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The Physics Research Center and Iran's Parallel Military Nuclear Program

A key issue for the International Atomic Energy Agency (IAEA) is whether Iran has a parallel military nuclear program that can provide nuclear weapons if the regime decides to build them. Understanding that issue depends critically on what Iran's military nuclear entities have achieved already. Newly acquired information sheds light on one of Iran's most important and least understood military nuclear organizations, the Physics Research Center, which operated in the 1990s and was consolidated into successive military nuclear organizations. The new information also demonstrates the incompleteness and inadequacy of Iran's declarations to the IAEA about its past and possibly on-going military nuclear efforts.

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Summary

Evidence obtained by the IAEA indicates that the Iranian revolutionary regime made its first decision to research and develop nuclear weapons in the mid-to-late 1980s, and it ordered the development of a parallel military nuclear fuel cycle. According to information received by the IAEA and included in its November 2011 report, the Physics Research Center (PHRC) appears to have been created in 1989 as part of an effort to create an undeclared nuclear program, likely aimed at the development of a nuclear weapon. PHRC in turn may have evolved from a project at Shahid Hemmat Industrial Group (SHIG) in the late 1980s that may have sought to research a nuclear warhead for a ballistic missile. In 2003, under intense international pressure, Iran agreed to suspend its uranium enrichment programs. Based on the IAEA's findings, Iran sought to keep its nuclear weaponization programs secret from the inspectors and took steps to better hide this program's existence. The razing of the Lavisan Shian in 2004 site that formerly housed the PHRC was likely an attempt to prevent the IAEA from carrying out environmental sampling, a technique that had uncovered other secret Iranian nuclear activities in 2003.

Although Iran has admitted that the PHRC was related to the military and had a nuclear purpose in the area of defense preparedness and radiation detection, its actual nuclear role appears much more extensive. ISIS has accumulated from multiple sources a range of procurement information related to the PHRC. ISIS has obtained supplier companies' information, a set of over 1,600 telexes between PHRC or Sharif University and overseas suppliers, and other information obtained from governments, IAEA reports, and the media. The information provides an extensive picture of PHRC's wide-ranging procurement efforts in the early 1990s. Several experts retained by ISIS have assessed the information in the telexes. About 50 telexes referenced in the report's text are found in a supplement.

The information and documents assembled by ISIS suggest that the PHRC had departments focused on a wide range of nuclear technology, including gas centrifuges and laser enrichment, radiation protection, uranium conversion, uranium exploration and possibly mining, and heavy water production. This finding supports the allegation that Iran's Ministry of Defense was involved in many aspects of the nuclear fuel cycle and the research and development of nuclear weapons.

In the early 1990s, the Physics Research Center engaged in an extensive procurement effort that included using Sharif University of Technology and other entities to assist in outfitting a nuclear program. In many cases, Sharif University appears to have been used as a front for purchases made by PHRC. Some goods could have gone to Sharif University, but the bulk of the procurements appear destined for the PHRC or its sponsors. Sharif University also housed significant relevant expertise on nuclear technology, and there may have been cooperation between Sharif University and PHRC on undeclared nuclear activities that went beyond procurement.

Iran has failed to declare all of PHRC's activities to the International Atomic Energy Agency. Iran has stated to the IAEA that the PHRC procurements were not related to a nuclear program. The information assembled in this ISIS report, however, contradicts this claim. Iran has created a cover story for the PHRC involving Sharif University that attempts to hide its true activities, including a vast number of both successful and attempted procurements for ostensibly undeclared nuclear programs.

Whatever nuclear activities PHRC pursued in the early 1990s, they appear independent of those of the Atomic Energy Organization of Iran (AEOI) in the area of gas centrifuges, uranium exploration and possibly mining, and uranium conversion. Iran should explain to the IAEA why there appears to have been a parallel, organized nuclear program.

The telexes, which mainly date to 1990-1993, do not reveal an extensive effort to research or develop nuclear weapons, commonly called nuclear weaponization. However, some procurements or attempted procurements appear aimed at equipment or technology that would be a prerequisite for such work.

What did the PHRC accomplish and was it closed in 1998, as Iran declared to the IAEA? The IAEA has suggested in its November 2011 report that PHRC instead was consolidated under the AMAD Plan. Where are the goods procured by the PHRC, and where are all the hundreds of engineers, scientists, and administrators who worked there?

Prior to Iran's suspension of its centrifuge program in late 2003, military contractors at the 7th of Tir Facility made the most sensitive centrifuge components, namely the rotating ones, for the P1 centrifuges. In about 2001, the AEOI had ordered enough of these parts from 7th of Tir for 10,000 P1 centrifuges, slated for eventual installation at the then secret Natanz enrichment site, according to the IAEA. Perhaps, Iran's Ministry of Defense originally intended to use this same manufacturing site and others to make 3,000 P1 centrifuges for a parallel military centrifuge plant that would use uranium hexafluoride produced by another project of this parallel effort. Many questions remain about the origin and purpose of the Gchine mine and the original intended function of the deeply buried Qom centrifuge plant discovered in 2009 by Western intelligence. Was the Qom site, now called the Fordow site, to be a military-controlled site dedicated to the production of weapon-grade uranium? With the end of the suspension in 2006, did the Ministry of Defense also resume its centrifuge plans as well and plan to install centrifuges at the Qom plant?

PHRC may have aimed to ensure that the military had a strong hand and competence in the nuclear fuel cycle and weaponization. Although the bulk of the nuclear fuel cycle competence would remain in the AEOI, the military would have gained enough to ensure that it could build a highly secretive parallel program aimed at obtaining both weapon-grade uranium and the weapon itself.

Despite all the new information, the PHRC remains difficult to fully understand. Iran should clarify PHRC's exact purpose and accomplishments and its relationship to the IAEA's broader question of the military dimensions of Iran's nuclear effort.

Introduction

Iran has a unique opportunity to greatly reduce international tensions about its nuclear program by forthrightly and transparently discussing any past and possibly on-going nuclear weaponization efforts. The outlines of these efforts were described in the International Atomic Energy Agency's November 2011 report, which presented the IAEA's findings about this program based on information from multiple sources and years of assessments.[1] Iran's response to the report, similar to what it has said in the past, was that it had never had a nuclear weaponization program of any type and that some of the documents that the IAEA references had been forged. However, among many key governments, the IAEA's report has proven compelling. Despite an intensive investigation, the IAEA has not uncovered evidence of forgery in the documents. Meanwhile, the IAEA has accumulated a substantial body of evidence that Iran had a structured nuclear weaponization effort prior to 2004 that may have continued on a reduced basis afterwards.

In the public debate over Iran's military nuclear programs, the Physics Research Center (PHRC) is a critical case. It is one of the few publicly identified sites linked to alleged nuclear weaponization activities and a military nuclear program. Controlled by the Ministry of Defense, it was housed at an industrial compound in the Lavisan Shian neighborhood of north Tehran from 1989 until at least 1998. It is suspected of carrying out undeclared nuclear programs parallel to the Atomic Energy Organization of Iran and creating Iran's nuclear weaponization efforts.[2]

The PHRC first emerged publicly as nuclear related in early 2004, at a time when Iran had said it had already "come clean" about its secret nuclear activities. Commercial satellite imagery showed the razing of this industrial site. Was the destruction of the Lavizan site part of an Iranian cover-up to hide its weaponization efforts? Could the regime have decided that the nuclear weaponization effort, which is described in the November 2011 IAEA report, had to be hidden, requiring the destruction of the site and a drastic reduction in the weaponization effort? Moreover, Iran could also have decided to deny any PHRC involvement in the nuclear fuel cycle in order to prevent the IAEA from establishing that there existed a second nuclear program under military control, separate from the AEOI, an ostensibly civilian, nuclear program.

The role of the PHRC has gained additional importance because the scale of Iran's nuclear weaponization program described in the IAEA's November 2011 report is too large to have started in 2002. At that time, the IAEA states that the weaponization work was under the "AMAD Plan," a structured effort that was working on developing nuclear warheads sufficiently small to fit into the re-entry vehicle of a ballistic missile. The IAEA describes in some detail the weaponization effort at that time, and its abrupt halt in late 2003, adding further to the assessment that Iran decided to hide its nuclear weaponization activities. The report states that the predecessor to the AMAD Plan was the PHRC without providing much detail about its efforts. In general, the IAEA report has very little information about nuclear weaponization activities or military nuclear programs that took place in the 1990s, when the PHRC was in full operation. It does state that sometime after Iran commenced covert procurement activities in the late 1980s, "organizational structures and administrative arrangements for an undeclared nuclear program were established and managed through the Physics Research Center, 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

[1] IAEA Director General, *Implementation of the NPT Safeguards Agreement and the relevant provisions of the Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/65, November 8, 2011.

[2] According to the IAEA PHRC was under the Education Research Institute (ERI), which was created in 1989 or 1990 to coordinate defense research and development. ERI is also known in procurement information assembled by European companies as Gorohe Tahghighat Vagostaresh or the Research and Development Group.

