nuclear program.
- Provides an analysis of the likely payload of an Iranian missile, given the above indicators. It shows that Iran's R&D into its ballistic missile and nuclear programs reflect a probable effort to develop both nuclear warheads and an effective delivery vehicle thereof.
- The IAEA report also provides insight into the foreign sources that supplied Iran with nuclear equipment and technical know-how. One of these sources was referred as a "clandestine nuclear

> supply network," purported to be the now-disbanded A.Q. Khan network. According to the report, Iran admittedly had contact with the network in the late 1980s and early 1990s. The document also asserts that this network supplied Iran with technical know-how regarding the production of neutron initiators and spherical hemispherical enriched uranium metallic component, neither of which have any real civilian application.

According to the IAEA, Iran admitted to having received a 15-page document that provided detailed instructions for the construction of components critical to building a nuclear device. This document, known as the "uranium metal document" was also provided to Libya, and is known to have been part of a larger package of information that includes elements of a nuclear explosive design. Given the circumstances surrounding Iran's acquisition of the document as well as the well-known role the A.Q. Khan network played in jump-starting nuclear weapons programs in Pakistan, Libya, and North Korea, it remains doubtful that Iran's program is purely peaceful.

The IAEA's report of November 8, 2011 also stated that there were "…strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin." [4]

The Institute for Science and International Security (ISIS) later identified this individual as former Soviet weapons engineer Vyacheslav Danilenko. According to the IAEA, Danilenko worked in Iran from 1996 to 2002, returning to Russia in 2002 [5] Moreover, given the small size and sophistication of a multipoint initiation system the IAEA observed in Iran in 2004, it was likely to have been developed using Danilenko's expertise as a springboard. [6] Iran's strides in detonator technology are, in all likelihood, the result of Danilenko's technical expertise.

It is now more than three years since the IAEA issued this report, but it has not received either any serious clarification from Iran, or any meaningful updates from member countries that allow it to fully update its military annex aside from data on a possible weapons simulation text site at Parchin In fact, on November 7, 2014 – some three weeks from the deadline set for negotiating a comprehensive agreement between the P5+1 and Iran, the Director General of the IAEA was forced to issue a report on the *Implementation of the NPT Safeguards Agreement and Relevant Provisions of the Security Council Resolutions in the Republic of Iran* that stated that, "Iran has not provided any explanations that enable the Agency to clarify the outstanding practical measures, nor has it proposed any new practical measures in the next step of the framework of cooperation."[7]

Iran did not provide data on key weapons-related issues like its work on the initiation of high explosives that could be used in an implosion weapon or neutron transport calculations. The section on "Possible Military Dimensions" noted that in spite of the fact the IAEA had acquired some additional information since 2011 showing that Iran had a weapons program and/or weapons related activities – such as Iranian activity at Parchin – "In February 2012, Iran dismissed the Agency's concerns largely on the grounds that Iran considered them to be based on unfounded allegations." In August 2014, Iran again stated that, most of the issues (were) mere allegations and do not merit consideration."

In short, Iran has done nothing to refute or explain any of its major actions relating to a weapons program or weapons related research and development, to set the stage for complying with this aspect of a permanent agreement, setting the stage for meaningful inspection, and providing a clear indication of how close it is to a working weapons design and planning for the actual deployment of nuclear weapons on its missile and aircraft.

As testimony by David Albright of ISIS before the House Terrorism, Nonproliferation, and Trade Subcommittee, Committee on Foreign Affairs on November 18, 2014 noted,[8]

> A key goal of the negotiations is to ensure that any deal provides adequate reaction time, namely, adequate time to respond diplomatically and internationally to stop Iran if it does decide to renege on its commitments and build nuclear weapons. According to Undersecretary of State Wendy Sherman, "We must be confident that any effort by Tehran to break out of its obligations will be so visible and time-consuming that the attempt would have no chance of success." That goal must be at the core of any agreement.
>
> … Obtaining adequate reaction time requires that limitations are placed on Iran's sensitive nuclear programs, adequate verification is ensured, and concrete progress has been demonstrated that Iran will address the IAEA's concerns about its past and possibly on-going nuclear weapons efforts. Because of Iran's long history of non-compliance with its safeguards obligations, a deal must last long enough, on order of 20 years, so that there is little risk of Iran seeking nuclear weapons.
>
> …Despite a great effort over the last year, the IAEA has learned little from Iran that has added to the inspectors' ability to resolve their concern about Iran's past nuclear weapons efforts and possibly on-going work related to nuclear weapons. Recently, the IAEA has also been unable to reach agreement with Iran on how to tackle the remaining military nuclear issues. The IAEA has repeatedly emphasized that the military nuclear issues need to be addressed and solved. For years, the inspectors have unsuccessfully asked the Islamic Republic to address the substantial body of evidence that Iran was developing nuclear weapons prior to 2004 and that it may have continued some of that, or related, work afterwards, even up to the present. Before a deal is concluded, concrete progress is needed on the central issue of whether Iran has worked on nuclear weapons and is maintaining a capability to revive such efforts in the future. Addressing all of the IAEA's outstanding concerns about Iran's past and possibly on-going military nuclear efforts prior to the November deadline appears unlikely. Nonetheless, without concrete progress, which could take several forms, a deal should not be signed.
>
> Supreme Leader Ali Khamenei often declares that nuclear weapons violate Islamic strictures. His denials are not credible. The United States, its main European allies, and most importantly the IAEA itself, assess that Iran had a sizable nuclear weapons program into 2003. The U.S. intelligence community in the 2007 National Intelligence Estimate (NIE) agreed: "We assess with high confidence that until fall 2003, Iranian military entities were working under government direction to develop nuclear weapons." The Europeans and the IAEA have made clear, the United States less so, that Iran's nuclear weapons development may have continued after 2003, albeit in a less structured manner.
>
> In its November 2011 safeguards report, the IAEA provided evidence of Iran's pre- and post-2003 nuclear weaponization efforts. The IAEA found, "There are also indications that some activities relevant to the development of a nuclear explosive device continued after 2003, and that some may still be ongoing." To reinforce this point to Iran, the United States in late August sanctioned Iran's Organization of Defensive Innovation and Research (SPND), which it said is a Tehran-based entity established in early 2011 that is primarily responsible for research in the field of nuclear weapons development. Thus, there is widespread evidence and agreement that Iran has worked on developing nuclear weapons and that some of those activities may have continued to today.
>
> Addressing the IAEA's concerns about the military dimensions of Iran's nuclear programs is fundamental to any long-term agreement. Although much of the debate about an agreement with Iran rightly focuses on Tehran's uranium enrichment and plutonium production capabilities, an agreement that side steps the military issues would risk being unverifiable. Moreover, the world

> would not be so concerned if Iran had never conducted weaponization activities aimed at building a nuclear weapon. After all, Japan has enrichment activities but this program is not regarded with suspicion. Trust in Iran's intentions, resting on solid verification procedures, is critical to a serious agreement.

While Iran's weapons development efforts are only one part of providing the necessary reaction time, they are clearly the area where the least is known at any public level, where Iran has done the least to comply, and where major questions remain as to whether any agreement could keep Iran from running a covert research and development and planning effort short of serious and clearly detectable fissile event.

The Uncertain Level of Iranian Progress: No News is No News

The US, however, has also done comparatively little at the official level to help set the stage for evaluating this critical aspect of any agreement – and the consequences of a non-agreement. It has long since cancelled the annual Department of Defense unclassified summary of international proliferation activity, and has not reported regularly on Iranian missile development or the extent to which Iran's long range missile problem is dependent on nuclear warheads because of its inaccuracy and reliability problems.

The US did issue an unclassified nine-page summary of a National Intelligence Estimate on Iran: Nuclear Intentions and Capabilities on November 7, 2014. That summary concluded that,[9]

- We judge with high confidence that in fall 2003, Tehran halted its nuclear weapons program; we also assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons.
- We judge with high confidence that the halt, and Tehran's announcement of its decision to suspend its declared uranium enrichment program and sign an Additional Protocol to its Nuclear Non-Proliferation Treaty Safeguards Agreement, was directed primarily in response to increasing international scrutiny and pressure resulting from exposure of Iran's previously undeclared nuclear work.
- We assess with high confidence that until fall 2003, Iranian military entities were working under government direction to develop nuclear weapons.
- We judge with high confidence that the halt lasted at least several years. (Because of intelligence gaps discussed elsewhere in this Estimate, however, DOE and the NIC assess with only moderate confidence that the halt to those activities represents a halt to Iran's entire nuclear weapons program.)
- We assess with moderate confidence Tehran had not restarted its nuclear weapons program as of mid-2007, but we do not know whether it currently intends to develop nuclear weapons.
- We continue to assess with moderate-to-high confidence that Iran does not currently have a nuclear weapon.
- Tehran's decision to halt its nuclear weapons program suggests it is less determined to develop nuclear weapons than we have been judging since 2005. Our assessment that the program probably was halted primarily in response to international pressure suggests Iran may be more vulnerable to influence on the issue than we judged previously.

