

**Revisiting AQ Khan's 1990
offer to assist Iraq's
Nuclear Weapons Program**

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Background

In 1991, I was a nuclear intelligence specialist at Los Alamos National Laboratory. I was asked by the United Nations Special Commission (UNSCOM) to go to Iraq and participate in investigations of a possible Iraqi nuclear weapons program. That assignment led to a diplomatic posting at the International Atomic Energy Agency (IAEA) in Vienna as a director of Iraq inspections. The IAEA group assessing Iraq was known as the Action Team. That job was largely complete by the end of 1993 and I returned to Los Alamos.

Iraq inspections produced thousands of pages of Iraqi documents, many in Arabic describing the nuclear program. There was little interest and funding at the IAEA or member states to dig into these documents in detail. A high-level assessment of the documents was adequate to produce a political assessment of the past program and document its demise. In 2001, I returned to the IAEA, again as a director to close out the Iraqi file and examine documents in more detail. That task was interrupted by the September 11 attacks on the United States and another war in Iraq.

During this period, we evaluated many translated Iraqi documents and reached more detailed conclusions. This study, for example, identified a major shift in Iraq's approach to initiating a chain reaction in an imploding uranium nuclear bomb. Unfortunately, there was no way to disseminate the analysis because the Iraq Action Team had no publications procedure. So, the report sat, finished and unnoticed. In 2023 conversations with Gordon Corera, the BBC's security correspondent and author of a book on the Iraq nuclear program, brought to light the likelihood that A.Q. Khan had possibly influenced the Iraqi nuclear program. Up until that time it was known that he had offered help but the official conclusion was that his help was not accepted. This report highlights how his advice may have been implemented. There may be more undiscovered gems such as this. Maybe further reviews of documents buried in files will uncover more instances.

Introduction

A year before the first Gulf War in 1991, the Pakistani metallurgist AQ Khan, sometimes known (incorrectly) as the father of Pakistan's nuclear bomb, approached the Iraqi government with an offer to help Iraq develop a nuclear weapon program. The Iraqi government labelled it "Project A/B" (for Atomic Bomb Project) [Deception].

In fact, *Deception* includes an entire book chapter devoted to the Project A/B. Khan subsequently became infamous as the purveyor of nuclear weapons information to several countries such as Iran, Libya, the Democratic Peoples Republic of Korea (DPRK) and possibly others. He has since been acclaimed as the greatest nuclear proliferator of all-time. But in 1990 Khan was primarily known for clandestinely acquiring sensitive uranium enrichment designs from Europe and adapting them to a nuclear weapons program in Pakistan.

As a condition of the cease fire agreement in 1991 at the end of the war, Iraq allowed United Nations investigation teams into the country to find and destroy its Weapons of Mass Destruction (WMD) programs. The responsible UN body, the UN Special Commission (UNSCOM) tasked the International Atomic Energy Agency (IAEA) to find and destroy Iraq's nuclear weapons programme elements. In the process, the IAEA Action Team investigating Iraqi nuclear weapons nuclear ambitions discovered a letter making the offer and questioned the Iraqis on their response. [Corera] Iraqi scientists replied that they thought the offer was a false flag offer from the US CIA and declined to accept the help. [Fitzpatrick]

In fact, a 2002 Action Team analysis of Iraqi technical progress shows that Iraq made a radical shift in a key element of their program 28 days after the Project A/B offer. They stopped work on a World War II era neutron initiator for starting the chain reaction in a bomb. [Rhodes] Instead, they switched to a more modern design, one associated with AQ Khan that he offered Libya, possibly Iran, and featured on the cover of one of his books. [AQ Khan] Iraq published a summary document describing its entire nuclear program for the IAEA in 1998. In this Summary of Technical Achievements, Iraq notes that in July 1990 there was a shift to producing a more modern type of neutron initiator of a type proffered by AQ Khan, without mentioning Khan. [Achievements].