Logistics (MODAFL)".[3] The report also provides a list of departments at the PHRC that were responsible for work on the nuclear fuel cycle, including gas centrifuges and laser enrichment, uranium conversion, and "nuclear physics" which could include efforts to develop the technology for nuclear weapons. The IAEA report states that by the late 1990s or early 2000s, the PHRC activities were consolidated under the AMAD Plan.

ISIS has collected information that adds considerable detail to the nature and procurement activities of PHRC departments identified in the IAEA report and lends support to the view that the PHRC operated or was involved in undeclared nuclear programs. The information contradicts Iran's statements about the PHRC's activities in the early 1990s, the time period that is the focus of this ISIS study. Much of this information is published here for the first time. This information supports that the PHRC was purchasing goods for almost the entire nuclear fuel cycle, goods useful to a nascent nuclear weapons effort, under Iran's Ministry of Defense. This effort operated largely in parallel to the AEOI's larger nuclear fuel cycle programs. The IAEA has been skeptical of Iran's explanation of the PHRC's activities. It has noted in its reports that it continues to seek corroboration of Iran's statements about the PHRC and to verify this issue as part of its verification of the completeness of Iran's declarations. The data collected by ISIS only compounds that skepticism and the need for more openness by Iran.

In 2008, Iran stopped talking to the IAEA about the PHRC, despite agreeing earlier to discuss remaining issues about the PHRC's role and activities.[4] It is time for that discussion to resume.

Nuclear Role of Lavisan Shian Site Discovered in 2004

The first connection of the site housing PHRC to weapons of mass destruction occurred in May 2003, when the National Council for Resistance of Iran (NCRI), an Iranian opposition group, held a press conference and presented information alleged to be evidence of a biological weapons program in Iran.[5] NCRI revealed a list of organizations, people and materials associated with this program. Included in this list was what NCRI described as a new biological weapons center known as Malek Ashtar University that was based at the "Lavizan Shian Technological Research Center." NCRI did not associate this site with nuclear work.

Almost a year later, ISIS learned that the Lavizan site was suspected to have been associated with undeclared nuclear activity and that Iran was demolishing the buildings. ISIS learned that the site contained highly sensitive whole body counters, used for measuring internal radiation exposures. It was suspicious for such equipment to be located at a facility that Iran had not declared as having a nuclear purpose, but the site's razing caused the greatest concern.

[3] Information received by the IAEA specifies that the Iranian revolutionary regime decided to start a nuclear weapons effort as early as 1984. According to an IAEA document, which is referred to as the Agency in this document, "The Agency was informed that in April 1984 the then President of Iran, H.E. Ayatollah Khamenei declared, during a meeting of top-echelon political and security officials at the Presidential Palace in Tehran, that the spiritual leader Imam Khomeini had decided to reactivate the nuclear programme. According to Ayatollah Khamenei this was the only way to secure the very essence of the Islamic Revolution from the schemes of its enemies, especially the Unitd States and Israel, and to prepare it for the emergence of the Imam Mehdi. Ayatollah Khamenei further declared during the meeting, that a nuclear arsenal would serve Iran as a deterrent in the hands of God's soldiers."

[4] IAEA Director General, *Implementation of the NPT Safeguards Agreement and Relevant Provisionis of Security Council Resolutions 1737 (2006, 1747 (2007), and 1803 (2008) in the Islamic Republic of Iran*, GOV/2008/15, May 26, 2008, Annex, p.2, Section B.1.

[5] Iranian Regime's Programs for Biological and Microbial Weapons, Press briefing by Soona Samsami and Alireza Jafarzadeh, National Council of Resistance of Iran, May 14, 2003: http://www.iranwatch.org/privateviews/NCRI/perspex-ncri-cbw-051503.htm

In June of 2004, ISIS released commercial satellite images showing the facility's destruction.[6] The images showed that the facility had contained six buildings, including mechanical workshops, laboratories, administration buildings, and a radiation monitoring station used in support of the defense department. The original site is seen in an August 11, 2003 satellite image (see figure 1). By March of 2004, the buildings on the site had all been removed (see figure 2).

Based on the ISIS report, the International Atomic Energy Agency (IAEA) requested a visit to this site. Iran responded that the Ministry of Defense had razed the site as a result of a court order to return the land to the City of Tehran. Iran stated to the IAEA that no declarable nuclear material had been present at the site. The IAEA visited the site from June 28-30, 2004 and took environmental samples. The sampling did not reveal the presence of any nuclear material. The IAEA noted, however, that the sampling at the site would be unlikely to indicate the presence of nuclear material had it been present at the site previously, due to the complete razing of the site by the time of the visit. Later satellite imagery shows athletic fields and a park present at the site (see figure 3).

Iran's Explanation of the PHRC

Iran provided the IAEA with a history of the Lavizan site.[7] It stated that the Physics Research Center (PHRC) was established at the site in 1989, and that its purpose was "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 said that the operation of the PHRC at the Lavizan site stopped in 1998, and it changed to the "Biological Study Centre" said to conduct "biological R&D" and "'radioprotection' activities." In 2002, the Lavizan site also contained the Institute of Applied Physics (IAP), according to Iran, and biological studies continued at the site. But, Iran stated to the IAEA, the Lavizan site by that time was used principally to "use the capabilities of universities in the country (in particular, at the Malek Ashtar University near Esfahan) for the education and R&D needs of the Ministry of Defense."

PHRC was headed by Sayyed Abbas Shahmoradi-Zavareh from its formation in 1989 until its reported consolidation in 1998. Like many government engineers and physicists, he also had an academic position at Sharif University of Technology. Afterwards, Mohsen Fahkrizadeh is alleged to have taken over a major portion of the PHRC's efforts, including the nuclear weaponization efforts that became the AMAD Plan identified by the IAEA. According to a Western source, these are the two leading officials that have been involved in Iran's Ministry of Defense nuclear efforts.

Iran denies any PHRC involvement in the nuclear fuel cycle or nuclear weapons. It maintains that there has not been any uranium enrichment project in Iran except that carried out by the AEOI.[8] Its denial of ever having conducted any work on nuclear weaponization is well known. According to Iran, any PHRC procurements that might look nuclear-related were in fact not so.[9] Iran claimed that none of the procurements purchased or enquired about by the PHRC were intended for use in uranium enrichment or conversion-related activities.

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[6] *ISIS Imagery Brief: Destruction at Iranian Site Raises New Questions About Iran's Nuclear Activities*, Institute for Science and International Security, June 17, 2004: http://isis-online.org/isis-reports/detail/isis-imagery-brief-destruction-at-iranian-site-raises-new-questions-about-i/

[7] IAEA Director General, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, November 14, 2004: http://www.iaea.org/Publications/Documents/Board/2004/gov2004-83.pdf

[8] IAEA Director General, *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran*, GOV/2008/4, February 22, 2008, p.4

[9] IAEA Director General, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, GOV/2006/15, February 27, 2006, p. 7, paragraph 34.

Procurement or procurement attempts by PHRC or Shahmoradi, according to Iran, were also made on behalf of other entities in Iran.[10]

Iran also claimed that Shahmoradi helped departments or laboratories at Sharif University of Technology obtain goods because he was also a professor there. He used his business contacts abroad and the resources of PHRC in those endeavors. However, according to Iran, these procurements were not for any nuclear weapon, uranium enrichment, or uranium conversion purposes.

Although Iran allowed the inspectors to twice interview Shahmoradi about Sharif University, he would not discuss the activities of the PHRC. He in fact tried to downplay his role. He asserted that he was a professor at Sharif University and like many Iranian professionals took a second job, in his case at PHRC, to supplement his income.

Iran made available to the IAEA some equipment supposedly procured by the PHRC for Sharif University including mass spectrometers, vacuum pumps, fluorine, and balancing machines. The IAEA tested these vacuum pumps, usable in a uranium enrichment process, and found traces of highly enriched uranium (HEU). Iran responded that these traces must have resulted from cross-contamination from equipment that originated from Pakistan, which had provided used P1 centrifuges contaminated with HEU. The IAEA viewed this explanation as possible but it did not settle the issue about the original purpose of the equipment. The issue of PHRC's potential role in a military nuclear program was never settled prior to Iran's refusal to cooperate further in 2008.

ISIS Information

Since publicly revealing the Lavisan site in 2004, ISIS has accumulated from multiple sources a range of procurement information related to the PHRC. ISIS has obtained supplier companies' information, a set of over 1,600 telexes between PHRC or Sharif University and overseas suppliers, and other information obtained from governments, IAEA reports, and the media. The information provides an extensive picture of PHRC's wide-ranging procurement efforts. Several experts retained by ISIS have assessed the information in the telexes.

ISIS has judged the telexes, which it obtained from a Western source, as genuine and is making several of them public in this report. To check on their authenticity, ISIS matched a number of the telexes to company records or other information that ISIS collected independently. ISIS has been contacting additional companies about the information in these telexes.

