



## Syria's Unresolved Nuclear Issues Reemerge in Wake of ISIL Advance and Ongoing Civil War

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*The destroyed Al Kibar reactor site in Syria is now under the control of ISIL/Daesh, which is apparently dismantling and possibly conducting excavation activities at the site (see figure 1). Its intentions are unknown. There is no new information about Syria's supply of uranium that would have been used in the destroyed reactor, although it is not believed to be at the reactor site or in the hands of ISIL/Daesh. New information adds support that Syria intended to build a plant to separate plutonium from the reactor's irradiated fuel. Although Syria is no longer believed to have an active, secret nuclear reactor program at this time, it is believed to be hiding assets associated with its past undeclared nuclear efforts. These unresolved nuclear concerns coupled with the deteriorating security situation in Syria, caused by the on-going civil war and advances by ISIL/Daesh, continue to raise concerns about the security of any nuclear materials, including an alleged large stock of natural uranium, nuclear-related equipment, and nuclear scientists and engineers still present in the country. There is concern that nuclear material could end up in the hands of terrorists, pariah states, or those who may wish to sell it on the black market. The natural uranium, alleged to exceed 50,000 kilograms, is not as readily usable as Syria's past chemical weapons stockpile, because it requires further enriching to be usable in a nuclear weapon. This amount of natural uranium would be enough, if enriched to weapon-grade, for at least 3-5 nuclear weapons. Therefore, Syria's nuclear assets need to be located and placed under international monitoring or removed from the country.*

Few doubt that Syria was building a nuclear reactor with the aid of North Korea when the reactor was bombed by Israel in September 2007. Although Syria is no longer believed to have an active, secret nuclear program, it is believed to be hiding and retaining assets associated with this past undeclared nuclear reactor effort. Such a reactor is accompanied by a range of nuclear and other materials, such as natural uranium, specialized equipment, expertise, and know-how. But where are the remains of this program? Where is the natural uranium fuel for the reactor? What has become of the scientists and engineers assigned to the program? Was Syria planning to separate the plutonium? If so, did it have designs for a plutonium separation plant and some of the necessary equipment? Who controls the remains? What can the International Atomic Energy Agency (IAEA) do, other than providing its past assessment that the bombed site was likely a gas-graphite reactor large enough to support a small nuclear weapons program?

The remnants of Syria's undeclared nuclear program pose a proliferation risk. Any known or suspected nuclear materials inside Syria are not as readily usable as a chemical weapons stockpile. For example, natural uranium is not readily usable in a nuclear weapon unless it is further enriched to highly enriched uranium (HEU) or put in a reactor to make plutonium and subsequently separated from the irradiated fuel. Natural uranium is a weak radioactive source and thus a poor choice for a dirty bomb. Nonetheless, the allegedly large stock of natural uranium, other nuclear-related materials, equipment, and other resources associated with the past

nuclear program would be attractive to terrorists, certain states, and commodity traffickers. They may wish to sell these goods on the black market or otherwise seek to use them to extract concessions or cause damage. This material may also end up in undeclared nuclear programs of other states.

This report seeks to update the situation with new, albeit limited, information. It is a follow-on to earlier reports.<sup>1</sup> As recommended before, Syria's nuclear assets, particularly those that were part of its undeclared nuclear efforts, need to be located and placed under international monitoring or removed from the country.

## Al Kibar Reactor Site

The reactor was damaged heavily in the Israeli bombing and by subsequent Syrian cover-up activities. After the 2007 bombing, Syria dug up parts of the reactor, conducted a huge explosion of the site, buried any remnants of the reactor, and constructed a building over the old site, making excavation more difficult (see figure 2).<sup>2</sup>

Since about late 2012 or early 2013, this site has not been under the control of the Syrian government. It was seized first by the Free Syrian Army (FSA) and then by ISIL/Daesh. In February 2013, videos posted on Armscontrolwonk.org showed that Syrian rebels seized the Al Kibar reactor site, which had been transformed into a scud missile storage and launching site in 2009.<sup>3</sup> However, ISIL/Daesh is reported to have taken over the site (and perhaps the missiles)<sup>4</sup> from the Free Syrian Army in early summer 2014.<sup>5</sup> Additionally, there are some very recent unconfirmed reports stating that ISIL/Daesh has been "excavating" the nuclear site, "looking for radioactive material", and leaving "empty metal barrels" in the area.<sup>6</sup>

