Institute for Science and International Security

ISIS REPORT

September 17, 2012

# Revisiting Danilenko and the Explosive Chamber at Parchin: A Review Based on Open Sources

*With increased concern about Iran's activities at the Parchin military site, ISIS revisits open source information on Vyacheslav Danilenko and his activities in Iran that could have supported Iran's past nuclear weapons efforts involving high explosive testing at Parchin. Danilenko's own writings support that he had considerable skills and knowledge gained from the Soviet nuclear weapons program. They also add credence to the IAEA's concerns that the explosive chamber at Parchin could have contained high explosive tests relevant to a nuclear weapons development program. As part of this ISIS review, Mark Gorwitz has produced a separate, more extensive survey of Danilenko's technical writings, and ISIS translated part of Danilenko's 2003 book from Russian that has direct relevance to an explosive chamber at Parchin.*

By David Albright and Robert Avagyan

In the August 30, 2012 International Atomic Energy Agency (IAEA) safeguards report on Iran, the IAEA underlined that "Iran, in addition to carrying out activities at Parchin which hamper effective verification, has also simply dismissed its concerns or has not responded to "the Agency's initial questions on Parchin and the foreign expert" who is alleged to have contributed to Iran's high explosive activities at Parchin that were part of a nuclear weapons development effort. ISIS earlier identified this expert as former Soviet nuclear weapons expert Vyacheslav V. Danilenko.

The IAEA also stated in its recent safeguards report that based on information provided by member states, Iran constructed a "large explosives containment vessel in which to conduct hydrodynamic experiments. The information also indicates that this vessel was installed at the Parchin site in 2000. The location at the Parchin site of the vessel was only identified in March 2011. The Agency notified Iran of that location in January 2012." After Iran was notified, it started large-scale activities that appear aimed at sanitizing the site to prevent an IAEA investigation from finding incriminating evidence. (Many of these apparent sanitization activities are reported in ISIS satellite imagery briefs). In media reports, at least one of these experiments is stated to have contained natural uranium metal or specialized compounds of uranium and deuterium.

The IAEA Board of Governors passed a resolution on September 13, 2012 stressing that it is "essential for Iran to immediately conclude and implement" an agreement on a structured approach for resolving outstanding issues related to possible military dimensions, including "as a first step providing the access the IAEA has requested to relevant sites." It added that the Board decided that "Iranian cooperation with IAEA requests aimed at the resolution of all outstanding issues is essential and urgent to restore international confidence in the exclusively peaceful nature of Iran's nuclear program." The IAEA's immediate access to Parchin and credible Iranian answers about Danilenko's activities are a critical part of meeting the requirements of this Board resolution.

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**Danilenko's Alleged Activities**

The IAEA suspects that Danilenko was involved in building the explosive chamber seen in satellite images at Parchin.[1] Danilenko reportedly has denied that he did work on this chamber. However, his stance is contradicted by a statement to the media by his former son-in-law that the container was built under Danilenko's direct supervision.

Danilenko has admitted to being in Iran and helping Iran on the dynamic detonation synthesis of diamonds, and the IAEA (and ISIS) acknowledges that Danilenko did such work for Iran. But did he do more? In a statement to the IAEA a few years ago, he denied helping Iran develop nuclear weapons, but he admitted that he could not exclude that the information he provided was used for other purposes, namely nuclear weapons. Despite his denials, however, the IAEA suspects he also helped Iran's nuclear weapons effort more than he has admitted so far.

**Nuclear Weapons Expertise**

Danilenko is of particular concern because of his extensive knowledge of key technologies critical to making nuclear weapons, particularly initiating them. Mark Gorwitz, an expert on open source technical literature, has investigated Danilenko's background and prepared a detailed report for ISIS. A summary of Gorwitz' report is:

> While at Chelyabinsk-70 from the 1960s until the late 1980s, Vyacheslav Danilenko developed deep expertise in high explosion compaction (compression) methods which had been developed for application in nuclear weapons and high speed diagnostics of high explosive phenomena. While at this premier nuclear weapons site, Danilenko worked with many of the greats of Russian nuclear science. He applied this knowledge to the explosive formation, compaction, and sintering of diamonds. Initially, according to Danilenko himself, experiments aimed at methods for diamond synthesis were highly classified because they depended on considerable knowledge applicable to the design of nuclear weapons.[2] For security reasons, the methods were initially contained only in secret reports from Chelyabinsk-70. Overall, his knowledge of nuclear weapons related technologies and methods would have been highly valuable to the nuclear weapons program of a proliferant state, such as Iran.