The telexes among suppliers, the PHRC, and Sharif University include requests for catalogs, specific goods and their prices, orders for goods and their implementation; actual or potential suppliers' responses and questions; communications about arranging or extending, sometimes desperately, letters of credit for a purchase; and a range of correspondence typical in international purchases. In many cases, more than one telex exists about particular requests from a supplier.

However, the available telexes show that the set is not a complete record of communication; there were other communication, such as faxes, letters, in person exchanges. In addition, there were likely additional telexes not included in the ISIS set. For example, many times it is not known if an item was actually delivered; and thus the telexes should not be used to make conclusions about the supply of goods to Iran by a company, unless a telex confirms that such a delivery has happened. Moreover, several companies mentioned in the telexes are

[10] IAEA Director General*, Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran*, GOV/2008/4, February 22, 2008, p.4, paragraph 12.

defunct or have changed ownership. Many have much stricter internal compliance systems in place against smuggling efforts such as those conducted by the PHRC. Despite its incompleteness, the set of telexes provides considerable new detail about PHRC's procurements and attempted procurements.

The available information shows that the PHRC was an entity that systematically procured a wide range of goods. It does not appear to be a procurement front for Sharif University or the AEOI. Earlier, ISIS published that the PHRC was a procurement front for the AEOI's centrifuge effort that started in the early 1990s following the compromising of an AEOI front company buying in Europe for the centrifuge program. The newer information contradicts this earlier assessment.

On the issue of whether PHRC had any involvement in the nuclear fuel cycle, one telex appears to contradict Iran's claim. The telex, dated September 15, 1990, was from the PHRC purchasing department to a European high-tech manufacturer that had often supplied nuclear projects (telex 579). (ISIS has decided not to release the name of the manufacturer.) The PHRC kindly requested that the company send its catalogs about (1) components for nuclear research and industrial applications and (2) plants and systems for uranium enrichment, fuel element production, nuclear reactors and reprocessing plants. The telex is a mélange of contact information showing that the intent was likely to make the telex look as if it was from Sharif University. The telex was sent from a Sharif University's telex number, despite clearly stating it was from the PHRC, although the telex did not provide what PHRC stood for. It had a return post office box of the PHRC and a fax number of Sharif Univeristy. The high-tech company responded five days later that it had no catalogs covering the products mentioned. Nonetheless, the PHRC is requesting catalogs from an industrial supplier that imply a direct interest in buying nuclear systems and facilities, rather than an interest limited strictly to nuclear defense.

Numbering System on Telexes

Many of the telexes have what is called a "message number" that is independent of the usual telex numbering system. Starting in about late 1990, many of these message numbers start with a three or four-digit code that reflects a chronological order. This message number resets down to a lower number towards the end of the year in 1991 and 1992. Based on an analysis of the telexes, a second set of numbers appears to reflect both a department and perhaps a project within each department. The goods linked to these secondary numbers can be interpreted as related to separate departments interested in particular technologies, which below will be linked to various nuclear technologies. For example, a telex with a message number of "1218.221" is likely associated with Department 2, the first number following the period (see figure 4). The numbers "21" after the ".2" likely represent a specific project under Department 2. The numbers "1218" appear to reflect a chronological number assigned to this item request.

Iran has stated to the IAEA that several PHRC procurements were associated with a number of Sharif University departments, which were relying on PHRC for some of their procurements. The telexes and company records, however, provide strong support that the PHRC was instead using Sharif University as a front to purchase certain items. Many telexes from Sharif University have the post office box or fax number of the PHRC, not those of Sharif University (see figures 4, 5, and 6). So, if a supplier needed to send "Sharif University" more information than typically allowed in a telex, it could fax them or send official documents or small shipments to a post office box. However, it was actually connecting directly with PHRC, even though the supplier thought it was dealing with Sharif University exclusively. The PHRC fax and post office boxes were not widely known, so a supplier could be easily duped into thinking it was providing goods to an educational institution.

This coordinated numbering system includes both the telexes from PHRC and Sharif University, as if a centralized authority were assigning these numbers to specific telexes. If these were for various unrelated departments at the University, as Iran has stated to the IAEA, there would not be a common ordering system

to the item requests—each would likely have their own system. ISIS has obtained records of other telexes from Sharif University to suppliers that have a "U" before the message number.

The interconnected numbering system is illustrated in figure 7. The switching between PHRC and Sharif University is clearly seen in a range of telexes. Figure 8, taken from an ISIS excel spreadsheet tabulating the telexes, covers a period from December 17, 1990 to January 10, 1991, when Iran sent inquiries for magnets and converters to several suppliers. The similarity in the message numbers for each implies that the telexes were related requests for a similar project. Furthermore, four of the requests took place on the same day. The entity in Iran listed on the telexes as having requested the items, however, alternates between PHRC and Sharif University. Two requests that appear to have been sent on the same day are nearly identical with regard to the items, but PHRC is listed as the purchaser in one and Sharif University in the other. This suggests that both names were being used interchangeably to procure for the same projects and that Sharif University was being used in name to procure on behalf of PHRC. There should not have been a need to use PHRC as a procurement agent for Sharif University if Iran was already using the name of the university in related telexes to companies.

The telex collection shows that Sharif University was regularly seeking items abroad and many had a PHRC fax or post office box. These procurements or attempted procurement were not occasional, as Iran has stated to the IAEA. Moreover, Sharif University appears integrated into a PHRC led procurement effort to deceive foreign suppliers. Most would believe that a university would want goods for a non-nuclear, non-military educational purpose. Thus, the suppliers would be less likely to question a university's end use statement.

However, during 1992 and 1993, Sharif University started to appear in foreign media, based on information leaked by Western governments, as a buying front for Iran's centrifuge program. During this period, PHRC started to use Sharif University less in its procurement efforts (see figure 7). PHRC remained less well known in the West during the early 1990s, and this shift towards using PHRC as the entity contacting suppliers may have reflected growing concern about Sharif University's exposure.

Thus, the appearance of the message numbers on a telex appears to indicate a PHRC procurement, whether it is sent from PHRC or Sharif University. The choice seems to be made at PHRC.

Dr. Ali Akbar Salehi, currently Iran's foreign minister and former head of the AEOI, was president of Sharif University from 1989-1993. Did he know of these procurements by the PHRC?

Mass Spectrometer

Iran provided the IAEA information about an earlier Shahmoradi procurement that, if true, implicates Sharif University in illicit nuclear trade schemes as far back as 1988. Iran declared the following about this procurement. Prior to heading PHRC, Shahmoradi was head of the "Mechanics Workshop" at Shahid Hemmat Industrial Group (SHIG). In 1988, the AEOI asked a Dean of Sharif University for help in procuring a mass spectrometer. The Dean then approached Shahmoradi at SHIG, who requested unsuccessfully a Finnegan MAT 281 mass spectrometer with specifications for nuclear application.

Some of the telexes may shed some light on this procurement, although they also raise additional questions.

A telex dated May 21, 1988 from Department 54/02, SHIG to Finnigan Mat Ltd asks for general catalogs of its mass spectrometers, asking for prompt action (no telex file number). The telex is not signed by a person but instead SHIG.[11] (A month later, SHIG asked a European supplier for information about both secondary ion mass

[11] The post office box on the telex from SHIG is 16765-1595, whereas PHRC had post office box 16765-463 and 16765-1831.

and neutral mass spectrometers. In this case, the request came from Department 54/03 and likewise asked for a quick response.)

A later set of telexes describe an effort to acquire such a MAT 281 spectrometer that has the characteristics of a smuggling operation against the United States. The effort utilizes an overseas trading company to hide the true end user and defeat U.S. government sanctions. The Iranian company requesting the items is identified in the telex with the abbreviation ATC and a telex abbreviation of VARS IR; the telex is signed M. Ashtari. ISIS could not identify the actual Iranian company name.

An enquiry from ATC, dated August 30, 1988, to a company identified only as ICT in Switzerland requested this specific type of spectrometer and 30 U.S. military panel mounted aircraft radio transceivers (see telex no. 587). Ashtari preferred the U.S.-origin goods but stated that equivalent German equipment could be substituted. The stated end user was "Sepah Pasaran", which is Iran's Revolutionary Guard Corps (IGRC). This end user would likely cause more alarm among legitimate suppliers than if the AEOI was listed as the final recipient.

An official at ICT, likely a middleman, responded to the Iranian purchaser in a telex with the heading: "RE mass spectrometer system model "MAT 281" for uranium hexafluoride isotope analysis" (see telex no. 1486). He stated he was willing to acquire the item but asked for an official letter stating no military or government involvement in the spectrometer, particularly warning not to mention in any papers Sepah Pasaran.

If ICT is the Swiss company Inter-commerce Treuhand, Handels and Finanz, it was implicated in an illicit purchase of ammonium perchlorate from a U.S. supplier in 1988.[12] This chemical is used in rocket fuel.