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<sup>1</sup> See David Albright and Robert Avagyan, "Syria's Past, Secret Nuclear Program Poses Proliferation Risks," ISIS Imagery Brief, September 12, 2013, [http://isis-online.org/uploads/isis-reports/documents/Marij\\_as\\_Sultan\\_12sept2013.pdf](http://isis-online.org/uploads/isis-reports/documents/Marij_as_Sultan_12sept2013.pdf); Paul Brannan, "ISIS Analysis of IAEA Report on Syria: IAEA Concludes Syria 'Very Likely' Built a Reactor, ISIS Report, May 24, 2011, [http://isis-online.org/uploads/isis-reports/documents/ISIS\\_Analysis\\_IAEA\\_Report\\_Syria\\_24May2011.pdf](http://isis-online.org/uploads/isis-reports/documents/ISIS_Analysis_IAEA_Report_Syria_24May2011.pdf); David Albright and Paul Brannan, "Satellite Image Shows Suspected Uranium Conversion Plant in Syria," ISIS Imagery Brief, February 23, 2011, <http://isis-online.org/isis-reports/detail/satellite-image-shows-suspected-uranium-conversion-plant-in-syria1/14>; David Albright and Paul Brannan, "The Al Kibar Reactor: Extraordinary Camouflage, Troubling Implications," ISIS Report, May 12, 2008, [http://isis-online.org/uploads/isis-reports/documents/SyriaReactorReport\\_12May2008.pdf](http://isis-online.org/uploads/isis-reports/documents/SyriaReactorReport_12May2008.pdf); David Albright and Paul Brannan, "Syria Update III: New information about Al Kibar reactor site," ISIS Report, April 24, 2008, [http://isis-online.org/uploads/isis-reports/documents/SyriaUpdate\\_24April2008.pdf](http://isis-online.org/uploads/isis-reports/documents/SyriaUpdate_24April2008.pdf); "New Construction at Syrian Site, ISIS Report, January 14, 2008, <http://isis-online.org/uploads/isis-reports/documents/Syria14January2008.pdf>; "Syria Update II: Syria Buries Foundation of Suspect Reactor Site" ISIS Report, October 26, 2007, <http://isis-online.org/uploads/isis-reports/documents/SuspectSiteUpdate26October2007.pdf>; David Albright, Paul Brannan, and Jacqueline Shire, "Syria Update: Suspected Reactor Site Dismantled," ISIS Report, October 25, 2007, <http://isis-online.org/uploads/isis-reports/documents/SyriaUpdate25October2007.pdf>; David Albright and Paul Brannan, "Suspect Reactor Construction Site in Eastern Syria: The Site of the September 6 Israeli Raid?" ISIS Report, October 23, 2007, [http://isis-online.org/uploads/isis-reports/documents/SuspectSite\\_24October2007.pdf](http://isis-online.org/uploads/isis-reports/documents/SuspectSite_24October2007.pdf).

<sup>2</sup> Background Briefing with Senior U.S. Officials on Syria's Covert Nuclear Reactor and North Korea's Involvement, April 24, 2008. [www.fas.org/irp/news/2008/04/odni042408.pdf](http://www.fas.org/irp/news/2008/04/odni042408.pdf)

<sup>3</sup> Jeffrey Lewis, "FSA Overruns Al Kibar," Armscontrolwonk.com, February 25, 2013, <http://lewis.armscontrolwonk.com/archive/6309/fsa-overruns-al-kibar>; George Jahn, "Syria Built Missile Facility Over Bombed Site, Officials Say," Associated Press, February 25, 2009, [http://www.boston.com/news/world/middleeast/articles/2009/02/25/syria\\_built\\_missile\\_facility\\_over\\_bombed\\_site\\_officials\\_say/](http://www.boston.com/news/world/middleeast/articles/2009/02/25/syria_built_missile_facility_over_bombed_site_officials_say/).