Gorwitz discovered in Danilenko's writings direct confirmation that the technology used to make diamonds depended on highly classified information gained from Soviet nuclear weapons development. Danilenko considers himself one of the world's experts on this technology. According to Gorwitz, Danilenko's technical writings demonstrate considerable knowledge of the technologies of compression and high speed diagnostics that are critical in the development of fission weapons based on the implosion method. It is implosion designs that the IAEA believes Iran was developing while Danilenko was in Iran in the late 1990s and early 2000s. Moreover, he had been recruited to come to Iran by Dr. Seyed Abbas Shahmoradi, then leader of Iran's Physics

[1] The chamber was placed or assembled at the site prior to the construction of the building. The IAEA has several satellite images, which were provided by a member state, that show the chamber at the Parchin site and subsequently show the construction of a roof and walls around the chamber. See: George Jahn, "New Image Reportedly Depicts Iran's Military Nuclear Testing Site," Associated Press. May 13, 2012. The IAEA likely did not receive these images from the member state until March 2011.

[2] "At that time, experiments aimed at methods for diamond synthesis were highly classified because they depended on considerable knowledge applicable to the design of nuclear weapons. For security reasons, the methods were initially contained only in secret reports from the VNIITF [Chelyabinsk-70]. Only in 1987 were parts of those reports forwarded to other members of the 'diamond club'." From Danilenko, V.V. (2004). On the History of the Discovery of Nanodiamond Synthesis, *Physics of the Solid State*, 46(4), 595-599. See report by Gorwitz, p. 3.

Research Center, which was heading a parallel military nuclear program. Shahmoradi would have recognized the value of Danilenko's skills and knowledge to a nascent nuclear weaponization program.[3]

Danilenko has denied that he is an expert in nuclear physics or nuclear warheads modeling. According to Gorwitz, "Danilenko is correct that he is not a physicist, and his contributions to nuclear weapons science should instead be looked at from the material science point of view."

Given his background, Danilenko should have had reason to believe that his knowledge and expertise could be misused by the Iranians. His statement to the IAEA about the possible misuse of his assistance acknowledged as much. His expertise and research in shock compression and high speed diagnostics would have been immensely useful to an Iranian implosion development program of the type that the IAEA's evidence supports being conducted in Iran while Danilenko was there.

**High Explosive Chamber at Parchin**

In addition to his expertise in nanodiamond production and nuclear weapons technologies, Danilenko is acknowledged as an expert in high explosive chambers. Based on his writings, he has been involved in the design, production, and employment of a multitude of explosive chambers capable of containing blasts from devices ranging from holding a few grams to hundreds of kilograms of high explosives. He wrote: "In 1991 at the VNIIEF, a unique experiment on UDD [ultra dispersed diamonds] synthesis [sic] by exploding a charge with a mass of 140 kg in a water jacket was carried out in a chamber 300 $m^3$ in volume."[4] Even larger charges were tested in Russia. He explained: "In 1980 in Russia two spherical chambers were built with a diameter of 12 m, wall thickness 100mm, mass 350 tonnes, and volume of 905$m^3$, designed for explosive devices of up to 1 tonne. For the construction of the chambers the unique, very strong and elastic steel AK-36 was used. In such a chamber were conducted explosions of devices of 250 kg mass, one of 500 kg and one more of 1 tonne of TNT."[5]

Danilenko emphasizes that the main distinguishing characteristic of explosive chambers is their internal volume on which depends the maximum mass of the explosive device. As a general rule of thumb, for every one kilogram of explosive material there needs to be 1-4 cubic meters of volume. But he also describes several other techniques used by Soviet and Russian developers to reduce the blast pressure and ensure the survival of the chamber. These include using multi-layer steel shells, surrounding the explosive with sand, water, or foam shells, spraying the chamber with water, and placing the chamber under vacuum. The issue of shrapnel within the chamber, Danilenko writes, was solved with the use of wood sheets, asbocement[6] tubes, or steel screens.[7]

Danilenko's writings directly contradict claims that explosive chambers cannot contain more than 10 kilograms of high explosives. (See also a report by Susan Voss on the *Nuclear Diner* blog). His writings also imply in a

[3] The IAEA has asked to interview Shahmoradi about his activities with the Physics Research Center but Iran has refused. The IAEA interviewed him several years ago but he refused to discuss the Physics Research Center and his activities as its head. He also held a faculty position at Sharif University while he headed the Physics Research Center and was more willing to discuss at least some of his activities associated with Sharif University. The recent Board resolution's also covers the outstanding issues centered on Shahmoradi and the Physics Research Center.