Iran's statement about using SHIG to obtain a mass spectrometer implicates Sharif University as a willing accomplice in illicit nuclear trade, and the above telexes support such an attempt. However, was the AEOI the actual purchaser? Why did not the AEOI request the items itself or use its own smuggling networks which were substantial at the time. These networks were successfully buying a wide range of centrifuge-related equipment, including centrifuge components from overseas suppliers. An alternative possibility is that the AEOI was not the true customer. Could this procurement for a mass spectrometer have been for a parallel military gas centrifuge uranium enrichment program that was in its infancy and based in SHIG?

Additional information from Western sources suggests that the genesis of Iran's weaponization program was in the late 1980s at SHIG. A main function of SHIG was the development of ballistic missiles, which may have been referred to as group or project 1 in procurement records. Project or group 2 may have been its nuclear complement, albeit it at a very early stage of activity on nuclear efforts. Was PHRC formed to expand the military's nuclear efforts?

Departments or Buying Centers in PHRC

Re-ordering the telexes according to the number after the decimal point in the chronological message number suggests that the PHRC had an internal structure organized around specific technologies or projects. As discussed above, the telex with message number "1218.221" is likely associated with Department 2, the first number following the period (see figure 4). The procurements associated with Department 2 can be associated with a gas centrifuge program. Likewise, telexes with the message numbers xxx.02 appear also to pertain to procurements of centrifuge related items.

There are enough telexes to identify at least 8-11 departments, each specializing in specific nuclear technologies such as gas centrifuges, uranium conversion, mining and metallurgy. Figure 9 is the IAEA list of the purpose of these departments. ISIS has confirmed this assignment for Departments 1-8. ISIS is assessing

[12] Michael Gordon, "Shipment of U.S. Chemical Seized on Way to Iran," *The New York Times*, March 23, 1989.

other departments, including a Department 70 that may have been responsible for creating a PHRC technical library on the nuclear fuel cycle and obtaining relevant know-how from suppliers as well as sometimes seeking catalogues and inquiring as to the cost of purchasing various items.

The following summarizes the results of assessing telexes with numbers for departments 2, 4, 5, 7, 8, 1, and 70. The ISIS assessment is not finished for Departments 1 and 70 but initial findings are discussed. Subsequent reports will continue these assessments, include other departments and information in the collection of telexes, and incorporate additional data from suppliers approached by the PHRC or Sharif University.

Department 2

Department 2 has procurements that ISIS experts have linked to centrifuge activities. In addition, these efforts involve a possible initial attempt to acquire large numbers of ring magnets suited for use in a production-scale centrifuge program that used centrifuges based on the P1 or P2 gas centrifuge designs. ISIS found a total of 89 telexes that have "2" in the appropriate place to associate these with Department 2. Of this total, 53 telexes concern Sharif University, typically the Purchasing Department, 35 involve the PHRC Purchasing Department, and one is from Iran's Ministry of Defense Purchasing Department concerning a letter of credit to pay a Dutch company, with a copy also sent to PHRC. Some of the telexes sought information about a particular item from a number of overseas companies in a "barrage" approach to illicit procurement—sending out multiple requests for the same item or items to multiple companies.

In many cases, there are multiple telex communications regarding the same item request, and likewise reference the same message number. Typically, the message number is associated with initial communications, and subsequent telexes may or may not include the original message number. In identifying related telexes, ISIS evaluated the context of the discussion or other references that made clear the linkage to the one with a message and department number. However, in no case, did ISIS judge that the telexes necessarily represent all the communication that occurred between the Iranians and supplier companies or banks.

The items requested by the PHRC and Sharif University under Department 2 concerned many items that are often associated with centrifuges. The goods organized under Department 2 include permanent magnets, hysteresis motors, converters (drive-up units), inverters, a balancing machine, bearing needles, balls, and cups, vacuum pumps, gas flow regulators, leak and isolation valves, and pressure transducers. ISIS cannot judge every item as to its suitability for use in a centrifuge, because of incomplete information in the telexes. Nonetheless, the fact that so many items are of the type used in centrifuges and organized under one specific heading stands out in the data. Some items appeared ambiguous or out of place in this grouping as to their function in a centrifuge program, but overall the list strongly suggests a centrifuge research and development purpose.

Adding further suspicion to PHRC's interest in centrifuges was another enquiry that is not in the telexes but known to ISIS. PHRC sought in 1991 high strength (7075) aluminum bars consistent with the dimensions of the centrifuge design Iran's AEOI had acquired in 1987 from the Khan network.

A leader of that effort said that after the designs were brought to Tehran, other Iranian entities received these same designs but he was not told which ones. He suspected that two or three other groups were working on centrifuges in addition to his group at the AEOI.[13]

Magnets Iran told the IAEA that Shahmoradi had purchased "some magnets" on behalf of Sharif University's physics department for educational purposes. Iran said all of these magnets were discarded.[14]

[13] Albright, *Peddling Peril (New York: Free Press, 2010), p. 79.*

The telexes, however, imply a much deeper interest in magnets, some of them ring magnets, which could be intended for the upper bearing of a centrifuge. In total, several tens of telexes discuss the purchase of a variety of magnets in various shapes from several companies. Many of the requested magnets are innocuous, but several raise suspicions that the underlying intention is to acquire centrifuge subcomponents. Enquiries from Sharif University to at least three companies, Thyssen, Bakker Madava, and Magnet Applications, all on December 17, 1990, include a request for the prices of several small samples of various shapes of magnets, along with a request for a price list for 10,000 magnets. This large amount is atypical for educational purposes, but consistent with the purchase of ring magnets for a centrifuge program. The three telexes have message numbers that imply that the magnets are for Department 2 or centrifuges (telex 686, telex 660, an unnumbered telex). The one to Magnet Applications instructs that samples should be sent by airmail to PHRC's post office box. Likewise, this telex has PHRC's fax number.

In the case of the enquiries to Thyssen and Bakker Madava, the request is for a variety of axially magnetized ring magnets made from cobalt samarium or neodymium.[15] The dimension of the ring magnets was less than 100 millimeters (outer diameter) and greater than 40 millimeters (inner diameter) and less than 10 millimeters thick. The enquiry to Magnet Applications gives the exact dimensions of a requested ring magnet as 52.4 millimeters (outer diameter), 36 millimeters (inner diameter), and 10 millimeters thick. All the dimensions are the right order for P1 and P2 centrifuges, the type Iran received from Pakistan. For example, a P2 ring magnet sought by Iran later has dimensions of 52.8 mm x 36.8 mm x 8mm. P1 ring magnets have similar dimensions.

It is unknown if PHRC received a large order of magnets. In any case, Iran's statement to the IAEA about magnets is incomplete.

Schenck Balancing Machine One purchase could not be traced to Department 2 but nonetheless is a candidate for inclusion. By late 1990 or early 1991, Sharif University had placed an order for a Schenck balancing machine, type RS-1 (telexes 621 and 1043). This machine is suitable to balance the relatively small rotor assembly parts of the P1 centrifuge. Delivery occurred on September 10, 1991. The department number of this order is unknown; the telexes start after the initial enquiry. One of the telexes discussing a proforma invoice does have message number 1311 but nothing following it, suggesting a PHRC procurement but lacking a department number (telex 201).

A Dr. M. Hosseini, apparently from Sharif University, is initially involved in discussions with Schenck employees about the balancing machine, but by the summer of 1991, the correspondence involves a letter of credit with a guarantee in favor of Shahmoradi, giving his address with a PHRC P.O. Box (telex 75). It is unclear if Schenck was aware that Shahmoradi worked at PHRC.

Iran told the IAEA that Sharif University's Mechanical Engineering Department bought the balancing machine for educational purposes. The IAEA expected to discuss its questions about this machine during talks on the military dimensions of Iran's nuclear program, but these talks never took place.

This balancing machine is unlikely to have been for the AEOI, which had earlier bought both a vertical and horizontal balancing machine from Schenck. These particular balancing machines were later inspected by the IAEA in 2003 in the Natanz centrifuge assembly shop.

[14] IAEA Director General, Implementation of the NPT Safeguards Agreement and Relevant Provisionis of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran, GOV/2008/4, February 22, 2008, p.3.
[15] In the case of the Thyssen enquiry, the enquiry asks for Secolit and Neronit, which appear to be trade names used by Tridelta for its cobalt samarium and neodymium magnets. Perhaps, Tridelta was approached as well.

Status of Effort The status of a PHRC centrifuge effort is difficult to characterize from the list of equipment sought by PHRC and Sharif University. According to ISIS experts, the centrifuge effort appears to be early in nature rather than associated with a mature program.

These procurements do not appear to be for AEOI, and Iran does not claim this in any case. It would be a difficult case to make. In 2003, the AEOI allowed the IAEA to inspect its centrifuge equipment and materials at its major centrifuge facilities, and the IAEA generated extensive lists of equipment and learned when much of it was procured. Most of these goods were purchased in the late 1980s and early 1990s by known AEOI officials through several European companies, before PHRC started its procurements. Thus, the equipment attributed to Department 2 is unlikely to be for AEOI's centrifuge program.