<sup>4</sup> When FSA captured Al Kibar in February 2013, they released videos of the site, showing three static launchers, two with missiles, identical to the one ISIL displayed in a parade through Al-Raqqa (apprx. 100 km from Al Kibar) in July 2014. Jeremy Binnie, "ISIL displays captured weapons", IHS Jane's Defence Weekly, July 2, 2015, <http://www.janes.com/article/40256/isil-displays-captured-weapons>

<sup>5</sup> "Report: Islamic State Excavating Destroyed Syrian Nuclear Site", JewishPress.com, June 1, 2015, <http://www.jewishpress.com/news/breaking-news/report-islamic-state-excavating-destroyed-syrian-nuclear-site/2015/06/01/>

<sup>6</sup> Daniel Greenfield, "Good News – ISIS Digging Through Ruins of Syrian Nuclear Reactor", Front Page Mag, June 1, 2015, <http://www.frontpagemag.com/2015/dgreenfield/good-news-isis-digging-through-ruins-of-syrian-nuclear-reactor/>

After the recent reporting, ISIS purchased and analyzed Airbus commercial satellite imagery of the Al Kibar site. Figure 1 shows an image dated June 11, 2015 which shows the building erected over the remnants of the buried reactor. But in a significant change, the new imagery also shows that more of the roof and perhaps other parts of the building are now being dismantled. Additionally, the absence of the roof on a section of the building allows the visualization of two soil patches, possibly related to the reported excavation activities, and the presence of an unidentified cube-shaped object inside the building.

## Uranium Fuel for the Al Kibar Reactor Site

The fate of reactor fuel to be used at the Al Kibar site remains a mystery and source of concern given the deteriorating security situation in the country. Previous [ISIS reports](#) examined the fate of the fuel and Syria's alleged fuel fabrication capabilities.<sup>7</sup> To summarize, this type of reactor holds about 50,000 kilograms of uranium fuel, where each rod has a mass of about 6 kilograms (kg), meaning that a core contains over 8,000 fuel rods. IAEA inspectors estimated, based on available information, that the reactor core had 843 fuel channels and a thermal power of 25 megawatts-thermal or more.<sup>8,9</sup> The Al Kibar reactor was reportedly close to completion before it was destroyed. Therefore, U.S. governmental analysts assessed that Syria was likely already in possession of the fuel necessary to start the reactor.<sup>10</sup> However, there is not enough information available to determine the fate of the uranium. The potential size of the stock of uranium would make it an attractive target for a range of groups.

## Fuel Location Today

Although some uranium was present at the Al Kibar site, most assessments suggest that at the time of the 2007 Israeli airstrike the core of the Al Kibar reactor had not been loaded with fuel, or if it were, Syria likely removed the fuel after the bombing. In any case, it remains unknown what exactly happened to the fuel. The fuel could have been moved to a number of locations. Moreover, it could have been given to North Korea for safekeeping. Determining its location must remain a priority, especially given the worsening of the Syrian civil unrest coupled with the advance of ISIL/Daesh throughout the country. Is the uranium still in Syria? Is this stock at risk of theft or diversion by opposition forces or worse, ISIL/Daesh? There is concern that this uranium stock could end up in the hands of those who may wish to sell it on the black market or otherwise seek to use it to extract concessions or cause damage. This material may also end up in undeclared programs of other states. Fifty tonnes of natural uranium would be enough, if enriched to weapon-grade, for 3-5 nuclear weapons, depending on centrifuge efficiency and cascade operations.

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<sup>7</sup> See "Syria's Past, Secret Nuclear Program Poses Proliferation Risks," op. cit.; "ISIS Analysis of IAEA Report on Syria: IAEA Concludes Syria 'Very Likely' Built a Reactor," op. cit.; "Satellite Image Shows Suspected Uranium Conversion Plant in Syria," op. cit.; "The Al Kibar Reactor: Extraordinary Camouflage, Troubling Implications," op. cit.; "Syria Update III: New information about Al Kibar reactor site," op. cit.; "New Construction at Syrian Site," op. cit.; "Syria Update II: Syria Buries Foundation of Suspect Reactor Site" op. cit.; "Syria Update: Suspected Reactor Site Dismantled," op. cit.

<sup>8</sup> IAEA Director General, Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic, GOV/2011/30, May 24, 2011. [http://isis-online.org/uploads/isis-reports/documents/Syria\\_24May2011.pdf](http://isis-online.org/uploads/isis-reports/documents/Syria_24May2011.pdf).

<sup>9</sup> "Syria's Past, Secret Nuclear Program Poses Proliferation Risks," op. cit.