The US has not fully seriously even this limited level of analysis since 2007. However, the unclassified annual reports by the Director of National Intelligence (DNI) that touch on the Iranian nuclear and missile programs do provide some insights. The 2013 report stated that,[10]

> We assess **Iran** is developing nuclear capabilities to enhance its security, prestige, and regional influence and give it the ability to develop nuclear weapons, should a decision be made to do so. We do not know if Iran will eventually decide to build nuclear weapons.
>
> Tehran has developed technical expertise in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.
>
> Of particular note, Iran has made progress during the past year that better positions it to produce weapons-grade uranium (WGU) using its declared facilities and uranium stockpiles, should it choose to do so. Despite this progress, we assess Iran could not divert safeguarded material and produce a weapon-worth of WGU before this activity is discovered.
>
> We judge Iran's nuclear decision making is guided by a cost-benefit approach, which offers the international community opportunities to influence Tehran. Iranian leaders undoubtedly consider Iran's security, prestige and influence, as well as the international political and security environment, when making decisions about its nuclear program. In this context, we judge that Iran is trying to balance conflicting objectives. It wants to advance its nuclear and missile capabilities and avoid severe repercussions—such as a military strike or regime threatening sanctions.
>
> We judge Iran would likely choose a ballistic missile as its preferred method of delivering a nuclear weapon, if one is ever fielded. Iran's ballistic missiles are capable of delivering WMD. In addition, Iran has demonstrated an ability to launch small satellites, and we grow increasingly concerned that these technical steps—along with a regime hostile toward the United States and our allies—provide Tehran with the means and motivation to develop larger space-launch vehicles and longer-range missiles, including an intercontinental ballistic missile (ICBM).
>
> Iran already has the largest inventory of ballistic missiles in the Middle East, and it is expanding the scale, reach, and sophistication of its ballistic missile arsenal. Iran's growing ballistic missile inventory and its domestic production of anti-ship cruise missiles (ASCM) and development of its first long-range land attack cruise missile provide capabilities to enhance its power projection. Tehran views its conventionally armed missiles as an integral part of its strategy to deter—and if necessary retaliate against—forces in the region, including US forces.

The 2014 statement also failed to address any aspect of Iran's research and development activity and progress in a nuclear weapons design. It did state, however, that,[11]

> We continue to assess that Iran's overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so. At the same time, Iran's perceived need for economic relief has led it to make concessions on its nuclear program through the 24 November 2013
>
> Joint Plan of Action with the P5+1 countries and the European Union (EU). In this context, we judge that Iran is trying to balance conflicting objectives. It wants to improve its nuclear and missile capabilities while avoiding severe repercussions—such as a military strike or regime-threatening sanctions. We do not know if Iran will eventually decide to build nuclear weapons.
>
> Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.
>
> Of particular note, Iran has made progress during the past year by installing additional centrifuges at the Fuel Enrichment Plant, developing advanced centrifuge designs, and stockpiling more low-enriched uranium hexafluoride (LEUF6). These improvements have better positioned Iran to produce weapons grade uranium (WGU) using its declared facilities and uranium stockpiles, if it

> chooses to do so. Despite this progress, we assess that Iran would not be able to divert safeguarded material and produce enough WGU for a weapon before such activity would be discovered. Iran has also continued to work toward starting up the IR-40 Heavy Water Research Reactor near Arak.
>
> We judge that Iran would choose a ballistic missile as its preferred method of delivering nuclear weapons, if Iran ever builds these weapons. Iran's ballistic missiles are inherently capable of delivering WMD, and Iran already has the largest inventory of ballistic missiles in the Middle East. Iran's progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including an intercontinental ballistic missile (ICBM).
>
> We assess that if Iran fully implements the Joint Plan, it will temporarily halt the expansion of its enrichment program, eliminate its production and stockpile of 20-percent enriched uranium in a form suitable for further enrichment, and provide additional transparency into its existing and planned nuclear facilities. This transparency would provide earlier warning of a breakout using these facilities.

A careful reading of these words shows that they focus exclusively on enrichment and fissile production, say nothing about Iran's current level of nuclear weapons design and production data, say nothing about the timer it would take for Iran to deploy a meaningful nuclear force, and provide no basis for knowing whether the US intelligence community feels it can detect Iran weapons research and development activity outside the fuel cycle, or whether an agreement would give the IAEA a credible verification activity.

More broadly, the statement did nothing to address the question of Iran's real-world reaction time in moving from acquiring fissile material to actual weaponization and deployment. It was, however, a notable advance over the annual threat assessment by the Director of DIA, which did not address the issue at all.[12]

Going Into a P5+1 Negotiation Without a Public Position on Iran's Weapons-related Activities

Some seven years after the last serious US estimate, the most the US has said in unclassified terms seems to be that it believes Iran has not reconstituted a large, visible effort. It has never said that Iran is not conducting covert nuclear weapons research and development activities under another guise, explained Iran's calculations in creating a missile program that currently can only be effective with nuclear weapons, or discussed the problems Iran would face in any conflict in the Gulf or the rest of the region using its obsolete conventional forces without nuclear threat. It also has never defined its estimate of how quickly Iran could actually go from creating fissile material to actually having a weapon.

Fissile Material Does Not Mean Weaponization

This is critical in evaluating both an actual agreement and the risks in continuing to negotiate. Even actual nuclear weapons designers cannot agree on just how difficult it now is to design and manufacture a reliable and deployable nuclear weapon. Reports that Iran may have received significant design data from a number of sources, and reports by the IEA that Iran has been working on the design and key components for fission weapons for years, do not mean that Iran has detailed design data of the kind that allows it to produce an effective implosion weapon. Neither does it mean that it can easily move to develop a family of different weapons ranging from small nuclear weapons to boosted weapons that can be deployed on missiles or as relative light bombs.

North Korea's uncertain tests of fission devices -- which seem to have involved devices far too large for warhead weaponization -- show that getting large yields from a test device remains a major challenge. For new proliferators, India and Pakistan have both made spurious claims about the yields of their tests to disguise what seem to have been at least partial design failures. Even the simpler forms gun devices can present significant problems in terms of reliability and yield.

The US and Iran's neighbors may choose to assume that Iran could rapidly deploy a functioning nuclear weapon once it has sufficient fissile material, but such assumptions can exaggerate Iran's military capabilities, and it is unclear what kind of assumptions are actually correct. Bomb design also involves serious safety and reliability issues, as well as the need to be able to predict yield, the ability to operate in spite of the stress of a missile or air launch, and the ability of fusing systems to trigger the weapon at the desired height of burst.

It is difficult, however, to go from standard fission implosion weapons to boosted weapons that have much higher yields, potentially raising the explosive force from a purely fissile 20-kiloton weapon to boosted weapons with yield of 100 kilotons or more. These involve key design issues, which include the problems involved in handling tritium and deuterium or solid lithium deuteride-tritide, and the fact that such designs are normally associated with plutonium weapons, not the uranium-based weapons that Iran would construct if it were successful in building a weapon.

How Much is Enough vs. How Much is Too Much

Much of the unclassified analysis of how soon Iran could get a weapon is tied to weapons and warhead design issues. Many tacitly assume that Iran could assemble a gun device or even nuclear missile warheads without any practical testing or even a fissile event. They also fail to state the assumptions made regarding the amount of material needed per weapon, and the major uncertainties involved.