Did PHRC plan to build its own centrifuges? Did it want to develop an expertise in running and understanding centrifuges? The data are insufficient to answer these questions, but they cannot be dismissed. Moreover, what happened to any such effort in the late 1990s, when PHRC was supposedly closed?

Prior to the suspension in 2003, military contractors at the 7th of Tir Facility made the most sensitive centrifuge components, namely the rotating ones, for the P1 centrifuges slated for the Natanz enrichment site.[16] Perhaps, the Ministry of Defense's original intention was develop and maintain a centrifuge capability to allow it to pursue a parallel centrifuge program. In this case, the centrifuge manufacturing sites would have also made 3,000 or so centrifuges for a parallel military centrifuge plant. Many questions remain about the original purpose of the deeply buried Qom centrifuge plant discovered in 2009 by Western intelligence. Was this site to be a military-controlled site dedicated to the production of weapon-grade uranium? With the end of the suspension in 2006, did the Ministry of Defense also resume its centrifuge plans as well and plan to install centrifuges at the Qom plant?

Department 4

ISIS tabulated about 140 telexes that fall under Department 4. ISIS assesses that the telexes associated with Department 4 appear to be focused on acquiring equipment for uranium conversion. In particular, many of the telexes under Department 4 appear to involve the procurement of equipment or materials capable of producing fluorine and designed to handle high temperatures, high pressure, and corrosive materials. This equipment appears to be associated with the processes related to the production of uranium oxide, uranium tetrafluoride, or uranium hexafluoride. A uranium conversion program could include a plan to convert uranium yellowcake into uranium tetrafluoride, and a process to add fluorine to create uranium hexafluoride—the feedstock for gas centrifuge uranium enrichment.

One expert with decades of experience in the fuel cycle said these communications can be related to a uranium conversion facility. Moreover, he found nothing in the Department 4 telexes that would contradict that the procurements were supporting a uranium conversion effort. He added that the type of procurements or attempted procurements implied a decision to establish a full-scale program.

A foreign centrifuge expert also involved in planning the secret purchase of the components of a uranium hexafluoride plant provided an independent but similar assessment. He thought that the procurements or attempted procurements indicated an indigenous effort to develop a uranium conversion capability.

The telexes in this department show an interest in fluorine, an essential component of uranium tetrafluoride and uranium hexafluoride. In a telex sent on August 12, 1991, the PHRC requests from a supplier company catalogues and information for monitoring equipment for "CO2, SO2, H2O, HF, H2SO4, H2S, SIF4…" where the

[16] David Albright, Jacqueline Shire and Paul Brannan, Can Military Strikes Destroy Iran's Gas Centrifuge Program? Probably Not. ISIS Report, The Institute for Science and International Security, August 7, 2008: http://isis-online.org/uploads/isis-reports/documents/Centrifuge_Manufacturing_7August2008.pdf

HF likely refers to hydrogen fluoride, a common source for fluorine (telex 425). A telex sent on May 17, 1991 from a company named Air Products confirms for the recipient, Sharif University, that it has applied for an export license for fluorine gas (telex 18). Ultimately, Air Products decided not to provide the fluorine (see also section on fluorine below)

A January 14, 1992 telex from PHRC requests equipment capable of withstanding high pressures (telex 367), while another telex requests items capable of withstanding high temperatures associated with furnaces (telex 548). In this message, the PHRC is explaining to the supplier that they require steel pipes with high melting points for use in furnaces. Such specifications for equipment would be expected in those used in a uranium conversion process.

According to the IAEA, the Green Salt project allegedly involved a covert effort by Iran in the early 2000s to produce uranium tetraflouride. Was Department 4 an early version of a conversion project and the Green Salt project a later partial manifestation of this work?

Department 5

The telexes linked to department 5 are assessed by ISIS experts as related to uranium mining. These telexes were sent from late 1990 into early 1993 with most in 1991 and 1992. They are mainly from PHRC, although several are from Sharif University. One telex to a supplier discusses a feasibility study for uranium, copper, and vanadium mines and the need for analyzing these elements (telex 671). It goes on to discuss possible equipment needs for analyzing the concentration of U_3O_8 in ore. On the whole, the goods sought were principally related to conducting geological surveys for uranium or other minerals rather than mining itself.

One exception was an enquiry from Sharif University to Outokumpu Electronics for a "courier 20 online X-ray analyzer" that could be used in a production process to assay elements in slurries (telex 753). This telex has the familiar pattern of stating that the enquiry comes from Sharif University but asks for a response to a PHRC fax number.

The goods are unlikely to have been for the AEOI's Saghand mine and mill, which the AEOI was already developing in that period. According to Iranian statements to the IAEA, by 1989, Iran had established the extent of uranium reserves at Saghand in central Iran in cooperation with Chinese experts.[17] In 1995, Iran signed a contract with Russia for equipping the Saghand mine and designing a uranium ore processing plant. One of the telexes is a letter of credit from Iran's AEOI to Russia about paying up to $2.45 million for the elaboration of the process flow sheet and design documentation for the construction of uranium ore processing in Saghand and of the detail design for construction of a mine in Saghand (telex 1569). Missing from this telex are any of the familiar references to PHRC or Sharif University.

According to IAEA information, PHRC or Shahmoradi had close relations to the head of Kimia Maadan, Mr. Haratian, who is linked to the Gchine mine. Did Department 5 at PHRC become Project 5.15 under the AMAD program that was involved in the Gchine mine project? Iran says that the AEOI was responsible for the Gchine mine and had no military involvement, but was PHRC in 1991 and 1992 putting together the beginnings of the Gchine mine in a parallel program to the AEOI? Was the intended goal in 2002 or 2003 of the Gchine mine to produce uranium for a parallel military program?

[17] IAEA Director General, *Implementation of the NPT Safeguards Agreement and Relevant Provisionis of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran*, GOV/2008/4, February 22, 2008, p. 5.

Department 7

The telexes under Department 7 include requests for a furnace, lathe, pump and a surface grinding machine. The number of telexes in this set is less than fifteen. A clear nuclear technology does not emerge from this data.

Taken together, the equipment requested and the companies contacted indicate that Department 7 is involved in metallurgy or a workshop project. There are several applications for metal making or working in a nuclear program. On a larger scale, uranium could be made into a metal as fuel for a nuclear reactor. On a smaller scale, highly enriched uranium would be made into metal and shaped into pieces usable in a nuclear explosive device. Highly accurate metal working is necessary in machining the specialized metal components in a gas centrifuge. It is unclear in the telexes the purpose or scale of the metallurgy or metal workshop program supported by Department 7.

There are multiple telexes between PHRC and a machine tool company headquartered in Germany. In a telex sent November 10, 1991, PHRC requests from the company a price quote for a surface grinding machine—used for machining pieces of metal (telex 414). A couple months later, the company responds that it forwarded a price quote for a grinding machine through its local representative in Tehran (telexes 919 and 1198). These types of machines could be used to machine metal into specific shapes. They could also be used to machine the metal into specific shapes for use in gas centrifuges.

In addition to grinding machines, Department 7 sought lathes from a well-known Swiss company that made high quality machine tools. A lathe is used to spin the metal piece while another machine or tool shapes or cuts it. Sent in November of 1991, a telex is a response to PHRC from the company providing price quotes for two of its models (telex 889). It is unclear if Iran ever received machines from this company, or their suitability for use in making centrifuge parts.

Several of the companies that the PHRC contacted with these Department 7 telexes are well known. The German company contacted in one telex makes metal forming machines, pumps for the metal industry and spindles for turning metals on a lathe (see telex 414). Another German company that PHRC contacted for an in-line pump in a telex under Department 7 makes many of the same metal forming specialty systems (telex 453). Other companies contacted under this Department make equipment to measure metal products, as well as electrodes and crucibles common in melting metal and making metal forms.

Vacuum induction furnace One attempted purchase could not be traced to Department 7 but nonetheless may be relevant to this department. In late winter 1991, Shahmoradi visited Europe to acquire a range of goods. Traveling as a representative of Sharif University, he contacted at least one company requesting a small vacuum induction furnace (telex 106). The small capacity of this furnace would imply that it was likely for laboratory-scale use.

Six months later, Department 70 of Sharif University, but with a PHRC P.O. Box number, telexed AEG-Elotherm seeking technical information, catalogs, and the cost of purchasing and operating a vacuum induction melting furnace with a bottom pouring crucible (telex 482). Such a furnace is well-suited to produce uranium metal when there are contaminants. The contaminants would float to the surface, so if a tilt system were used to pour the metal, the contaminants would mix with the uranium metal. A bottom removal system allows for the drawing of pure uranium metal.

Department 70 also sent the same request to several other companies at about the same time based on telexes from companies responding to such an enquiry. Several said that they did not make such furnaces or did not have bottom pouring models. Some of these companies referred Department 70 to German firms that did make them. It is unknown if PHRC obtained one.