[4] Vyskubenko, B.A., Danilenko, V.V., Lin, E.E., Mazanov, V.A., Serova, T.V., Sukharenko, V.I. & Tolochko, A.P. (1992). Effect of Scale Factors on the Sizes and Yields of Diamonds in Detonation Synthesis, Physics of Combustion and Explosion, 28(2), 108-109.

[5] V. V. Danilenko, *Sintez i Spekanie Almaza Vzryvom* (Explosive Synthesis and Sintering of Diamonds), Energoatomizdat, 2003, p. 89.

[6] Asbocement is cement that contains 10-15 percent asbestos for added strength or fireproofing.

[7] *Sintez I Spekanis,* op. cit., chapter 3, which is on explosive chambers.

thorough manner that these explosive chambers could contain hydrodynamic tests or other tests relevant to nuclear weapons.

Based on his expertise, Danilenko certainly was well qualified to have designed and overseen the construction of the explosive chamber at Parchin, as alleged by his former son-in-law. In Danilenko's 2003 book, there is additional support for his involvement in the design and manufacture of the chamber at Parchin.

Danilenko's writings describe a chamber that he designed in 1999 and 2000 that is strikingly similar to the one at Parchin. According to Olli Heinonen, a senior fellow at the Belfer Center at Harvard University and former Deputy Director General of IAEA, the IAEA obtained a photo of the chamber installed at Parchin that was built by the Iranian company Azar AB Industries. The Associated Press obtained a description and drawing of the chamber built for the Parchin site from a country tracking Iran's nuclear program. The drawing was based on information from a person who had seen the chamber at the Parchin site. Based on this information, the IAEA concluded that the chamber at Parchin is akin to one designed by Danilenko and described in his 2003 book, titled *Sintez i Spekanie Almaza Vzryvom* (Explosive Synthesis and Sintering of Diamonds), which a European intelligence agency said he wrote based on the lectures he delivered in Iran. In his book, parts of which ISIS has translated from Russian, he states that in 1999-2000, he designed a cylindrical chamber of 4.6 x 19 $m^2$ with a volume of 315 $m^3$ capable of withstanding multiple explosions of devices up to 70 kg. The chamber's air-water system is pictured in figure 3.3 (figure 1 in this report). The external part of the central section of a length of 9 meters is strengthened with a reinforced concrete square section of 7.6 x 7.6 $m^2$ and a mass of 700 tonnes. Before an explosion, the chamber can be showered with water, and a vacuum can be created.[8] These dimensions and characteristics of this chamber are similar to those of the Parchin chamber described by the media.[9]

[8] Ibid., p. 90.

[9] The Associated Press report states that the chamber's diameter is 4.6 m, its length is 18.8 m, and it has a volume of 300 cubic meters. It can be put under vacuum, and has a water spray system. Although the text does not discuss a reinforced concrete collar, the accompanying image appears to show one at the end of the cylinder, George Jahn, "New Image Reportedly Depicts Iran's Military Nuclear Testing Site," Associated Press, May 13, 2012. An earlier report on the chamber by Michael Adler also included the dimensions of the reinforced concrete section. See: Michael Adler, "Iran's Parchin Test Site: What UN Nuke Inspectors Think They'll Find," *AOL Defense*, March 15, 2012.