Such estimates also tend to focus on one estimate of the necessary fissile material without noting the uncertainties in any nominal estimate or the variation by weapons design. Unclassified estimates made in an article on nuclear weapons design by the Federation of American Scientists illustrate the scale of the uncertainties involved -- as well as some of the reasons effective weapons design is so difficult and uncertain without actual testing:[13]

> The minimum mass of fissile material that can sustain a nuclear chain reaction is called a critical mass and depends on the density, shape, and type of fissile material, as well as the effectiveness of any surrounding material (called a reflector or tamper) at reflecting neutrons back into the fissioning mass. Critical masses in spherical geometry for weapon-grade materials are as follows:

	Uranium-235	Plutonium-239
Bare sphere:	56 kg	11 kg
Thick Tamper:	15 kg	5 kg

> The critical mass of compressed fissile material decreases as the inverse square of the density achieved. Since critical mass decreases rapidly as density increases, the implosion technique can make do with substantially less nuclear material than the gun-assembly method. The "Fat Man" atomic bomb that destroyed Nagasaki in 1945 used 6.2 kilograms of plutonium and produced an explosive yield of 21-23 kilotons [a 1987 reassessment of the Japanese bombings placed the yield at 21 Kt]. Until January 1994, the Department of Energy (DOE) estimated that 8 kilograms would

> typically be needed to make a small nuclear weapon. Subsequently, however, DOE reduced the estimate of the amount of plutonium needed to 4 kilograms. Some US scientists believe that 1 kilogram of plutonium will suffice.
>
> ….In the gun device, two pieces of fissionable material, each less than a critical mass, are brought together very rapidly to forma single supercritical one. This gun-type assembly may be achieved in a tubular device in which a high explosive is used to blow one subcritical piece of fissionable material from one end of the tube into another subcritical piece held at the opposite end of the tube.
>
> Manhattan Project scientists were so confident in the performance of the "Little Boy" uranium bomb that the device was not even tested before it was used. This 15-kt weapon was airdropped on 06 August 1945 at Hiroshima, Japan. The device contained 64.1 kg of highly enriched uranium, with an average enrichment of 80%. The six bombs built by the Republic of South Africa were gun-assembled and used 50kg of uranium enriched to between 80 percent and 93 percent in the isotope U-235.
>
> Compared with the implosion approach, this method assembles the masses relatively slowly and at normal densities; it is practical only with highly enriched uranium. If plutonium -— even weapon-grade -- were used in a gun-assembly design, neutrons released from spontaneous fission of its even-numbered isotopes would likely trigger the nuclear chain reaction too soon, resulting in a "fizzle" of dramatically reduced yield.
>
> ...Because of the short time interval between spontaneous neutron emissions (and, therefore, the large number of background neutrons) found in plutonium because of the decay by spontaneous fission of the isotope Pu-240, Manhattan Project scientists devised the implosion method of assembly in which high explosives are arranged to form an imploding shock wave which compresses the fissile material to supercriticality.
>
> The core of fissile material that is formed into a super-critical mass by chemical high explosives (HE) or propellants. When the high explosive is detonated, an inwardly directed implosion wave is produced. This wave compresses the sphere of fissionable material. The decrease in surface to volume ratio of this compressed mass plus its increased density is then such as to make the mass supercritical. The HE is exploded by detonators timed electronically by a fuzing system, which may use altitude sensors or other means of control.
>
> The nuclear chain-reaction is normally started by an initiator that injects a burst of neutrons into the fissile core at an appropriate moment. The timing of the initiation of the chain reaction is important and must be carefully designed for the weapon to have a predictable yield. A neutron generator emits a burst of neutrons to initiate the chain reaction at the proper moment —- near the point of maximum compression in an implosion design or of full assembly in the gun-barrel design.
>
> A surrounding tamper may help keep the nuclear material assembled for a longer time before it blows itself apart, thus increasing the yield. The tamper often doubles as a neutron reflector.
>
> Implosion systems can be built using either Pu-239 or U-235 but the gun assembly only works for uranium. Implosion weapons are more difficult to build than gun weapons, but they are also more efficient, requiring less SNM and producing larger yields. Iraq attempted to build an implosion bomb using U-235. In contrast, North Korea chose to use 239 Pu produced in a nuclear reactor.
>
> To fission more of a given amount of fissile material, a small amount of material that can undergo fusion, deuterium and tritium (D-T) gas, can be placed inside the core of a fission device. Here, just as the fission chain reaction gets underway, the D-T gas undergoes fusion, releasing an intense burst of high-energy neutrons (along with a small amount of fusion energy as well) that fissions the surrounding material more completely. This approach, called boosting, is used in most modem nuclear weapons to maintain their yields while greatly decreasing their overall size and weight.

There are many different weapons designs Iran might choose from, many different levels of fissile material requirements, and many different levels of associated risk. Iran might take the risks of producing weapons without actual testing by trusting foreign design data and ignoring key safety and reliability issues. It is also possible that Iran might claim it has nuclear weapons without actually producing them or concluding that it has them in a truly usable form. However, Iran has been cautious in the past about taking any steps than threatened the existence of its regime. It seems equally or more possible that Iran would never seriously weaponize without either full design details or some form of underground or other active testing.

As noted earlier, the IEA has reported that Iran has had many elements of an R&D and test program that examines the behavior of every other aspect of weapons performance by setting off bomb designs without fissile material and examining the result. The now dismantled facility Iran created at Parchin might well have been designed for the purpose of non-fissile testing on an entire weapons assembly.

A September 2014 report by the Institute for Science and International Security (ISIS) notes that activity at the Parchin facility had started again, raising concerns about Iran's suspected effort to develop a nuclear weapon:[14]

> Recent Digital Globe satellite imagery dated August 12, 2014 shows that some activity continues at the Parchin site. As figure 1 shows, new construction material or debris, as well as new dirt or water runoff, appear in front of three buildings in the southern part of the site. Also, light vegetation appears to be growing at the center of the site, including on the protective berm, and the construction material or debris previously identified in front of the suspected test building remains. Finally, the dirt or water runoff and some of the possible construction material that appeared in previous imagery is no longer present in front of the large building in the northern part of the site.
>
> A May 2014 ISIS Imagery Brief showed several signs of external activity at the site. ISIS noted that possible building material and debris appeared in front of two main buildings at the site. Two trucks or containers had been removed from the area surrounding the suspected high explosives test building, while a larger object, possibly a truck or large container, appeared slightly north of it. Dirt or water runoff was visible in front of the northern building and three vehicles were clearly visible at the south entrance.
>
> Previously, a February 2014 ISIS Imagery Brief confirmed IAEA reporting of possible building material and debris appearing at the site. All of this activity followed a period of lull at the site (second half of 2013) in which commercial satellite imagery showed no significant visible alterations.

Some experts feel that Iran might also seek to obtain additional design validation data in the future by using subcritical radioactive material in such a test program, a speculation some other experts discount on the grounds it might not produce a reliable indication of full scale fissile event performance.

This makes obtaining accurate estimates of how much design data Iran actually has a critical issue. The UN Panel of Experts report issued in June 2014 did, however, confirm earlier IAEA reports, and stated that,[15]

> There remain areas of concern regarding the Islamic Republic of Iran's nuclear program and its possible military dimensions. In its report of 20 February 2014, IAEA referred to its 2011 analysis of allegations that the Islamic Republic of Iran has carried out activities relevant to the development of a nuclear explosive device.
>
> Among the issues identified by IAEA in 2011 are concerns about "alleged studies" regarding "how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile"
>
> …IAEA recently noted that information regarding the Islamic Republic of Iran's development of a nuclear explosive device "is assessed by the Agency to be, overall, credible" and despite the

> country's insistence that the claims are unfounded, "the Agency has obtained more information since November 2011 that has further corroborated the analysis contained in [the annex to the Director-General's report of November 2011]"… It is not known whether the additional information addresses the integration of a nuclear payload on a delivery vehicle.

As work by Michael Eisenstadt notes that,[16]

> Iran's weapons design choices will also be influenced by the kind of foreign assistance it has received in the past, and could receive in the future. This includes a Chinese weapons design that it may have received from the AQ Khan network (reportedly a smaller, more advanced design than that the latter provided to Libya); useful insights it might have gleaned from flawed plans for a firing set that the CIA allegedly provided Iran in order to sabotage and delay its weapons program (i.e., Operation Merlin); and assistance it may have received in designing the initiation and conventional explosives system for a nuclear weapon from the Russian scientist Vyacheslav Danilenko. In light of this history, it would be prudent to assume that Iran's future weapons design efforts will continue to benefit from foreign assistance, despite best efforts by the U.S. and others to prevent it.

This leaves any effort to assess Iran's actual weaponization capability dependent on public data going back to the IAEA report in November 2011. As noted earlier, the Institute for Science and International Security summarized Vyacheslav Danilenko's contributions to the Iranian nuclear program, and gave some technical details regarding one aspect of Iran's nuclear weapons development.