Department 8

The 90 telexes under Department 8 contain requests that ISIS experts assess are for the production of deuterium oxide (D_2O), or heavy water. D_2O is used as a moderator in heavy water reactors and it is relatively difficult to make with the necessary 99.75% or greater purification. There are multiple ways to make D_2O and based on the telexes, Iran may have intended to use a combination of ammonia/hydrogen exchange and distillation.

Several of the telexes involve requests from PHRC for fluid pumping equipment with directions that it be able to handle chemicals specifically found in D_2O production. A telex from PHRC sent on September 20, 1992 requests a price quote for an oil free, centrifugal "compressor blower", where the fluid to be handled is "NH3," or ammonia (telex 1106). Ammonia is used in the ammonia/hydrogen exchange system for making D_2O, where the ammonia breaks down to many compounds, including nitrous oxide (NO), and it becomes the transfer agent between D_2O and H_2O.

Several telexes between PHRC and a German company over the course of a month in early 1992 detail a request for saddle or packing beds—equipment used in chemical process towers. In a distillation column associated with D_2O production, the liquid flows over these packing beds which ensure the counter current flows from top to bottom receive maximum mixing.

There are ten telexes under Department 8 over the course of approximately nine months in 1992, though most occurred within a three-week period, where PHRC requested price quotes on various "level switches", used in regulating fluid levels with pumps. The number and type of pumps suggest they could be used in a distillation column, where there are multiple fluid levels that need to be maintained. There are also multiple telexes under Department 8 requesting price quotes from companies for a "steam jet ejector". In a D_2O production plant, steam is used to move much of the material throughout the system. Several telexes request prices quotes for valves, Y-strainers for pipelines, and other equipment that is specified to handle sulfuric acid. Sulfuric acid can be used as a cleaning agent in a D_2O production plant.

In July and August of 1992, PHRC sent multiple telexes to a German company that specializes in making mixing plates, membranes and washing and recovery equipment of the type used in D_2O production. Another company contacted by PHRC specializes in supplying distillation equipment. Common problems in D_2O production involve corrosion and the degradation of the product purity. Multiple companies contacted under Department 8 make equipment specialized for use in corrosive environments and process flow equipment.

In a nuclear program, the equipment and specifications outlined and the companies contacted in the Department 8 telexes are consistent with D_2O production. Why was PHRC involved in these procurements? What was their role in the Arak Heavy Water Production Plant?

Department 1

The heading for this department in figure 8 is nuclear physics or neutronics. There are at least 15-20 telexes that can be associated with Department 1.

NEA Codes A telex dated January 14, 1992, has message number 1088.0104 and contains a request to the Nuclear Energy Agency (NEA) data bank for information (see telex 410). Although the request is from Sharif University's telex, the structure of the message number implies that the request originated at the PHRC, According to a Western source, NEA provided about 40 unclassified computer codes. An ISIS consultant analyzed this list of codes and could identify most of them.[18] These codes are an unclassified collection of

[18] Mark Gorwitz, "Physics Research Center – NEA Code Analysis," January 2012.

software, including codes related to the design of light water reactors and heavy water reactors, fallout predictions following reactor and criticality accidents, and neutronic codes.

The AEOI would have been expected to have had these codes already. By obtaining these codes, PHRC or a customer methodically sought to bolster its nuclear computing capabilities.

Many of the codes are consistent with PHRC's declared mission, namely to prepare against nuclear attacks and accidents. But was the purpose of these codes and any others the PHRC acquired strictly according to this narrowly defined mission? The procurements of most of the other departments are hard to reconcile with such a narrow mission, as described by Iran to the IAEA. Although these codes are all designed for unclassified applications, they are dual-use in nature and can be used to better one understanding of reactors or nuclear explosives, particularly if PHRC obtained other codes that Iran is known to have acquired earlier, such as the Monte Carlo N-particle transport code (MCNP). MCNP was used as early as 1989 by researchers at Malek Ashtar University in experiments on thermal neutron cross section.

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Other Telexes An additional telex asks for a range of nuclear equipment from the defunct British company Wallac Ltd (see telex 606). Dated August 8, 1989, this telex has an earlier message number system and is from Department 1, Sharif University but with a PHRC P.O. box.[19] The items requested are (1) various types of detectors in the nuclear industry field, (2) single and multichannel analyzers, and (3) related instruments in nuclear physics and engineering.

Hadland Ballistic Range Camera One of the telexes that could be relevant to Department 1 is from November 1992. M. Abbaspour of the Mechanical Engineering Department of Sharif University sought a Hadland high speed ballistic range camera through Samamicro Co. Ltd (telex 1098). The telex does not have Sharif University's telex number but one from a group with a telex name PCIG IR. A Majid Abbaspour was reportedly head of IGRC's chemical weapons program, in which case PCIG could stand for Pasaran Chemical Industry Group. This particular camera was designed primarily for exterior and terminal ballistic tests. However, experts have accessed that Hadland ballistic range cameras can be adapted for use in testing the initiation and detonation of high explosives.[20]

There were later enquiries for high speed cameras .According to the IAEA, PHRC or its successor the Institute of Physics at Lavisan made enquiries in 2001 for high speed cameras from DRS Hadland in the United Kingdom and Photonics in Germany.

Danilenko. Although the set of telexes do not contain information on former nuclear weapon expert Vycheslav V. Danilenko, IAEA information has established a connection between Danilenko and Shahmoradi.[21]

[19] Telex 606 lists a Sharif University fax no. 0098821-908538.

[20] Manfred Held, "Detonation Studies with a Ballistic Range Camera," *Propellants, Explosives, Pyrotechnics*, Volume 20, Issue 6, pages 337–344, December 1995. The abstract is: "With an appropriate test setup, the Hadland Photonics Ballistic Range Camera (SVR), designed primarily for exterior and terminal ballistics, can also be used very well for studying initiation events and analyzing a variety of detonation phenomena. This paper discusses detonics experiments carried out with the Ballistic Range Camera explaining in detail the test setup and the analysis of the results. The ability of the camera system to superimpose up to 16 images on a single frame allowed particularly detailed examination of detonation propagation, velocity, corner turning distance and the non-reacting radial zones."

[21] David Albright, Paul Brannan, Mark Gorwitz and Andrea Stricker, ISIS Analysis of IAEA 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 13, 2011: http://isis-online.org/isis-reports/detail/irans-work-and-foreign-assistance-on-a-multipoint-initiation-system-for-a-n/8

After leaving the famous Soviet nuclear weapons research and development facility, VNIITF, in either 1989 or 1991, Danilenko moved to Ukraine and established the company ALIT in Kiev, producing ultra-dispersed diamonds (UDD or nanodiamonds). He experienced economic difficulties by the mid-1990s. According to the IAEA, he contacted the Iranian embassy in mid-1995, offering his expertise on UDD. At the end of the year, he was contacted by Shahmoradi. Danilenko signed a contract with Shahmoradi, according to IAEA documents.

Shahmoradi would have undoubtedly recognized Danilenko's value to an incipient nuclear weapons effort. Synthetic diamond production is unlikely to have been a priority, although it has obvious value as a cover story. In assessing the important contributions made by scientists and engineers to secret proliferant state nuclear programs, ISIS has not found any that did not initially offer other, more benign assistance that provided a plausible cover for their secret nuclear assistance. In some cases, their intention was originally benign but they were lured by money to assist in sensitive nuclear areas.

According to the recent IAEA safeguards report, Danilenko worked in Iran from about 1996 until about 2002, "ostensibly to assist Iran in the development of a facility and techniques for making UDD, where he also lectured on explosion physics and its applications." He told the IAEA that he lectured and constructed an explosive firing cylinder which was not designed for experiments on spherical systems. In 2002, he returned to Russia.

The IAEA has reviewed publications by Danilenko and has met with him. It has been able to verify through three separate sources, including the expert himself, that he was in Iran during that time. Danilenko told the IAEA that he does not exclude that his information was used for other purposes.

Multiple Departments' Interest in Critical Material Fluorine

Iranian declaration about a fluorine procurement When presented with procurement evidence, Iran admitted to the IAEA that the PHRC attempted unsuccessfully to purchase 45 gas cylinders, each containing 2.2 kilograms of fluorine, on behalf of the Office of Industrial Interrelations of Sharif University. However, it claimed a non-nuclear use for the fluorine at the university. Fluorine is also needed to make uranium hexafluoride.

The telexes portray a different situation than what Iran has stated. PHRC appears to use Sharif University as a front in its attempts to purchase fluorine gas and possibly seek the technology to make fluorine itself. Moreover, there may have been more than one attempted or actual order of fluorine gas. The intended user of the fluorine is suspected to be PHRC's uranium enrichment and conversion departments.

Air Products The telexes appear to discuss this admitted procurement of fluorine and two others. Two telexes from Sharif University and dated December 27, 1990 cover requests to Air Products, a well-known supplier of fluorine. The message numbers in telexes 666 and 668 have PHRC message numbers 1192.20 and 1191.40, despite being sent from Sharif University's telex machine. The message numbers on these telexes are distinctive to PHRC Department 2, gas centrifuges, and Department 4, uranium conversion. As in many telexes from Sharif's telex, the one for Department 2 contains PHRC's post office box number and fax number.