<sup>10</sup> Background Briefing with Senior U.S. Officials on Syria's Covert Nuclear Reactor and North Korea's Involvement, April 24, 2008. [www.fas.org/irp/news/2008/04/odni042408.pdf](http://www.fas.org/irp/news/2008/04/odni042408.pdf). For background on North Korean gas-graphite reactors see, Albright and Kevin O'Neill, Solving the North Korean Nuclear Puzzle (ISIS Press, Washington, D.C., 2000). The mass of 50 tonnes is the uranium mass only.

## Marj as Sulṭān Site: Uranium Conversion and Fuel Fabrication Site

There is no new information about Syria's alleged, small uranium conversion and fabrication facility at the Marj as Sulṭān site, which ISIS has discussed in earlier reports.<sup>11</sup> In Google Earth imagery from June 2014, this site appeared to still be inactive as a nuclear site or as a location of any uranium. That view still appears to be true today.

The Marj as Sulṭān site is located in an area called Eastern Ghouta, nine miles outside of Damascus. For the Syrian rebels, Eastern Ghouta has been a strategic location used to organize and launch attacks ever since the beginning of the struggle against the Syrian regime in 2011. The site is located adjacent to a military depot that witnessed fighting between government and rebel forces in late fall of 2012.

In a September 2013 [ISIS Imagery Brief](#), ISIS analyzed commercial satellite images from November and December 2012 and February 2013 to confirm [reports](#) that suspicious activity occurred at the Marj as Sulṭān site.<sup>12</sup> This imagery showed signatures consistent with vegetation clearing, the digging of trenches (possibly defensive ones), the destruction of a shed, and remnants of equipment at the site. Additionally, in late November of 2012, Syrian rebels seized, and for a short period held the Marj as Sulṭān military helicopter base located less than three kilometers from this area, increasing the likelihood that the Marj as Sulṭān site did in fact see fighting in late October or early November.<sup>13</sup> The stark difference between the satellite images from 2012 and 2013 as compared to imagery from 2008 suggested that fighting had probably occurred in the area.

The site was subsequently abandoned by the government, according to an informed government official. It was reportedly in rebel-controlled territory since late 2012 or early 2013.<sup>14</sup> Moreover, this site is within a few kilometers of the areas which the Syrian regime attacked with chemical weapons on August 21, 2013, killing hundreds of civilians. It is likely that any uranium that had been stored at this site would have been removed prior to 2012.

## Plutonium Separation Plant

On April 24, 2008, when the U.S. government declassified its assessment that the site bombed by Israel was a nuclear reactor, it was largely silent in the public domain on any evidence about the existence of a plutonium separation plant. Such a plant would have given Syria a capability to separate plutonium produced by the reactor and use it in nuclear weapons. A U.S. charge that Syria was building a plant to separate plutonium, and thus establishing a concrete ability to make nuclear weapons, would have been highly inflammatory concerning both Syria and North Korea. To make such a charge, the U.S. intelligence community would have required high confidence in the evidence of a plutonium separation plant, something it apparently did not have. Although the U.S. government stated that it had high confidence that the site housed a nuclear reactor, the lack of clear evidence about a reprocessing plant contributed to a public U.S. government judgement that there was low confidence in the statement that the reactor was part of a nuclear weapons program.

That does not mean that the topic had not been hotly debated in the government. In briefings received by one of the authors on April 24, 2008, U.S. government officials expressed different opinions, albeit omitting any details, about the evidence of the existence of a plutonium separation plant. Some said they expected it to be

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<sup>11</sup> "Syria's Past, Secret Nuclear Program Poses Proliferation Risks," op. cit.

<sup>12</sup> "Syria's Past, Secret Nuclear Program Poses Proliferation Risks," op. cit.

<sup>13</sup> "Syria rebels seize Marj al-Sultan base near Damascus," BBC News, November 26, 2012.

<sup>14</sup> "Syrian Army Advances, Controls Strategic Region in Reef Damascus," Fars News Agency, August 12, 2013.

there but had no information. Others were intensely skeptical that a plutonium separation plant was in the works.