The technical details in the ISIS report give a sense of the progress that Iran was able to make with external assistance:[17]

> The IAEA obtained additional information that adds credibility to the conclusion that Danilenko used his technical and practical knowledge and expertise to provide assistance to Iran's program to develop a suitable initiation system for a nuclear explosive device. The IAEA assessed that a monitoring, or diagnostic, technique described in one of his papers had a remarkable similarity to one that the IAEA saw in material from a member state about a hemispherical initiation and explosives system developed in Iran (see below). This system is also described in the IAEA safeguards report as a multipoint initiation system used to start the detonation of a nuclear explosive.
>
> The IAEA also obtained from member states details of the design, development, and possible testing of what is called in IAEA information the R265 shock generator system, which is a round multipoint initiation system that would fit inside the payload chamber of the Shahab 3 missile tri-conic nose cone. This device involves a hemispherical aluminum shell with an inside radius of 265 mm and wall thickness of 10 mm thick. Outer channels are cut into the outer surface of the shell, each channel one by one millimeter, and contain explosive material. Each channel terminates in a cylindrical hole, 5 mm in diameter, that is drilled though the shell and contains an explosive pellet. The geometrical pattern formed by channels and holes is arranged in quadrants on the outer hemispheric surface which allows a single central point of initiation and the simultaneous detonation of explosives in all the holes on the hemisphere. This in turn allows the simultaneous initiation of all the high explosives under the shell by one exploding bridgewire (EBW). If properly prepared, the R265 constitutes the outer part of an explosively driven implosion system for a nuclear device. The outer radius of the R265 system is 275 millimeters, or a diameter of 550 millimeters, less than the estimated diameter of about 600 millimeters available inside the payload chamber of a Shahab 3 (or the Sejjil-2 missile).

No credible unclassified data currently exist to show just how much outside warhead design data that Iran has received, and this highlights a much broader limit to any unclassified analysis. How much is actually known at the classified level about Iran's access to serious design data, test program, and test options is obviously uncertain. What, if anything, this says about Iran's plans and intentions is another issue. If – as seems likely – Iran has been slowly advancing a nuclear weapons program since the time of the Shah, how much have the US and other intelligence communities learned that they have not made public? Intelligence does need to protect key sources and sensitive methods, but it often uses security to conceal the fact that its analysis is almost all method and "guesstimate" and no source.

This uncertainty regarding public versus unclassified knowledge is also critical to any real world success in implementing a P5+1 agreement or dealing with its failure. Any effort to both halt and characterize Iran's programs will, after all, be part of an ongoing duel with Iranian efforts to conceal as much as possible. No unclassified analysis can really address this aspect of Iran's programs. No one can do more than speculate as to what, if anything, Iran has been able to conceal that is not known to either outside intelligence agencies or analysts of the Iranian program.

Judging the Success or Failure of a Final Agreement

These issues are critical to judging a final agreement. At best, any meaningful arms control agreement must be based on the principle of "trust but verify." For all the reasons set forth in this analysis, there is no basis for trust in any aspect of Iran's weapons related activities. This will evidently be true whether an agreement is reached, the negotiations are extended, or the negotiations collapse.

At present, however, a successful negotiation would mean that key aspects of an agreement would take part in some kind of classified and non-public annex and focus on fissile material production or rely on some future level of inspection and verification with no agreed baseline as to how far Iran has moved towards designing and being able to produce a nuclear weapon.

Delay would mean going forward with no picture of how far Iran has already gotten, how dependent it is on visible actions like actual fissile or weapons tests for success, and how long Iran would need to develop a meaningful nuclear strike capability. It also would mean going forward without any serious public US assessment of how dependent Iran's missile program are an deploying nuclear weapons or the extent to which a nuclear-armed force is critical to deterring preventive/preemptive strikes or US and Gulf escalation to major conventional strikes on Iran if Iran should conduct a major military action like using its asymmetric forces to try to bloc petroleum exports out of the Gulf.

At the same time, the lack of such data means that many judgments based solely on Iran's theoretical ability to acquire fissile material may grossly exaggerate the speed with which Iran can acquire a meaningful nuclear capability, and the need for preventive strikes.

In summary, the November deadline will occur, one way or another, without a proper basis for judging the result, in part because of Iran and in part because of a failure by the US government to lay the proper ground work for any unclassified judgment of Iran's activities and future requirements, and the ability to verify an agreement.

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Annex A: What the IAEA November 8, 2011, Report Said in Detail

No summary can fully substitute for reading what the IAEA said in its own words as taken directly from IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*.[18]

Heavy Water Production

Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran has not suspended work on all heavy water related projects, including the construction of the heavy water moderated research reactor, the Iran Nuclear Research Reactor (IR-40 Reactor), which is subject to Agency safeguards.

On 17 October 2011, the Agency carried out a DIV at the IR-40 Reactor at Arak and observed that construction of the facility was ongoing and the coolant heat exchangers had been installed. According to Iran, the operation of the IR-40 Reactor is planned to commence by the end of 2013.

Since its visit to the Heavy Water Production Plant (HWPP) on 17 August 2011, the Agency, in a letter to Iran dated 20 October 2011, requested further access to HWPP. The Agency has yet to receive a reply to that letter, and is again relying on satellite imagery to monitor the status of HWPP. Based on recent images, the HWPP appears to be in operation. To date, Iran has not provided the Agency access to the heavy water stored at the Uranium Conversion Facility (UCF) in order to take samples.

Uranium Conversion Facility

Although it is obliged to suspend all enrichment related activities and heavy water related projects, Iran is conducting a number of activities at UCF and the Fuel Manufacturing Plant (FMP) at Esfahan that, as described below, are in contravention of those obligations, although both facilities are under Agency safeguards.

…On 18 October 2011, the Agency carried out a DIV at UCF during which the Agency observed the ongoing installation of the process equipment for the conversion of UF6 enriched up to 20% U-235 into U3O8. During the DIV, Iran informed the Agency that the initial tests of this conversion line, originally scheduled to start on 6 September 2011, had been postponed and would not involve the use of nuclear material.

As previously reported, Iran informed the Agency in July 2011 that it would start R&D activities at UCF for the conversion of UF6 enriched up to 5% U-235 into UO2. During the aforementioned DIV, Iran informed the Agency that 6.8 kg of DU in the form of UF6 had been processed and that Iran had produced 113 g of uranium in the form of UO2 that met its specifications.

According to Iran, this UO2 has been sent to FMP to produce test pellets. Iran has also started using UF6 enriched to 3.34% U-235 to produce UO2. During the DIV, Iran further informed the Agency that this UO2 would also be sent to FMP to produce fuel pellets, which would then be sent to TRR for "performance test studies".

In a letter dated 4 October 2011, Iran informed the Agency of the postponement of the production of natural UF6, involving the use of uranium ore concentrate (UOC) produced at the Bandar Abbas Uranium Production Plant, originally scheduled to restart on 23 October 2011.

In a letter dated 11 October 2011, Iran informed the Agency that, from 11 November 2011, it intended to use UOC produced at the Bandar Abbas Uranium Production Plant for the production of natural uranium in the form of UO2. During the DIV on 18 October 2011, the Agency took a sample of this UOC.

During the same DIV, Iran informed the Agency that, since 23 July 2011, it had fed into the process 958.7 kg of uranium in the form of UOC31 and produced about 185.6 kg of natural uranium in the form of UO2, and further indicated that some of the product had been fed back into the process.

In a letter dated 8 October 2011, Iran informed the Agency that it had transferred about 1 kg of this UO2 to the R&D section of FMP in order to "conduct research activities and pellet fabrication."

Possible Military Dimensions

Previous reports by the Director General have identified outstanding issues related to possible military dimensions to Iran's nuclear program and actions required of Iran to resolve these. Since 2002, the Agency has become increasingly concerned about the possible existence in Iran of undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile, about which the Agency has regularly received new information.

In resolution 1929 (2010), the Security Council reaffirmed Iran's obligations to take the steps required by the Board of Governors in its resolutions GOV/2006/14 and GOV/2009/82, and to cooperate fully with the Agency on all outstanding issues, particularly those which give rise to concerns about the possible military dimensions to Iran's nuclear program, including by providing access without delay to all sites, equipment, persons and documents requested by the Agency. Since August 2008, Iran has not engaged with the Agency in any substantive way on this matter.

…The information that serves as the basis for the Agency's analysis and concerns, as identified in the Annex, is assessed by the Agency to be, overall, credible. The information comes from a wide variety of independent sources, including from a number of Member States, from the Agency's own efforts and from information provided by Iran itself. It is consistent in terms of technical content, individuals and organizations involved, and time frames.