The Department 2 request is for 10 kilograms of "mega-grade" sulphur hexafluoride (telex 668). Sulfur hexafluoride has been used in centrifuge experiments in lieu of uranium hexafluoride. It is heavy enough to work in a regular centrifuge. Researchers have done calculations on sulfur hexafluoride in a centrifuge that allow comparison to experiments, providing information about the performance of a centrifuge without using uranium hexafluoride.

The second telex from Sharif University refers to an earlier Air Products' proforma invoice dated December 5, 1990, which is likely one for the cylinders and fluorine.[22] This telex specifically requests that Air Products provide certain equipment and services at no cost (telex 666). This equipment is mentioned in later telexes and is related to fluorine storage and use (telex 670). A request from Department 4 would be consistent with the use of fluorine in a uranium conversion program to make uranium hexafluoride.

A March 3, 1991 telex from Air Products sent to Sharif University's telex but addressed to PHRC's purchasing department implies that another PHRC department asked for fluorine gas (telex 716). An Air Products' representative asks about an earlier quotation for gas, cylinders, and equipment that was sent on October 3, 1990, in response to a telex from PHRC with message number 1096.331. This message number is associated with Department 3, laser enrichment. It is unclear if this order is related to the Department 4 order or a third, separate one. The reason for addressing this telex to PHRC is not explained, but the writer appears to understand that there is a connection between Sharif University and PHRC.

In late April 1991, the commercial manager of Sharif University telexed Air Products with regard to the order from Department 4 asking for the shipping schedule of their order. He states that he wants the information so as to finalize the letter of credit to pay for the order (telex 222). Rather than respond with a shipping date, Air Products telexes back the same day that it has made an application for an export license to British authorities for the fluorine gas, stating that shipment is possible only after receiving permission (telex 224). About three weeks later, Air Products reports that it is trying to get a quick decision from the licensing authorities but asks for Iran to extend its letter of credit by 180 days (telex 267). The reason for the relatively late announcement to seek a license with British authorities is not discussed in the telexes.

In June 1991, the British licensing authorities stated to Air Products that they wanted to impose the condition that any cylinders supplied would be returned to Air Products within one year of granting the license (telex 298). Air Products asks Sharif University to accept this condition.

A telex dated December 1, 1991 to Air Products from the Bazel Company in Tehran, conveys a message from Sharif University asking for the status of finalizing the letter of credit and stating that the customer has sent a telex to Air Products agreeing to return gas cylinders, at rate of 15 cylinders per year (telex 553). Bazel Co. appears to be an intermediary between Air Products and the PHRC. Several telexes illustrate Bazel's middleman role in this procurement and in orders with other companies.

By early 1992, Air Products had received a telex from Sharif University asking about the license. On February 17, 1992, Air Products telexed PHRC directly but addressed the text to Sharif University. It said that the application for a license had been denied, advising the cancellation of the letter of credit (telex 1276). This telex shows that at least by this time, Air Products was aware of PHRC's central role in this order.

Buss AG. A common way to make fluorine is to first produce hydrogen fluoride or HF, made by combining sulfuric acid with fluorite, also called fluorspar. When mixed with water, HF gas becomes hydrofluoric acid. PHRC may have been attempting to procure technology to create an indigenous capability to make HF. In a December 27, 1990 telex, Department 70 of Sharif University sent an enquiry to Buss in the United Kingdom asking for detailed information and catalogs regarding producing hydrofluoric acid from fluorspar and sulfhuric acid ASAP (telexes 751). This was followed a few weeks later on January 15, 1991 with a telex to Buss AG in Switzerland asking for the same thing (telex 667). Buss was well qualified to help.

[22] Telex 666 thanks Air Products for its P/I, which is a proforma invoice, a quotation which was intended for use in opening a letter of credit. In fact, this telex states that Sharif University is proceeding to open the L/C, letter of credit. Unlike the DPRK, according to one knowledgeable source, Iranians rarely sent Purchase Orders to accept a quotation or signed binding contracts.

Nonetheless, Buss AG responded on February 7, 1991, declining to help because of "work overload" (telex 162). Despite the rejection, Sharif University asked again on October 6, 1991. There are no later telexes on this request.

Department 70 of PHRC?

Two telexes suggest a link between Department 70 and PHRC. Dated September 9, 1991, with message number 010830, Department 70 Sharif University asks a company for technical information on a vacuum induction melting furnace with bottom pouring crucible (telex 482). The post office box on the telex is that of PHRC. Most of these Department 70 telexes in the ISIS set use a different message numbering system that is based on a six-digit number, such as 010771 or 010830. Shahmoradi signed one telex that has this type of message number, namely 010791, although the telex was sent from Sharif University (telex 1593). Thus, Department 70 may have been in charge of obtaining know-how or technology for the PHRC.

Department 70 was responsible for buying books and periodicals related to nuclear technologies associated with PHRC departments. This department bought tens of thousands of dollars of books and reports from a British document center with the acronym BLDSC, likely the British Library Document Supply Center (telex 748). The telexes show that over a relatively short period of time, Department 70 acquired a considerable number of documents that are related to sensitive parts of the nuclear fuel cycle from this center

ISIS's set of data contains over 30 telexes sent by Department 70 to the British document center. About 20 of these telexes were sent between March 1991 and September 1991 and have the above distinctive message numbers. Based on an analysis of this subset of telexes, ISIS found that Department 70 sent considerably more telexes during this six month period. From early March 1991 to the end of September 1991, the numbers in this subset of telexes range from 010782 to 010841, implying a total of 60 telexes. Given that ISIS has about 20 of these telexes, Department 70 could have sent up to 40 more orders for documents to the BLDSC and elsewhere during this period.

In an initial screening of the telexes, ISIS experts assessed that the publications ordered from the BLDSC cover a wide variety of technical aspects of the nuclear fuel cycle. There are many publications about the theory and operation of gas centrifuges and related equipment, atomic laser isotope enrichment, the production of uranium compounds including uranium tetrafluoride and uranium hexafluoride (and precursors such as hydrofluoric acid), nuclear reactors, nuclear grade graphite (its properties, purification, and radiation damage), and the production of heavy water. These publications cover both basic and advanced topics on these subjects and appear aimed at creating a technical library. One would have expected that that the AEOI would have already collected many of these documents.

The document requests include many studies about gas centrifuges. The intention appears to be the development of an understanding of gas centrifuges and the hardware associated with them such as hysteresis motors, vacuum pumps, and converters.

A centrifuge expert active at that time conducted a preliminary analysis of the list of publications in the telexes. He is familiar with many of them or the authors of these publications. Department 70 appears to have been trying to obtain everything that had been published about centrifuges, including studies by many of the world's leading experts. He assessed that Department 70 sought the bulk of the unclassified literature that existed on centrifuges at that time. Several of the publications were conference proceedings and reports that were not widely known, indicating a well organized search with the goal of assembling a comprehensive technical library on centrifuges, related equipment, and details of gas centrifuge plant design from the United States, Germany, Japan, France, URENCO and other countries.

Conclusion

Iran has admitted that the PHRC was related to the military and had a nuclear purpose in the area of defense preparedness and radiation detection. However, its actual nuclear role appears much more extensive.

Iran has failed to declare all of PHRC's activities to the International Atomic Energy Agency. Iran has stated to the IAEA that the PHRC procurements were not related to a nuclear program. The information assembled in this ISIS report, however, contradicts this claim. Iran has created a cover story for the PHRC involving Sharif University that attempts to hide its true activities, including a vast number of both successful and attempted procurements for ostensibly undeclared nuclear programs.

Whatever nuclear activities PHRC pursued in the early 1990s, they appear independent of those of the Atomic Energy Organization of Iran in the area of gas centrifuges, uranium exploration and possibly mining, and uranium conversion. Iran should explain to the IAEA why there appears to have been a parallel, organized nuclear program.

PHRC may have aimed to ensure that the military had a strong hand and competence in the nuclear fuel cycle and weaponization. Although the bulk of the nuclear fuel cycle competence would remain in the AEOI, the military would have gained enough to ensure that it could build a highly secretive parallel program aimed at obtaining both weapon-grade uranium and the weapon itself.

Despite all the new information, the PHRC remains difficult to fully understand. Iran should clarify PHRC's exact purpose and accomplishments and its relationship to the IAEA's broader question of the military dimensions of Iran's nuclear effort.

Figure 1. August 11, 2003 satellite image of the Lavizan site, the location of the Physics Research Center.

Figure 2. May 10, 2004 satellite image showing the site razed.

Figure 3. August 7, 2007 satellite image showing a park and athletic fields present on the site.