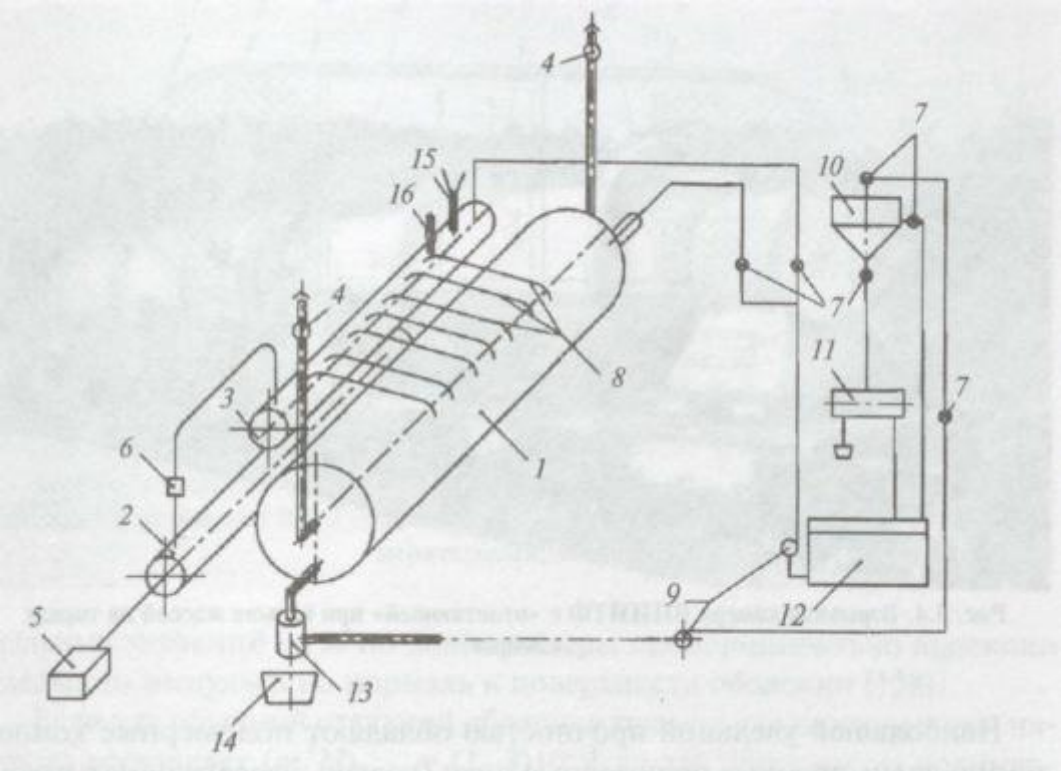


**Figure 1 - Blueprint for the air-water system of an explosive chamber [mentioned above] for diamond synthesis**:

1 – explosive chamber; 2- air receiver; 3 – water tank; 4 – fan (ventilator for gas); 5 – compressor (10 atm); 6 – electric valve; 7 – valve; 8 – pipes; 9 – water pump; 10 – sedimentation/condensation suspension tank; 11 – horizontal collection centrifuge with automatic unloading; 12 – main water tank; 13 – filter net for the separation of sizable pieces; 14 - fragment/shrapnel container ; 15 – water level indicator; 16 – electric valve

This chamber has the characteristics of those devoted to containing relatively large explosions. Danilenko wrote that steel chambers with an outer layer of reinforced concrete are more suitable for containing explosions of more than 40 kg of explosives.[10]

Assuming Danilenko supervised the construction of the Parchin chamber, it is unclear from the available information whether he did so at the Parchin site as well or only at Azar Industries near the city of Arak. He wrote in his 2003 book that steel-based chambers capable of containing sizeable explosions are heavy and difficult to transport. Thus, the chamber may have been moved to Parchin in large pieces and assembled there. The concrete square would have likely been assembled on site. Thus, to supervise the completion of the chamber, Danilenko may have visited the Parchin site.

**Explosive Chambers' Many Uses**

Danilenko states that explosive chambers are used for many purposes other than nanodiamond production. According to his 2003 book, the uses of relatively large chambers also include the testing of new explosive materials, explosive welding, and the explosive separation of diamonds and ceramics. Testing the compression of relatively large amounts of high explosives appears well within the capabilities of these large chambers.

[10] *Sintez I Spekanie Almaza Vzryvom,* op. cit., p. 109.

The IAEA does not rule out the use of the Parchin chamber for nanodiamond production, however, it needs to ascertain the evidence that the chamber was used for high explosive compression related to nuclear weapons development. Danilenko's writings suggest that such a use appears feasible. To resolve this issue, the IAEA needs to inspect the Parchin chamber and its environs and obtain answers to its questions about Danilenko's activities in Iran.