AQ Khan is known to have provided unsolicited nuclear information to potential customers. One example is provision of detailed information on uranium metallurgy to the Iranian nuclear program. There are also signs that Iran began pursuing an advanced neutron initiator as well after dealing with Khan. [New York Times Broad and Sanger] He also provided design drawings for a nuclear device including a neutron initiator to Libya circa 2003. The Libyan initiator is consistent with the shift in the Iraqi approach. It is possible that all he provided Iraq were clues to a better design and not a complete package.

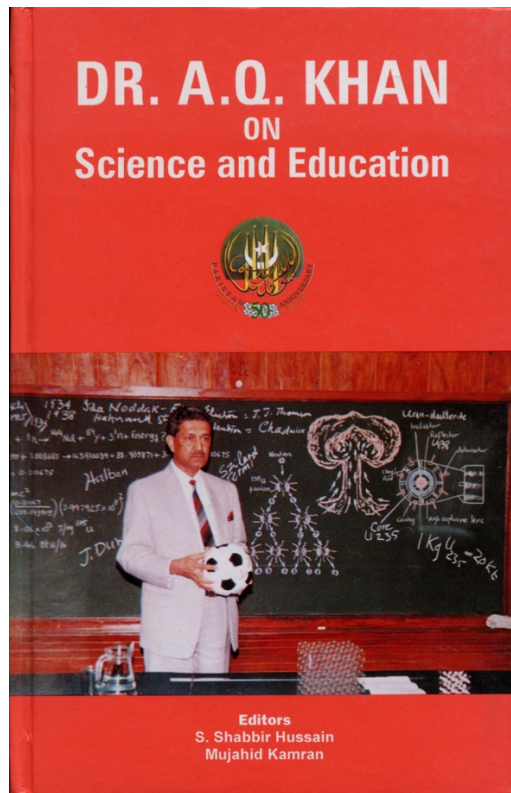


Figure 1. Khan's book cover showing schematic details of an implosion bomb.

The 2002 Action Team review was filed away and forgotten until 2023. Questions raised by Corera revived interest in assistance Khan had provided others, especially Iraq, before his well-documented assistance to Iran, Libya and the DPRK. The 1990 Project A/B story suddenly became relevant again. Atomic Reporters examines the coincidence of Iraq making a radical programmatic shift immediately after the Project A/B offer consistent with having received some technical advice from Khan after all. Similar to advice he gave to Libya and likely to Iran and the DPRK.

The Neutron Initiator

The neutron initiator is a vital item in a nuclear weapon. It produces a few neutrons at a precise time in the implosion sequence. The process only needs one neutron at the right time to start the runaway chain reaction. In a nutshell, the initiator only needs to produce a few neutrons in the window of opportunity to do its job. But it must produce neutrons at an exact time within microseconds during a bomb detonation sequence. In practice, the neutron initiator produces thousands of neutrons as a reasonable hedge to ensure it does its job.

A major challenge for the experimenter is to measure these few neutrons in a dynamic experiment inside a large block of detonating conventional high explosives. This is a very challenging measurement close to an explosion and electronic noise. Iraq's first choice for a neutron initiator was a crushable polonium-beryllium (^{210}Po -Be) source. This design of initiator was used in the first most primitive nuclear weapons. It was crudely sufficient for the first World War II American bombs but suffered from very short shelf-life (months) and other maintenance problems. It is a mechanical device that can

be studied in a laboratory under benign conditions. Iraq succinctly states that it was developing a neutron initiator based upon polonium-beryllium technology in its classified reports captured by the United Nations UNSCOM inspections and in its later declarations to the IAEA. [Atheer].

The secret Atheer progress report period covers a period up to the end of May 1990, and only describes the polonium-beryllium neutron initiator. Iraq was designing a gas gun to be used in Building 21 at its Al Atheer (Athir) planned Nuclear Weapons Development Center. The gas gun would provide dynamic conditions for crushing the experimental initiator at a precise time. Once the initiator is crushed, it becomes a steady state source that can be examined at leisure. Sensitive detectors could be placed close to the experiment to measure the timing and the output of neutrons. These are relatively easy conditions for carrying out such an experiment, and Iraq would have been able to be able to characterize its Po-Be source quite well, once the required testing gun, support equipment, and buildings had been completed.