The information indicates that Iran has carried out the following activities that are relevant to the development of a nuclear explosive device:

- Efforts, some successful, to procure nuclear related and dual use equipment and materials by military related individuals and entities (Annex, Sections C.1 and C.2);
- Efforts to develop undeclared pathways for the production of nuclear material (Annex, Section C.3);
- The acquisition of nuclear weapons development information and documentation from a clandestine nuclear supply network (Annex, Section C.4); and
- Work on the development of an indigenous design of a nuclear weapon including the testing of components (Annex, Sections C.5-C.12).

Summary of Concerns: While the Agency continues to verify the non-diversion of declared nuclear material at the nuclear facilities and LOFs declared by Iran under its Safeguards Agreement, as Iran is not providing the necessary cooperation, including by not implementing its Additional Protocol, the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.

The Agency has serious concerns regarding possible military dimensions to Iran's nuclear program. After assessing carefully and critically the extensive information available to it, the Agency finds the information to be, overall, credible. The information indicates that Iran has carried out activities relevant to the development of a nuclear explosive device. The information also indicates that prior to the end of 2003, these activities took place under a structured program, and that some activities may still be ongoing.

Given the concerns identified above, Iran is requested to engage substantively with the Agency without delay for the purpose of providing clarifications regarding possible military dimensions to Iran's nuclear program as identified in the Annex to this report.

The Agency is working with Iran with a view to resolving the discrepancy identified during the recent PIV at JHL...

Historical Overview of the Possible Military Dimension***s of Iran's Nuclear Program***

Since late 2002, the Director General has reported to the Board of Governors on the Agency's concerns about the nature of Iran's nuclear program.

Such concerns coincided with the appearance in open sources of information that indicated that Iran was building a large underground nuclear related facility at Natanz and a heavy water production plant at Arak.

Between 2003 and 2004, the Agency confirmed a number of significant failures on the part of Iran to meet its obligations under its Safeguards Agreement with respect to the reporting of nuclear material, the processing and use of undeclared nuclear material and the failure to declare facilities where the nuclear material had been received, stored and processed.

Specifically, it was discovered that, as early as the late 1970s and early 1980s, and continuing into the 1990s and 2000s, Iran had used undeclared nuclear material for testing and experimentation in several uranium conversion, enrichment, fabrication and irradiation activities, including the separation of plutonium, at undeclared locations and facilities.

In October 2003, Iran informed the Director General that it had adopted a policy of full disclosure and had decided to provide the Agency with a full picture of its nuclear activities. Following that announcement, Iran granted the Agency access to locations the Agency requested to visit, provided information and clarifications in relation to the origin of imported equipment and components and made individuals available for interviews.

It also continued to implement the modified Code 3.1 of the Subsidiary Arrangements General Part, to which it agreed in February 2003, which provides for the submission of design information on new nuclear facilities as soon as the decision to construct or to authorize construction of such a facility is taken. In November 2003, Iran announced its intention to sign an Additional Protocol to its Safeguards Agreement (which it did in December 2003 following Board approval of the text), and that, prior to its entry into force, Iran would act in accordance with the provisions of that Protocol.

Between 2003 and early 2006, Iran submitted inventory change reports, provided design information with respect to facilities where the undeclared activities had taken place and made nuclear material available for Agency verification. Iran also acknowledged that it had utilized entities with links to the Ministry of Defense in some of its previously undeclared activities.

Iran acknowledged that it had had contacts with intermediaries of a clandestine nuclear supply network in 1987 and the early 1990s, and that, in 1987, it had received a handwritten one page document offering assistance with the development of uranium centrifuge enrichment technology, in which reference was also made to a reconversion unit with casting equipment.

Iran further acknowledged that it had received a package of information related to centrifuge enrichment technology that also included a 15 page document (hereafter referred to as the "uranium metal document") which Iran said it did not ask for and which describes, inter alia, processes for the conversion of uranium fluoride compounds into uranium metal and the production of hemispherical enriched uranium metallic components.

The Agency continued to seek clarification of issues with respect to the scope and nature of Iran's nuclear program, particularly in light of Iran's admissions concerning its contacts with the clandestine nuclear supply network, information provided by participants in that network and information which had been provided to the Agency by a Member State.

This last information, collectively referred to as the "alleged studies documentation", which was made known to the Agency in 2005, indicated that Iran had been engaged in activities involving studies on a so-called green salt project, high explosives testing and the re-engineering of a missile re-entry vehicle to accommodate a new payload. All of this information, taken together, gave rise to concerns about possible military dimensions to Iran's nuclear program.

In August 2007, Iran and the Agency agreed on "Understandings of the Islamic Republic of Iran and the IAEA on the Modalities of Resolution of the Outstanding Issues" (generally referred to as the "work plan") (INFCIRC/711).

By February 2008, the four items identified in the work plan as "past outstanding issues", and the two items identified as "other outstanding issues", had been determined by the Agency to be either closed, completed or no longer outstanding. The remaining issues which needed to be clarified by Iran related to the alleged studies, together with other matters which had arisen in the course of resolving the six other issues and which needed to be addressed in connection with the alleged studies, specifically: the circumstances of Iran's acquisition of the uranium metal document, procurement and research and development (R&D) activities of military related institutes and companies that could be nuclear related; and the production of nuclear equipment and components by companies belonging to defense industries.

Between February and May 2008, pursuant to the work plan, the Agency shared with Iran information (including documentation) on the alleged studies, and sought clarifications from Iran. In May 2008, Iran submitted to the Agency a 117 page assessment of that information. While Iran confirmed the veracity of some of the information that the Agency had shared with it (such as acknowledgement of names of people, places and organizations), Iran's assessment was focused on deficiencies in form and format, and dismissed the allegations as having been based on "forged" documents and "fabricated" data.

The Agency continued to receive additional information from Member States and acquired new information as a result of its own efforts. The Agency tried without success to engage Iran in discussions about the information, and finally wrote to Iran in October 2010 to inform it about this additional information.

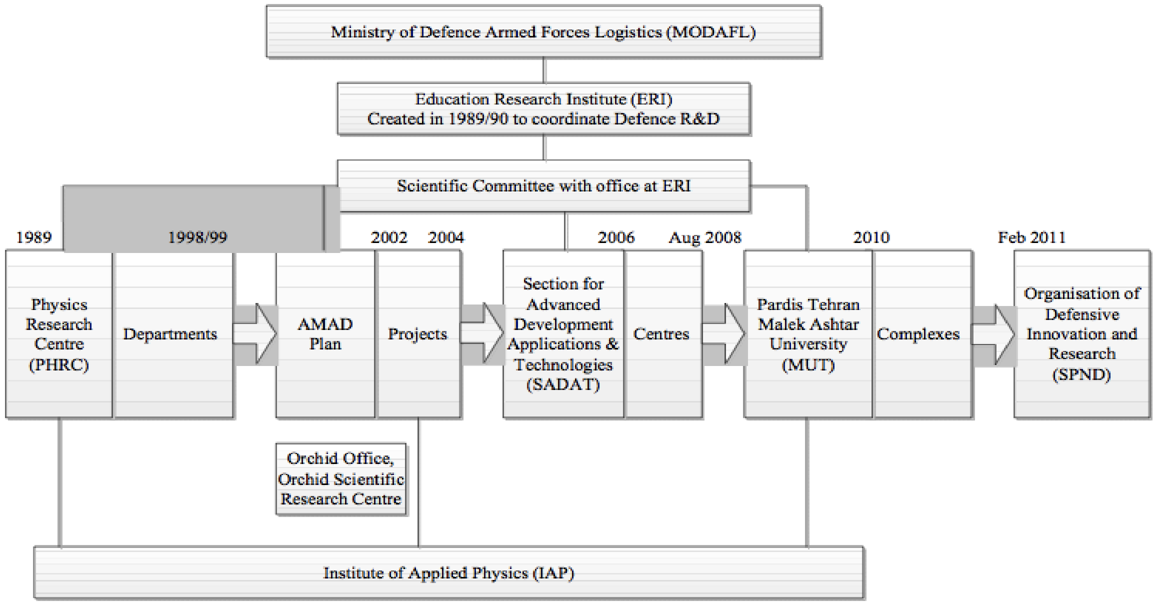
Between 2007 and 2010, Iran continued to conceal nuclear activities, by not informing the Agency in a timely manner of the decision to construct or to authorize construction of a new nuclear power plant at Darkhovin and a third enrichment facility near Qom (the Fordow Fuel Enrichment Plant). The Agency is still awaiting substantive responses from Iran to Agency requests for further information about its announcements, in 2009 and 2010 respectively, that it had decided to construct ten additional enrichment facilities (the locations for five of which had already been identified) and that it possessed laser enrichment technology…

Program Management Structure

The Agency has been provided with information by Member States that indicates that the activities referred to in Sections C.2 to C.12 were, at least for some significant period of time, managed through a program structure, assisted by advisory bodies, and that, owing to the importance of these efforts, senior Iranian figures featured within this command structure. From analysis of this information and information provided by Iran, and through its own endeavors, the Agency has been able to construct what it believes to be a good understanding of activities undertaken by Iran prior to the end of 2003.

