Institute for Science and International Security

ISIS REPORT

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Questions and Answers regarding Iranian document: "Outlook for special neutron-related activities over the next 4 years"

On December 14, the *Times* (London) published an article that describes the document titled "Outlook for special neutron-related activities over the next 4 years." The document was reportedly produced by the neutron group under an organization headed by Mohsen Fakrizadeh, a senior Iranian defense official consistently linked by intelligence and IAEA assessments to Iran's effort to develop the capability to make nuclear weapons.

ISIS's assessment, published here, is that the document describes a plan to develop a very specialized neutron initiator likely for use in a nuclear explosion. There has been considerable analysis of this document. ISIS encourages discussion and scrutiny of this document, including over the issue of its authenticity, and wants to add some additional information to its earlier assessment of this document.

ISIS understood at the time it received the English translation of the Farsi document that the *Times*' source removed headings from the original Farsi-language document and retyped the text in order to protect intelligence-sensitive information. The source made it clear that it had taken these steps to protect its sources and methods and made no attempt to conceal such steps from the *Times*. The *Times*' subsequent publication of both the Farsi document and its translation was not opposed by the source. ISIS understood that the source provided the document to relevant governments and the International Atomic Energy Agency (IAEA) in a different form. Nevertheless, the lack of an original document obviously complicates public assessments of the authenticity of the document. It also calls for the IAEA and governments to share their analysis of this document and how it fits into the other information they possess about Iran's nuclear efforts.

If the document is forged or otherwise tampered with, the source risks a severe blow to its credibility in both the short and medium term. Likewise, if the documents had been forged and subsequently obtained by the *Times*' source, the source's credibility would still be considerably damaged. In discussions with officials from several governments prior to the publication of the *Times* article, ISIS found that these officials unanimously believed that the source was unlikely to take such a risk. But because of the seriousness of the implications of the document, thorough vetting of the document should continue.

What does this document describe?

If the document is genuine, it concerns the design of an experiment to develop a neutron initiator set off by high explosives. The document describes an experiment to calibrate neutron detectors to measure pulsed neutrons from an experiment. The document is not, as some have suggested, about developing ordinary pulsed neutron sources called "neutron generators" (NG) or "dense plasma focus" (PF) devices. The document acknowledges that Iran already has these devices and that they will be used for calibration in an experiment to

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detect pulsed neutrons from a "hot" source. The paper states that there are existing sources, namely NG and PF that will be used to calibrate the experiment and that there will then be a new experiment using a "hot source", which is a hydrodynamic device. The hot source is assessed to be an implosion device that generates neutrons via D-D reactions (see figure 1).

The next few lines in the excerpt from the document shown in Figure 1 tell us the purpose is to do a calibration experiment for the "hot source" using conventional NG and PF devices. The purpose of the project outlined in the document is making pulsed neutrons and preparing an experiment to prove that the hot source will work as planned, using a hydrodynamic device at a location that requires mobile labs.

That the experiment is hydrodynamic in nature, a reference to shock compression which has nothing to do with NG and PF devices and the need for mobile laboratories, implies that the hot experiments involve tens of kilograms of high explosives.

This paper is not about developing pulsed laboratory sources such as neutron generators and dense plasma focus devices. It describes using those devices to calibrate a hot experiment to see if a nuclear weapon will work using a technology developed by the United States and China to produce neutrons for initiation of a fission nuclear explosive.

1-3 Creating experimental conditions similar to real conditions in order to detect pulsed neutrons obtained from hot sources

1-4 Designing and performing source detection experiments

1-4-1 Designing and performing detection experiments using NGs and PFs

1-4-2 Designing and performing detection experiments using a hot source

Figure 1. Translated text from Farsi document found here[1].

What is the importance of D-D initiators?

Samuel Glasstone, the well-known author of several definitive classified and unclassified texts on nuclear weapons and their history, addresses the importance of D-D thermonuclear sources in the initiation of early U.S. weapons. After describing the problems of early polonium-beryllium initiators, he writes:[2]

> *1.49 It is seen that when two deuterons interact, a neutron is formed in one case and a triton in the other; the triton then readily reacts with a deuteron to produce another neutron. Both deuteron-deuteron (D-D) and deuteron-triton (D-T) reactions are employed to provide neutrons for initiating fission chains.*

[1] Farsi and English Versions of Document on Neutron Initiator, ISIS, December 14, 2009: http://isis-online.org/isis-reports/detail/farsi-and-english-versions-of-document-on-neutron-initiator/

[2] Samuel Glasstone, *Introduction to Nuclear Weapons*, University of California, Los Alamos Scientific Laboratory and University of California, Lawrence Radiation Laboratory, Livermore, March 1963 (DTI Issuance Date), (unclassified version).

> *1.71 In the great majority of weapons of recent design the neutrons required for initiation are produced by the fusion reactions described in §1.48. [this section discusses deuterium-deuterium and deuterium-tritium reactions]. The procedures involve either the D-D or D-T reactions at high temperatures (thermonuclear reactions) or the interaction of accelerated tritons with a deuterium target (electronuclear reactions).*

Here, Glasstone explicitly points out that D-D reactions are used in thermonuclear initiators and draws the distinction versus D-T initiators using the electronuclear methods. This corroboration, along with the evidence acquired from the Khan network about the weapon design Pakistan obtained from China, leave little doubt that D-D is an attractive technology for some situations.

Is this paper about marketing PF devices?

One recent analysis in *The Guardian* newspaper suggests that the document discusses Iran's plans to continue development of PF devices and to market them to research centers. This is a misinterpretation of the document, and marketing such devices is a digression from the experiment at hand. The document addresses this issue directly, stating:

> *As regards **the document that covers ordinary activities**, the production of other PF samples is still achievable. It is possible, by protecting our capability regarding PFs at Shaheed Beheshti University, to produce more samples by mutual co-operation, then present these samples to other research centres for marketing purposes.*[3]

The authors are digressing to talk about their PF development work, and it is clearly a digression not related to the "hot source" work.

Is the UD_3 compound merely a storage media for deuterium?

It is certainly true that UD_3 is a good storage media, but the document is not about storage of deuterium, it is about producing pulses of neutrons in a hot test. The authors clearly point out the necessity of preparing the UD_3 source in a glove box, likely because the compound is highly pyrophoric. They note that the experiment is hydrodynamic in nature, a reference to shock compression to produce thermonuclear D-D reactions, which has nothing to do with simple storage, and they plan mobile laboratories because the hot experiments likely involve high explosives and cannot be done in a university laboratory.

What is the purpose of TiD_2?

The document mentions the development of titanium deuteride (TiD_2) as a replacement material to avoid uranium pollution in the production of UD_2. The exact purpose of the TiD_2 is difficult to determine without more information. Based on its source, the *Times* stated that the TiD_2 would be used as a surrogate material in hot tests to reduce uranium contamination at a test site.[4]

[3] Paragraph 1-2, Document on Neutron Initiator.
[4] This benefit only accrues if the neutron source is tested before conducting a cold test of the device at this site, where the weapon-grade uranium would be replaced with a surrogate material, likely 10-20 kilograms of natural or depleted uranium. In contrast, the amount of UD_3 is measured in grams.

Another purpose of the TiD_2 is to store deuterium, allowing the storage of deuterium as a solid for safety and high pressure gas concerns. Under this interpretation, after production, the deuterium would be captured on a bed of titanium. When the deuterium is needed, the TiD_2 is heated and the deuterium is driven off to react with uranium metal powder. To get an adequate UD_3 powder, this step would be repeated a few times. This method would reduce the amount of uranium in the preparation system.