A deuterium-tritium (DT) or a deuterium-deuterium (DD) fusion source imploded with high explosives is quite a different matter. It can only be tested in a high explosive simulation of the size of the nuclear bomb being designed. Timing is difficult and the production of neutrons will occur only over a few nanoseconds before the source is destroyed. The detectors in the experiment will also be destroyed unless they are well-shielded. Given the few neutrons they must detect, this is a difficult experimental trade-off.

Iraq Radically Shifts Direction

Iraq began to understand the value of a fusion implosion-type initiator in the summer of 1990. This was coincidentally just 28 days after the offer of help from Khan. On 9 July 1990, Mohamed Habib wrote a letter to the Director General (of the nuclear weapons design part of the project, almost certainly Khalid Ibrahim Said, leader of Group 4). [Habib]. He calls his attention to a Polish paper quoting Soviet scientists who produced neutrons by explosively compressing uranium deuteride in the chemical form UD_3 . [Poland]. Only two days earlier, on 7 July 1990, Khalid Said had tasked the Director of Department 40A (Mohamad Habib) to make calculations on the production of tritium in a reactor and the neutron output from all possible D-T reactions under a pressure wave of 30-40 mega bar. [Khalid Said] [Wilson]. The task was to be completed by 26 July 1990. The Head of Department 40B, Abdallah Kandush, was also tasked to support this activity.

Date	Event
1989-1990	Chinese paper on UD_3 initiator
1 May 1990 Al Athir (Atheer) Progress Report through 1 May	All effort on Po-Be source. No mention of UD_3 or DT
1990	Building 18 explosive test cell for initiators under construction at Al Atheer.

10 June 1990	A/B letter: AQ Khan to Iraq offering unspecified help to build a nuclear explosive	
7 July 1990	7 July 1990, Khalid Said had tasked the Director of Department 40A (Mohamad Habib) to do calculations on the production of tritium in a reactor and the neutron output from all possible D-T reactions under a pressure wave of 30-40 mega bar. The task was to be completed by 26 July 1990. The Head of Department 40B, Abdallah Kandush, was also tasked to support this activity.	
9 July 1990	Mohamed Habib wrote a letter to the Director General (Almost certainly Khalid Ibrahim Said, leader of Group 4). He calls his attention to a Polish paper quoting Soviet scientists who produced neutrons by explosively compressing UD_3 .	
26 July 1990	Target date for a report on these two topics	
2 August 1990	Iraq invades Kuwait	
6 October 1990	A landmark paper in this regard was published October 1990. The paper explicitly describes the experimental arrangement for fast neutron detectors to detect 14 MeV neutrons from a D-T reaction "in which explosive lenses will be used." There are details of the scintillation detectors, scintillating fluids, conversion foils, and photo multipliers.	
17 January 1991	UN coalition begins bombardment of Iraq	

Table 1. Timeline of critical events

There were also a growing number of efforts to quantify the production of tritium in a reactor. Calculations and experiments irradiating lithium-aluminum alloys are noted in several Iraqi papers. [Achievements]

Operation Iraqi Freedom

In the aftermath of the Second Gulf War the US acquired thousands of internal Iraqi documents in its post-war exploitations. Many of these documents were discovered at the Iraqi National Monitoring Directorate (NMD) in Baghdad where documents and correspondence with the IAEA Action Team in Vienna were archived. The US Army posted thousands of documents on the world wide web without consideration of their sensitivity. [NY Times Broad]. As a result of concerns expressed by the IAEA and others considering the NY Times article, the Army dissolved the website in November 2006, but not before thousands of pages of Iraqi nuclear documents were downloaded and preserved. This included a complete history of the Iraqi nuclear program written by the Iraqis. [Olbermann] But it did not contain the A/B offer.