The Agency's ability to construct an equally good understanding of activities in Iran after the end of 2003 is reduced, due to the more limited information available to the Agency. For ease of reference, the figure below depicts, in summary form, what the Agency understands of the program structure, and administrative changes in that structure over the years. Attachment 1 to this Annex provides further details, derived from that information, about the organizational arrangements and projects within that program structure. (See **Figure below.**)

Iranian Nuclear Program Structure



Departments, Projects, and Centers Relating to Iran's Nuclear Program

PHRC Departments	AMAD Plan Projects	SADAT Centers
Department 01: Nuclear Physics	Project 110: Payload Design	Center for Readiness & New Defense Technologies
Department 02: Centrifuge Enrichment	Project 111: Payload Integration	Center for R&D (1) of Explosion and Shock Technology
Department 03: Laser Enrichment	Project 3: Manufacture of Components 3.12: Explosives and EBW Detonator 3.14: Uranium Metallurgy	Center for Industrial Research & Construction
Department 04: Uranium Conversion	Project 4: Uranium Enrichment	Center for R&T (2) of Advanced Materials - Chemistry
Department 05: Geology	Project 5: Uranium Mining, Concentration, and Conversion 5.13: Green Salt Project 5.15: Gchine Mine Project	Center for R&T of New Aerospace Technology
Department 06: Health Physics	Projects 8, 9, and 10	Center for Laser and Phototonics Applications
Department 07: Workshop	Project Health and Safety	
Department 08: Heavy Water	Project 19: Involvement of IAP	
Department 09: Analytical Laboratory	Project/Group 117: Procurement and Supply	
Department 10: Computing		
Department 20: Analysis		

(1) R&D = Research & Development
(2) R&T = Research and Technology

Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

The Agency received information from Member States which indicates that, sometime after the commencement by Iran in the late 1980s of covert procurement activities, organizational structures and administrative arrangements for an undeclared nuclear program were established and managed through the Physics Research Centre (PHRC), and were overseen, through a Scientific Committee, by the Defense Industries Education Research Institute (ERI), established to coordinate defense R&D for the Ministry of Defense Armed Forces Logistics (MODAFL). Iran has confirmed that the PHRC was established in 1989 at Lavisan-Shian, in Tehran.

Iran has stated that the PHRC was created with the purpose of "preparedness to combat and neutralization of casualties due to nuclear attacks and accidents (nuclear defense) and also support and provide scientific advice and services to the Ministry of Defense". Iran has stated further that those activities were stopped in 1998. In late 2003/early 2004, Iran completely cleared the site.

According to information provided by Member States, by the late 1990s or early 2000s, the PHRC activities were consolidated under the "AMAD Plan". Mohsen Fakhrizadeh (Mahabadi) was the Executive Officer of the AMAD Plan, the executive affairs of which were performed by the "Orchid Office". Most of the activities carried out under the AMAD Plan appear to have been conducted during 2002 and 2003.

The majority of the details of the work said to have been conducted under the AMAD Plan come from the alleged studies documentation which, as indicated in paragraph 6 above, refer to studies conducted in three technical areas: the green salt project; high explosives (including the development of exploding bridgewire detonators); and re-engineering of the payload chamber of the Shahab 3 missile re-entry vehicle.

According to the Agency's assessment of the information contained in that documentation, the green salt project (identified as Project 5.13) was part of a larger project (identified as Project 5) to provide a source of uranium suitable for use in an undisclosed enrichment program.

The product of this program would be converted into metal for use in the new warhead that was the subject of the missile re-entry vehicle studies (identified as Project 111). As of May 2008, the Agency was not in a position to demonstrate to Iran the connection between Project 5 and Project 111. However, subsequently, the Agency was shown documents which established a connection between Project 5 and Project 111, and hence a link between nuclear material and a new payload development program.

Information the Agency has received from Member States indicates that, owing to growing concerns about the international security situation in Iraq and neighboring countries at that time, work on the AMAD Plan was stopped rather abruptly pursuant to a "halt order" instruction issued in late 2003 by senior Iranian officials. According to that information, however, staff remained in place to record and document the achievements of their respective projects. Subsequently, equipment and work places were either cleaned or disposed of so that there would be little to identify the sensitive nature of the work that had been undertaken.

The Agency has other information from Member States which indicates that some activities previously carried out under the AMAD Plan were resumed later, and that Mr. Fakhrizadeh retained the principal organizational role, first under a new organization known as the Section for Advanced Development Applications and Technologies (SADAT), which continued to report to MODAFL, and later, in mid-2008, as the head of the Malek Ashtar University of Technology (MUT) in Tehran. The Agency has been advised by a Member State that, in February 2011, Mr. Fakhrizadeh moved his seat of operations from MUT to an adjacent location known as the Modjeh Site, and that he now leads the Organization of Defensive Innovation and Research. The Agency is concerned because some of the activities undertaken after 2003 would be highly relevant to a nuclear weapon program.

Procurement Activities

Under the AMAD Plan, Iran's efforts to procure goods and services allegedly involved a number of ostensibly private companies that were able to provide cover for the real purpose of the procurements.

The Agency has been informed by several Member States that, for instance, Kimia Maadan was a cover company for chemical engineering operations under the AMAD Plan while also being used to help with procurement for the Atomic Energy Organization of Iran (AEOI).

In addition, throughout the entire timeline, instances of procurement and attempted procurement by individuals associated with the AMAD Plan of equipment, materials and services which, although having other civilian applications, would be useful in the development of a nuclear explosive device, have either been uncovered by the Agency itself or been made known to it.

Among such equipment, materials and services are: high speed electronic switches and spark gaps (useful for triggering and firing detonators); high speed cameras (useful in experimental diagnostics); neutron sources (useful for calibrating neutron measuring equipment); radiation detection and measuring equipment (useful in a nuclear material production environment); and training courses on topics relevant to nuclear explosives development (such as neutron cross section calculations and shock wave interactions/hydrodynamics).

Nuclear Material Acquisition

In 2008, the Director General informed the Board that: it had no information at that time — apart from the uranium metal document — on the actual design or manufacture by Iran of nuclear material components of a nuclear weapon or of certain other key components, such as initiators, or on related nuclear physics studies, and that it had not detected the actual use of nuclear material in connection with the alleged studies.

However, as indicated in paragraph 22 above, information contained in the alleged studies documentation suggests that Iran was working on a project to secure a source of uranium suitable for use in an undisclosed enrichment program, the product of which would be converted into metal for use in the new warhead which was the subject of the missile re-entry vehicle studies.

Additional information provided by Member States indicates that, although uranium was not used, kilogram quantities of natural uranium metal were available to the AMAD Plan.

Information made available to the Agency by a Member State, which the Agency has been able to examine directly, indicates that Iran made progress with experimentation aimed at the recovery of uranium from fluoride compounds (using lead oxide as a surrogate material to avoid the possibility of uncontrolled contamination occurring in the workplace).

In addition, although now declared and currently under safeguards, a number of facilities dedicated to uranium enrichment (the Fuel Enrichment Plant and Pilot Fuel Enrichment Plant at Natanz and the Fordow Fuel Enrichment Plant near Qom) were covertly built by Iran and only declared once the Agency was made aware of their existence by sources other than Iran.

This, taken together with the past efforts by Iran to conceal activities involving nuclear material, create more concern about the possible existence of undeclared nuclear facilities and material in Iran.

Nuclear Components for an Explosive Device

For use in a nuclear device, HEU retrieved from the enrichment process is first converted to metal. The metal is then cast and machined into suitable components for a nuclear core.

As indicated in paragraph 5 above, Iran has acknowledged that, along with the handwritten one page document offering assistance with the development of uranium centrifuge enrichment technology, in which reference is also made to a reconversion unit with casting equipment.

Iran also received the uranium metal document that describes, inter alia, processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components.

The uranium metal document is known to have been available to the clandestine nuclear supply network that provided Iran with assistance in developing its centrifuge enrichment capability, and is also known to be part of a larger package of information which includes elements of a nuclear explosive design.