However, the U.S. government did not in fact reveal all the information it possessed about this issue. Subsequently, ISIS has learned that information about a plutonium separation plant was provided to the U.S. government in 2007 and later to the IAEA, but that neither has been able to confirm this information. According to this information, Syria had chosen a site for a plutonium separation plant, fenced in the selected area, and possessed a design for the plant. However, at the time of the bombing, according to this information, no construction had yet taken place at this site.

That there could be a plutonium separation plant is not surprising, and U.S. officials' statements expecting one are justified. This type of reactor uses a type of fuel that is difficult to store for the long term; its cladding corrodes readily in water.<sup>15</sup> Moreover, in the North Korean case, its plutonium separation plant emerged a few years after its small gas-graphite reactor started. Thus, the absence in Syria of a construction site dedicated to plutonium separation would not be unusual and would be consistent with the North Korean experience, which after all was the model for Syria.

The IAEA has investigated the evidence of the planned construction of a plutonium separation facility. It reported that Syria acquired materials that may have been intended to be used for the construction of hot cells, shielded spaces used in the initial steps of separating plutonium from highly radioactive irradiated fuel.<sup>16</sup>

The IAEA reported in 2011:

*Large quantities of barite [mineral containing barium sulfate] were purchased by the AECS [Syrian Atomic Energy Agency] between 2002 and 2006. Syria has stated that the material was to be used for shielded radiation therapy rooms at hospitals, without providing any supporting information. However, the end use of the barite as stated in the actual shipping documentation indicates that the material was intended for acid filtration. Additionally, the delivery of the barite was stopped at the request of the AECS after the destruction of the building at the Dair Alzour [Al Kibār reactor] site and the remaining quantity was left undelivered. Given that barite is frequently used to improve radiation shielding properties of concrete, and the inconsistency concerning the end use of the barite and the involvement of the AECS in its procurement, the Agency cannot exclude the possibility that barite may have been intended for use in the construction of shielded spaces for purposes linked to nuclear fuel cycle related facilities.<sup>17</sup>*

Although the evidence for a plutonium separation plant remains unsubstantiated, it was more substantial than revealed in April 2008 by the U.S. government. Why was this?

It should be noted that the U.S. declassification of information about Syria's reactor program was highly controversial within the U.S. government. Consensus on what the United States should release was subject to intense internal debate. Once the decision had been made to declassify the existence of the reactor, this debate was not so much over the existence of the reactor and extensive North Korean aid in that effort, but

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<sup>15</sup> *Solving the North Korean Nuclear Puzzle*, op cit.

<sup>16</sup> ISIS was only able to determine that the company that obtained the barite was based in Hong Kong and that the Syrian Atomic Energy Agency had contracted with this Hong Kong company for the barite which in turn acquired it in China. When the Syrian Atomic Energy Agency suspended the contract in 2008, the Hong Kong company sued since it had already bought all of the required quantity in China. However, the identity of this company remains unknown.

<sup>17</sup> IAEA, Implementation of the NPT Safeguards Agreement in the Syrian Arab Republic, GOV/2011/30, May 24, 2011.