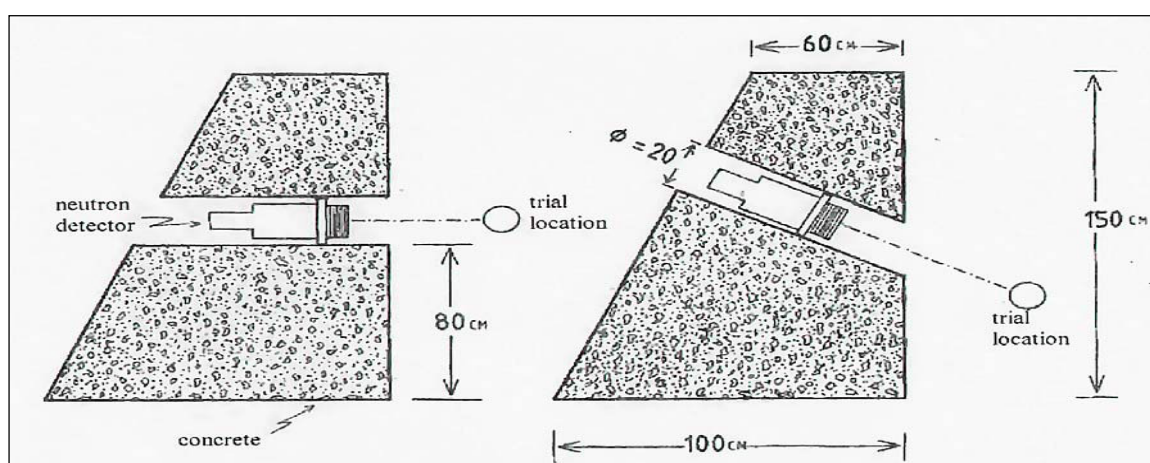
Experimental Arrangements

There are many references to diagnostics using scintillators as detectors for neutrons in Iraqi documents. These experiments may well be connected to Building 18 at Al Atheer. Building 18 was almost certainly originally built to measure weak neutron yield from polonium-beryllium initiators, but may have been adapted to look at very weak neutron yields from explosively compressed D-D.

Jafar Dhia Jafar was the head of the Iraqi nuclear weapons program. He was known for his obsession with uranium enrichment placing less emphasis on the actual design of a weapon. However, on one occasion, Jafar stated in a meeting with the author of this report that he wanted to use the reaction of a timing capsule as a diagnostic marker in a conventional hydrodynamic explosion experiment. Such a capsule would contain a small amount of deuterium-tritium gas mixture. If the high explosive test was well-designed and powerful, D-T would undergo nuclear fusion releasing a flood of neutrons at a precise time. If successful, that would be valuable for assessing success of the test and validating computer codes. D-T fusion is much easier to achieve than D-D fusion so we didn't connect this experiment to a neutron initiator at the time. Later we could not find another instance of this comment to substantiate this, other than my recollection of the meeting. When reinterviewed, Jafar would not discuss this further and seemed annoyed that he mentioned it and that it was noted.

A landmark paper in this regard was published October 1990 by a member of the Iraqi weapons program. [Hasan]. The paper explicitly describes the experimental arrangement for fast neutron detectors to detect 14 MeV neutrons from a D-T reaction "in which explosive lenses will be used." There are details of the scintillation detectors, scintillating fluids, conversion foils, and photo multipliers. Figures 6 and 7 of the paper show a physical outdoor arrangement of scintillators and a wax moderated helium-3 (^3He) detector in heavy concrete shielding blocks. The purpose of the blocks is to protect the instrumentation from the explosive blast.

Figure 2. Plans for scintillator placement published by Iraq in October 1990 [Hasan]



These blocks are large, about 1-meter in size. The blocks and the means of moving them may be detectable in an outdoor high explosives experiment. This is an important intelligence indicator in future proliferation investigations.