A similar package of information, which surfaced in 2003, was provided by the same network to Libya. The information in the Libyan package, which was first reviewed by Agency experts in January 2004, included details on the design and construction of, and the manufacture of components for, a nuclear explosive device.

In addition, a Member State provided the Agency experts with access to a collection of electronic files from seized computers belonging to key members of the network at different locations. That collection included documents seen in Libya, along with more recent versions of those documents, including an up-dated electronic version of the uranium metal document.

In an interview in 2007 with a member of the clandestine nuclear supply network, the Agency was told that Iran had been provided with nuclear explosive design information. From information provided to the Agency during that interview, the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004 as having been provided to Libya by the nuclear supply network.

Additionally, a Member State provided information indicating that, during the AMAD Plan, preparatory work, not involving nuclear material, for the fabrication of natural and high enriched uranium metal components for a nuclear explosive device was carried out.

As the conversion of HEU compounds into metal and the fabrication of HEU metal components suitable in size and quality are steps in the development of an HEU nuclear explosive device, clarification by Iran is needed in connection with the above.

Detonator Development

The development of safe, fast-acting detonators, and equipment suitable for firing the detonators, is an integral part of a program to develop an implosion type nuclear device. Included among the alleged studies documentation are a number of documents relating to the development by Iran, during the period 2002-2003, of fast functioning detonators, known as “exploding bridgewire detonators” or “EBWs” as safe alternatives to the type of detonator described for use in the nuclear device design referred to in paragraph 33 above.

In 2008, Iran told the Agency that it had developed EBWs for civil and conventional military applications and had achieved a simultaneity of about one microsecond when firing two to three detonators together, and provided the Agency with a copy of a paper relating to EBW development work presented by two Iranian researchers at a conference held in Iran in 2005.

A similar paper was published by the two researchers at an international conference later in 2005. Both papers indicate that suitable high voltage firing equipment had been acquired or developed by Iran. Also in 2008, Iran told the Agency that, before the period 2002-2004, it had already achieved EBW technology.

Iran also provided the Agency with a short undated document in Farsi, understood to be the specifications for a detonator development program, and a document from a foreign source showing an example of a civilian application in which detonators are fired simultaneously. However, Iran has not explained to the Agency its own need or application for such detonators.

The Agency recognizes that there exist non-nuclear applications, albeit few, for detonators like EBWs, and of equipment suitable for firing multiple detonators with a high level of simultaneity.

Notwithstanding, given their possible application in a nuclear explosive device, and the fact that there are limited civilian and conventional military applications for such technology, Iran’s development of such detonators and equipment is a matter of concern, particularly in connection with the possible use of the multipoint initiation system referred to below.

Initiation of High Explosives and Associated Experiments

Detonators provide point source initiation of explosives, generating a naturally diverging detonation wave. In an implosion type nuclear explosive device, an additional component, known as a multipoint initiation system, can be used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density.

The Agency has shared with Iran information provided by a Member State that indicates that Iran has had access to information on the design concept of a multipoint initiation system that can be used to initiate effectively and simultaneously a high explosive charge over its surface. The Agency has been able to confirm independently that such a design concept exists and the country of origin of that design concept. Furthermore, the Agency has been informed by nuclear-weapon States that the specific multipoint initiation concept is used in some known nuclear explosive devices. In its 117 page submission to the Agency in May 2008, Iran stated that the subject was not understandable to Iran and that Iran had not conducted any activities of the type referred to in the document.

Information provided to the Agency by the same Member State referred to in the previous paragraph describes the multipoint initiation concept referred to above as being used by Iran in at least one large scale experiment in 2003 to initiate a high explosive charge in the form of a hemispherical shell. According to that information, during that experiment, the internal hemispherical curved surface of the high explosive charge was monitored using a large number of optical fiber cables, and the light output of the explosive upon detonation was recorded with a high speed streak camera. It should be noted that the dimensions of the initiation system and the explosives used with it were consistent with the dimensions for the new payload which, according to the alleged studies documentation, were given to the engineers who were studying how to integrate the new payload into the chamber of the Shahab 3 missile re-entry vehicle (Project 111) (see Section C.11 below). Further information provided to the Agency by the same Member State indicates that the large scale high explosive experiments were conducted by Iran in the region of Marivan.

The Agency has strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon program of the country of his origin. The Agency has reviewed publications by this foreign expert and has met with him. The Agency has been able to verify through three separate routes, including the expert himself, that this person was in Iran from about 1996 to about 2002, ostensibly to assist Iran in the development of a facility and techniques for making ultra-dispersed diamonds ("UDDs" or "nanodiamonds"), where he also lectured on explosion physics and its applications.

Furthermore, the Agency has received information from two Member States that, after 2003, Iran engaged in experimental research involving a scaled down version of the hemispherical initiation system and high explosive charge referred to in paragraph 43 above, albeit in connection with non-nuclear applications. This work, together with other studies made known to the Agency in which the same initiation system is used in cylindrical geometry, could also be relevant to improving and optimizing the multipoint initiation design concept relevant to nuclear applications.

The Agency's concern about the activities described in this Section derives from the fact that a multipoint initiation system, such as that described above, can be used in a nuclear explosive device. However, Iran has not been willing to engage in discussion of this topic with the Agency.

Hydrodynamic Experiments

One necessary step in a nuclear weapon development program is determining whether a theoretical design of an implosion device, the behavior of which can be studied through computer simulations, will work in practice. To that end, high explosive tests referred to as "hydrodynamic experiments" are conducted in which fissile and nuclear components may be replaced with surrogate materials.

Information which the Agency has been provided by Member States, some of which the Agency has been able to examine directly, indicates that Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten. These components were said to have incorporated small central cavities suitable for the insertion of capsules such as those described in Section C.9 below.

The end use of such components remains unclear, although they can be linked to other information received by the Agency concerning experiments involving the use of high speed diagnostic equipment, including flash X ray, to monitor the symmetry of the compressive shock of the simulated core of a nuclear device.

Other information which the Agency has been provided by Member States indicates that Iran constructed a large explosives containment vessel in which to conduct hydrodynamic experiments. The explosives vessel, or chamber, is said to have been put in place at Parchin in 2000. A building was constructed at that time around a large cylindrical object at a location at the Parchin military complex.

A large earth berm was subsequently constructed between the building containing the cylinder and a neighboring building, indicating the probable use of high explosives in the chamber. The Agency has obtained commercial satellite images that are consistent with this information.

From independent evidence, including a publication by the foreign expert referred to in paragraph 44 above, the Agency has been able to confirm the date of construction of the cylinder and some of its design features (such as its dimensions), and that it was designed to contain the detonation of up to 70 kilograms of high explosives, which would be suitable for carrying out the type of experiments described in paragraph 43 above.

As a result of information the Agency obtained from a Member State in the early 2000s alleging that Iran was conducting high explosive testing, possibly in association with nuclear materials, at the Parchin military complex, the Agency was permitted by Iran to visit the site twice in 2005.

From satellite imagery available at that time, the Agency identified a number of areas of interest, none of which, however, included the location now believed to contain the building which houses the explosives chamber mentioned above; consequently, the Agency's visits did not uncover anything of relevance.

Hydrodynamic experiments such as those described above, which involve high explosives in conjunction with nuclear material or nuclear material surrogates, are strong indicators of possible weapon development.

In addition, the use of surrogate material, and/or confinement provided by a chamber of the type indicated above, could be used to prevent contamination of the site with nuclear material. It remains for Iran to explain the rationale behind these activities.

Modeling and Calculations

Information provided to the Agency by two Member States relating to modeling studies alleged to have been conducted in 2008 and 2009 by Iran is of particular concern to the Agency. According to that information, the studies involved the modeling of spherical geometries, consisting of components of the core of an HEU nuclear device subjected to shock compression, for their neutronic behavior at high density, and a determination of the subsequent nuclear explosive yield.

The information also identifies models said to have been used in those studies and the results of these calculations, which the Agency has seen. The application of such studies to anything other than a nuclear explosive is unclear to the Agency. It is therefore essential that Iran engage with the Agency and provide an explanation.

The Agency obtained information in 2005 from a Member State indicating that, in 1997, representatives from Iran had met with officials from an institute in a nuclear-weapon State to request training courses in the fields of neutron cross section calculations using computer codes employing Monte Carlo methodology, and shock wave interactions with metals.