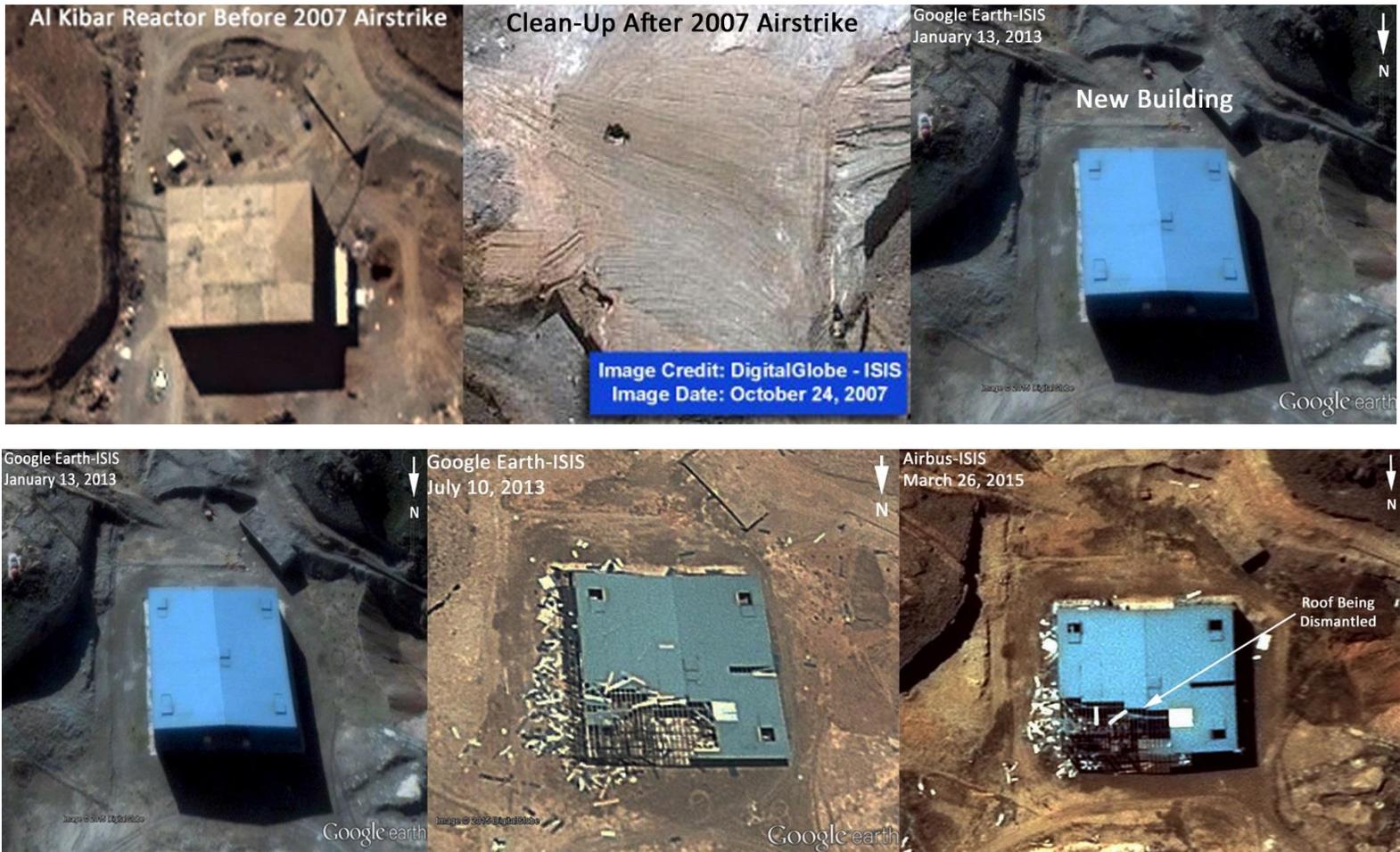
whether the evidence proved that North Korea was helping Syria build nuclear weapons. The existence of a plutonium separation plant would have hugely supported such a charge. And this charge of complicity in helping Syria obtain nuclear weapons, if made publicly by the U.S. government, could have scuttled on-going U.S. nuclear negotiations with North Korea. The side supporting on-going U.S./North Korean negotiations was understandably hesitant to accept anything but rigorously reviewed evidence of a plutonium separation plant. They argued that statements about the existence of a plutonium separation plant required a high level of confirmation, which the intelligence community could not provide. Thus, the sides reached an uneasy equilibrium encapsulated in the U.S. statements that the intelligence community had high confidence about the existence of the reactor but low confidence in statements that Syria had a plutonium separation plant, or more broadly, a non-peaceful nuclear program. But justified caution about evidence of nuclear proliferation activities should not be interpreted as equivalent to disproving the evidence. The issue of whether Syria was intending to separate plutonium and build nuclear weapons deserves continued attention.

## Conclusion

Regardless of the purpose of Syria's nuclear reactor program at Al Kibar, the deteriorating situation in Syria raises serious concerns about the security of nuclear material, equipment, and scientists. It is extremely important that Syria's nuclear assets are located and placed under international monitoring or removed from the country.



**Figure 1.** Airbus imagery dated June 11, 2015 showing the dismantlement of portions of the building that covered the site of the Al Kibar reactor building after the 2007 Israeli airstrike. The fact that soil is visible inside the building suggests that excavation efforts could be taking place.



**Figure 2.** Airbus/Google Earth/DigitalGlobe imagery the Al Kibar reactor building before the 2007 airstrike (top left), the building that was built after the airstrike (top right), and the dismantlement efforts between July 2013 and March 2015 (bottom images).