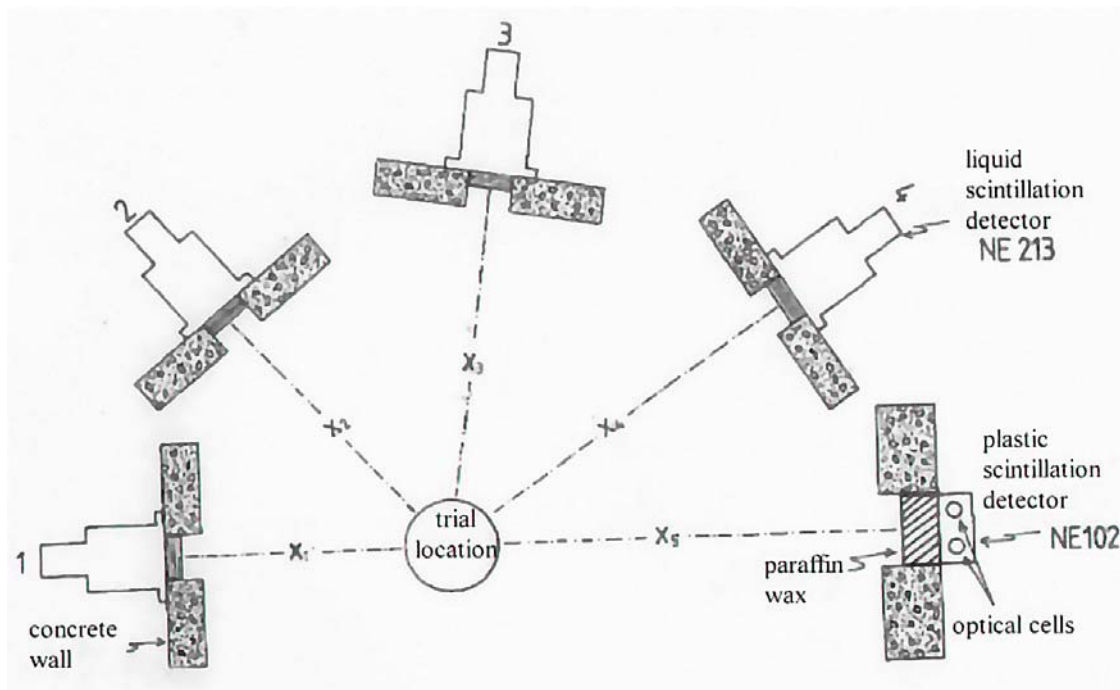


Figure 3. Planned experimental arrangement probably at Al Atheer high explosive test bunker.

Action Team inspectors of the Iraqi weaponization process were recruited from nuclear weapons laboratories in several states with nuclear weapons. The majority were from the US but there was considerable participation of UK and French scientists and engineers.

It is important to note at this point that the IAEA inspections were carried out under UN Security Council Resolution 687 and others. These were not traditional IAEA inspections under its nuclear materials verification agreements with states. Some regular IAEA employees did deal with routine nuclear materials accountably. But the weapons inspections and analysis were carried out by weapons scientists with access to detailed nuclear weapon design information and sensitive intelligence unavailable to the Vienna-based IAEA. The Action Team was not constrained by traditional limits imposed by the Nuclear Non-Proliferation Treaty. The Action Team inspections were highly intrusive and confrontational in keeping with Iraq's unwillingness to be open and forthcoming for the first few years of inspections.

Three employees of URENCO also provided advice not available within the IAEA. They advised on uranium gas centrifuge enrichment progress in Iraq. That knowledge had been acquired by espionage from several German scientists. Interestingly, AQ Khan was not involved in Iraq's illicit centrifuge program.

The same Iraqi team that was trying to do the detection of neutrons from a low yield explosive experiment had another task. This was to measure the neutron output from alpha-neutron reactions in masses of uranium metal. Undesirable alpha-neutron reactions give an unacceptably high neutron background and increase the chance of unacceptable early initiation of the nuclear device. There are several experiments described in the Iraq literature and progress reports. They use the same types of detectors, scintillators and scintillator fluids. The same Iraqi personnel were involved. It is important to separate these two activities when analyzing these data. Iraq built an approximately one-meter diameter sphere filled with scintillating fluid with five or more fluorescence detectors arranged around it. It was placed next to uranium metal samples with known amounts of light element impurities to determine chemical purity levels needed to avoid pre-initiation during implosion. The experience with this experimental arrangement was useful for the UD_3 initiator studies as well.