In a letter dated 14 May 2008, Iran advised the Agency that there was nothing to support this information. The Agency has also been provided with information by a Member State indicating that, in 2005, arrangements were made in Iran for setting up projects within SADAT centers (see Section C.1 and Attachment 1), inter alia, to establish a databank for "equation of state" information and a hydrodynamics calculation center.

The Agency has also been provided with information from a different Member State that, in 2005, a senior official in SADAT solicited assistance from Shahid Behesti University in connection with complex calculations relating to the state of criticality of a solid sphere of uranium being compressed by high explosives.

Research by the Agency into scientific literature published over the past decade has revealed that Iranian workers, in particular groups of researchers at Shahid Behesti University and Amir Kabir University, have published papers relating to the generation, measurement and modeling of neutron transport.

The Agency has also found, through open source research, other Iranian publications which relate to the application of detonation shock dynamics to the modeling of detonation in high explosives, and the use of hydrodynamic codes in the modeling of jet formation with shaped (hollow) charges. Such studies are commonly used in reactor physics or conventional ordnance research, but also have applications in the development of nuclear explosives.

Neutron Initiator

The Agency has information from a Member State that Iran has undertaken work to manufacture small capsules suitable for use as containers of a component containing nuclear material. The Agency was also informed by a different Member State that Iran may also have experimented with such components in order to assess their performance in generating neutrons.

Such components, if placed in the center of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction.

The location where the experiments were conducted was said to have been cleaned of contamination after the experiments had taken place. The design of the capsule, and the material associated with it, are consistent with the device design information which the clandestine nuclear supply network allegedly provided to Iran.

The Agency also has information from a Member State that work in this technical area may have continued in Iran after 2004, and that Iran embarked on a four year program, from around 2006 onwards, on the further validation of the design of this neutron source, including through the use of a non- nuclear material to avoid contamination.

Given the importance of neutron generation and transport, and their effect on geometries containing fissile materials in the context of an implosion device, Iran needs to explain to the Agency its objectives and capabilities in this field.

Conducting a Nuclear Test

The Agency has information provided by a Member State that Iran may have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device.

In particular, the Agency has information that Iran has conducted a number of practical tests to see whether its EBW firing equipment would function satisfactorily over long distances between a firing point and a test device located down a deep shaft.

Additionally, among the alleged studies documentation provided by that Member State, is a document, in Farsi, which relates directly to the logistics and safety arrangements that would be necessary for conducting a nuclear test.

The Agency has been informed by a different Member State that these arrangements directly reflect those which have been used in nuclear tests conducted by nuclear-weapon States.

Integration into a Missile Delivery Vehicle

The alleged studies documentation contains extensive information regarding work which is alleged to have been conducted by Iran during the period 2002 to 2003 under what was known as Project 111. From that information, *the project appears to have consisted of a structured and comprehensive program of engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile.* ***(See Figure 15 below***

According to that documentation, using a number of commercially available computer codes, Iran conducted *computer modeling studies of at least 14 progressive design iterations of the payload chamber and its* contents to examine how they would stand up to the various stresses that would be encountered on being launched and travelling on a ballistic trajectory to a target.

It should be noted that the masses and dimensions of components identified in information provided to the Agency by Member States that Iran is alleged to have been developing (see paragraphs 43 and 48 above) correspond to those assessed to have been used in Project 111 engineering studies on the new payload chamber.

During these studies, prototype components were allegedly manufactured at workshops known to exist in Iran but which Iran refused the Agency permission to visit. The six engineering groups said to have worked under Project 111 produced many technical reports, which comprise a substantial part of the alleged studies documentation.

The Agency has studied these reports extensively and finds that they are both internally consistent and consistent with other supporting information related to Project 111.

The alleged studies documentation also shows that, as part of the activities undertaken within Project 111, consideration was being given to subjecting the prototype payload and its chamber to engineering stress tests to see how well they would stand up in practice to simulated launch and flight stresses (so-called "environmental testing").

This work would have complemented the engineering modeling simulation studies referred to in paragraph 60 above. According to the information reflected in the alleged studies documentation, within Project 111, some, albeit limited, preparations were also being undertaken to enable the assembly of manufactured components.

Iran has denied conducting the engineering studies, claiming that the documentation which the Agency has is in electronic format and so could have been manipulated, and that it would have been easy to fabricate. However, the quantity of the documentation, and the scope and contents of the work covered in the documentation, are sufficiently comprehensive and complex that, in the Agency's view, it is not likely to have been the result of forgery or fabrication.

While the activities described as those of Project 111 may be relevant to the development of a non-nuclear payload, they are highly relevant to a nuclear weapon program.

Fusing, Arming, and Firing System

The alleged studies documentation indicates that, as part of the studies carried out by the engineering groups under Project 111 to integrate the new payload into the re-entry vehicle of the Shahab 3 missile, additional work was conducted on the development of a prototype firing system that would enable the payload to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground. Iran was shown this information, which, in its 117 page submission (referred to above in paragraph 8), it dismissed as being "an animation game".

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[1] International Atomic Energy Agency, "*Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*," November 8, 2011. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[2] This analysis draws on work by David Albright and other experts in the Institute for Science and International Security (ISIS) as well as the weapons annex to the International Atomic Energy Agency, "*Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*," November 8, 2011. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[3] International Atomic Energy Agency, "*Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*," November 8, 2011. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[4] Source: IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, November 8, 2011 http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf

[5] ISIS Report. "Iran's Work and Foreign Assistance on a Multipoint Initiation System for a Nuclear Weapon." David Albright, Paul Brannan, Mark Gorwitz, and Andrea Strick. November 13, 2011. http://isis-online.org/uploads/isis-reports/documents/Foreign_Assistance_Multipoint_Initiation_System_14Nov2011.pdf

[6] ISIS Report. "Iran's Work and Foreign Assistance on a Multipoint Initiation System for a Nuclear Weapon." David Albright, Paul Brannan, Mark Gorwitz, and Andrea Strick. November 13, 2011. http://isis-online.org/uploads/isis-reports/documents/Foreign_Assistance_Multipoint_Initiation_System_14Nov2011.pdf

[7] IAEA report GOV/2014/58, November 7, 2014, http://isis-online.org/uploads/isis-reports/documents/gov-2014-58.pdf.

[8] "Iranian Nuclear Talks" Testimony of David Albright, President Institute for Science and International Security (ISIS) before the Terrorism, Nonproliferation, and Trade Subcommittee, Committee on Foreign Affairs, U.S. House of Representatives, November 18, 2014, isis-online.org/uploads/conferences/documents/Albright_Testimony_Subcommittee_November_17_2014-Finalpdf.

[9] http://www.dni.gov/files/documents/Newsroom/Reports%20and%20Pubs/20071203_release.pdf.

[10] James R. Clapper, Director of National Intelligence, *Statement for the Record, Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence*, March 12, 2013, pp. 6-7.

[11] James R. Clapper, Director of National Intelligence, *Statement for the Record, Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence*, January 29, 2014, , pp. 6-7.

[12] Michael T. Flynn, Lieutenant General, U.S. Army, Director, Defense Intelligence Agency, *Annual Threat Assessment, Statement Before the Senate Armed Services Committee*, United States Senate, 11 February 2014.

[13] Federation of American Scientists (FAS), "Nuclear Weapon Design," http://fas.org/nuke/intro/nuke/design.htm.

[14] David Albright et al. "Update on Parchin: A Necessary Piece of a Comprehensive Nuclear Deal," *Institute for Science and International Security*, September 3, 2014, http://isis-online.org/isis-reports/detail/update-on-parchin-a-necessary-piece-of-a-comprehensive-nuclear-deal/.

[15] "Panel of Experts Establish Pursuant to Resolution 1929 (2010) - Final Report." Accessed via reported leak at http://www.scribd.com/doc/55737041/Leaked-UN-Panel-of-Experts-Report-on-Iran-Sanctions-May-2011, para. 12; IAEA, "Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran" (8 November 2011, GOV/2011/65, paras. 59. 64).

[16] Michael Eisenstadt, working draft of "If Iran Gets the Bomb: Weapons Design Choices and Force Structure Considerations for a Nascent Arsenal," NEPC, September 2014**.**

[17] David Albright et al., "ISIS Analysis of IAEA Iran Safeguards Report: Part II – Iran's Work and Foreign Assistance on a Multipoint Initiation System for a Nuclear Weapon," *Institute for Science and International Security*, November 2011, http://isis-online.org/isis-reports/detail/irans-work-and-foreign-assistance-on-a-multipoint-initiation-system-for-a-n/.

[18] International Atomic Energy Agency, "*Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*," November 8, 2011. http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_8Nov2011.pdf .