There is at least one building in Iraq that was designed expressly for making very low yield neutron measurements in an explosive configuration. This was building 18 at the Al Atheer Nuclear Weapons Development Center. [Wilson]



Figure 4. Building for testing polonium-beryllium neutron initiators at al Atheer. 1991. Los Alamos National Laboratory

Building 18 was not completed at the time of the war. [Author notes]. It was intended to be a very thick-walled chamber for conducting small explosive tests with blast containment. Explosive products would be immediately vented through three "chimneys" in the roof. A US consultant from a high explosives facility opined that the building could repeatedly contain about 10 kilograms or less of explosive without destructive stresses.

There are instrumentation bays on three sides of the explosive chamber. They were intended to have shock-isolated floors and shock isolated instrumentation positions. The bays were separated from the interior of the explosive chamber by relatively thin double glass windows - two layers of approximately 1 cm thick glass. This strongly suggests that some optical measurements were planned. The more important measurements were probably scintillators. The experiment is shown to be about 60 cm in diameter. A spherically converging shock in the box would produce neutrons before the flash of the high explosive exited the box and swamped the neutron scintillators and photo multipliers. There were several pipes that projected into the chamber from the outside. They were about 20 cm in diameter. These pipes could have been used to hold scintillators and photo multipliers to measure the low neutron yield.

Chinese Explosively Triggered Neutron Source

A very similar set-up is described in a contemporary (1989) Chinese paper by Dong et. al. [China] The authors describe producing neutrons from UD_3 in an 8 cm radius, high explosive staged system. Explosives in a sphere this size would weigh about 4 kg. This could have been contained in Building 18 at Al Atheer. The diagnostics are very similar to those in the Iraqi planned experiment. [Hasan]

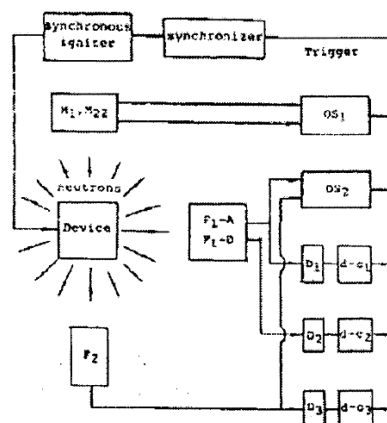


FIGURE 1
Schematic diagram of the test system: M_1, M_2 - BF_3 neutron detectors, F_1, F_2 -Scintillation-Photomultiplier detectors, D_1, D_2, D_3 -Digitizers, $d-c_1, d-c_2, d-c_3$ -Delay circuit, OS_1, OS_2 -Oscilloscopes.

Figure 5. Diagnostic set-up for 189x Chinese test of an explosively driven neutron source.

Conclusions

In the summer of 1990, the Iraqi nuclear weapons program had a major initiative to develop neutron initiators that start the chain reaction in an imploding bomb. A few days after Pakistani metallurgist AQ Khan offered help to build a nuclear bomb, Iraq made a drastic shift to developing the kind of neutron source that Khan was known to favor. When questioned in the post-war inspection process, Iraq firmly denied accepting any help from Khan. The circumstances and timing of the Iraq radical shift suggest otherwise.

Possibly Khan only gave the Iraqi a nudge to certain literature describing explosively driven fusion devices. Whatever the assistance, Iraq made a sharp change in the direction of their program. This involved new materials, new facilities and equipment and new challenges in diagnostics and calculations.

These initiators demand rigorous testing for total neutron output and neutron pulse timing. Specialized facilities and diagnostic equipment were required. Some of the experiments, buildings, and equipment are unique. This could help to distinguish nuclear weapons development from other high explosive testing. Many of these items have been found in Iraq or in their documentation. They could be a good starting point for future investigations and inspections. Some of the experimental arrangements may be visible in overhead photography. It is unlikely that IAEA would ever recruit or hire inspectors with these analytical skills because they wouldn't fit with the normal accounting mission of regular inspections. The Action Team weapon inspectors were temporary recruits from weapons states and were supplied to UNSCOM and IAEA because of the cease-fire that ended the first Gulf War. This was an extraordinary situation that may never be repeated.

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