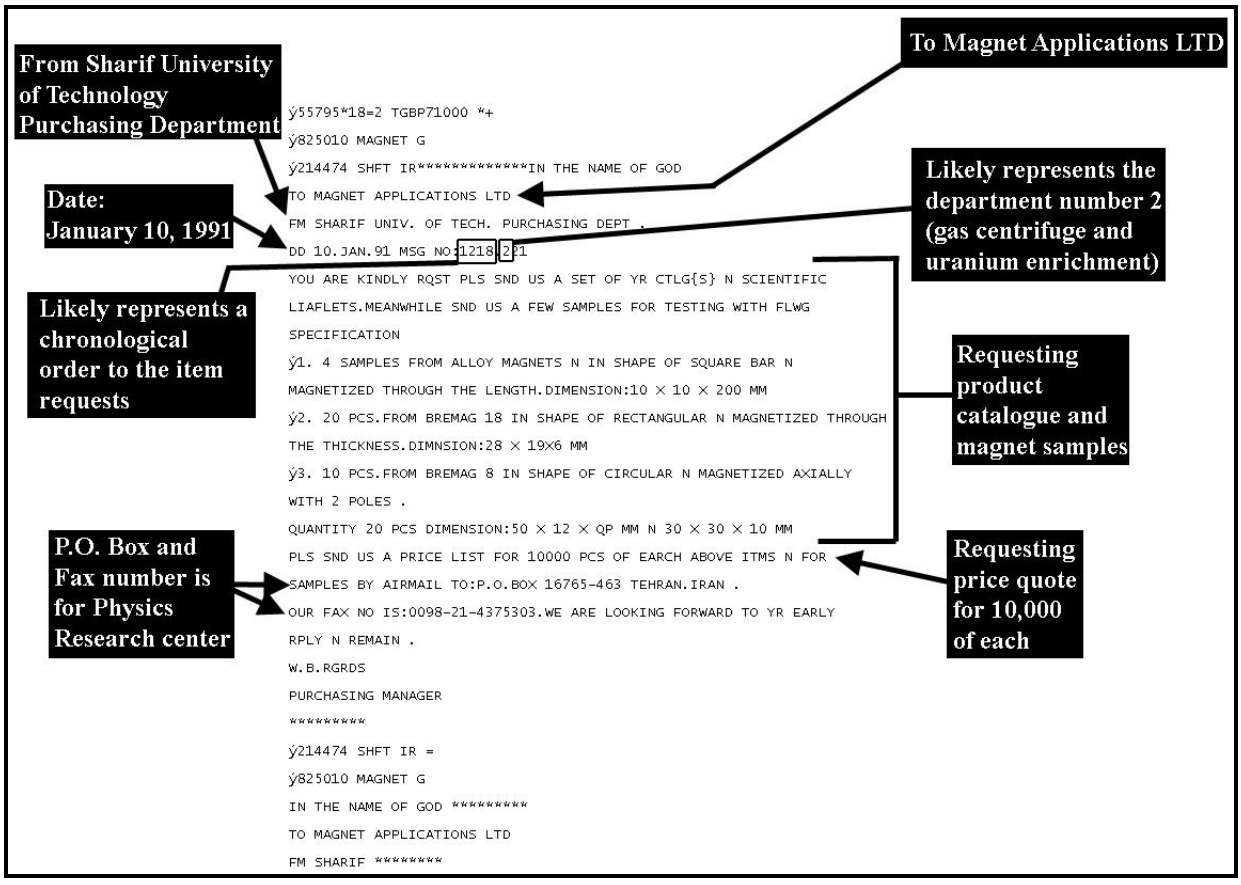

Figure 4. A sample telex showing the numbering system, the entities listed and the items requested in a telex enquiring about magnets.

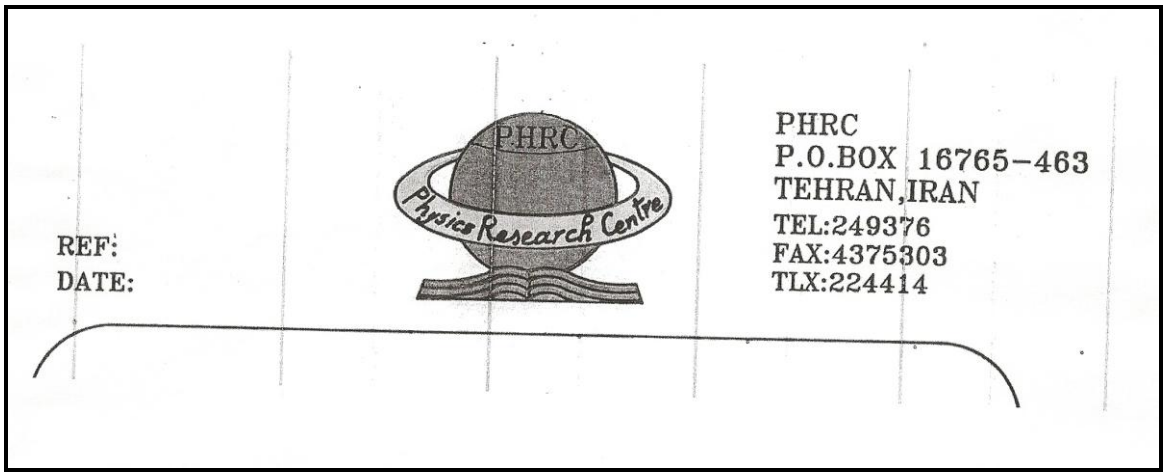

Figure 5. Physics Research Center (PHRC) logo and contact information. The PHRC fax and post office box numbers are listed as the contact information for Sharif University as seen in Figure 4.

PHRC

Fax number: 4375303

Telex number: 224414PHRC

P.O. Boxes used

16765-463

Sharif University of Technology

Azadi Avenue

Fax number: 908538

Telex number: 214474SHFT

Figure 6 Physics Research Center and Sharif University Contact Information

Date	Telex number for Physics Research Center: 224414	Telex number for Sharif University of Technolgy: 214474
1/28/1991		1242.206/A
2/4/1991		1256.408
2/4/1991	1258.02	
2/4/1991	1258.02	
2/18/1991		1277.4D07
2/25/1991		1284.4D07
2/25/1991		1284.4D07
4/11/1991		1297.4D03
4/11/1991		1303.4D04
4/11/1991		1304.4D09/B
4/11/1991		1304.4D09/B
4/16/1991		1304.4D09/B
4/16/1991		1304.4D09/B
4/16/1991	1434.04	
4/23/1991		1304.4D09/B
4/23/1991		1325.406
4/27/1991	1331.2010/B	
4/27/1991	1331.2010/B	

Figure 7a. An excerpt of a tabulation of the telexes by date and arranged by whether the telex number originated from PHRC or Sharif University. The digits appearing in each entry is the message coding given to the telex. In early 1991, some telexes were sent from a PHRC telex number, but many were sent from a telex number for Sharif University. The first four digits in the message number are generally sequential. The message number for the January 28, 1991 telex starts with “1242”. These first four digits gradually increase over the next three months for message numbers attributed to multiple Departments.

Date	Telex number for Physics Research Center: 224414	Telex number for Sharif University of Technolgy: 214474
1/1/1992		1143.022
1/2/1992	1021.0412	
1/2/1992	1026.0412	
1/2/1992	1021.0412	
1/6/1992	1398.0224	
1/6/1992		1115.0425
1/6/1992	139.0412	
1/13/1992	1119.0508	
1/13/1992	1126.0709	
1/13/1992	1131.0418	
1/14/1992		1136/0509
1/14/1992	1119.0508	
1/14/1992		1157/0205
1/14/1992	1155.0408	
1/14/1992		1115.0425
1/15/1992		1142.022

Figure 7b. An excerpt from a two-week period in January 1992. The telexes are split between having originated from PHRC versus Sharif University telex numbers. The first four digits in the messaging number is generally sequential.

Date	Telex number for Physics Research Center: 224414	Telex number for Sharif University of Technolgy: 214474
2/15/1993	1728.043O	
3/9/1993	1737.0212	
4/5/1993	1472.0501/1	
4/25/1993	1766.0205	
5/18/1993	1793.0205	
11/20/1993	1844.043O	
11/20/1993	1844.043O	
5/14/1994	1849.0716	
11/24/1994	1867.043O	
12/25/1994	1869.04	
12/25/1994	1869.043O	

Figure 7c. An excerpt from 1993 and 1994. The first four digits in the message number is still sequential, while all the messages originated from the PHRC telex number. Starting in approximately late January 1992, most every telex afterward appears to originate from the PHRC telex number.

Doc #	Dept	Date	Purchasing Dept or Bank	Items	Supplier Company or Bank	Topic
575	10679.203,6	7/30/1990	PHRC Purchasing Dept	PERMANENT MAGNETS FROM:ND-FE-B N RARE-EARTH N NEW PRODUCTS FROM ALNICO, HYSTERESIS MATRIAL N MOTOR	Goudsmit Magnet Systemen	Seeking price quote
866	MSG NO:1550.02	10/22/1990	FM PHRC PURCHASING DEPT	VACOMAX 80T,VACOMAX 170, VACOMAX 225 HR, VACODYM 400 HR, VACODYM 370 HR N VACODYM 400 WZ PERMANENT MAGNETS INDISC SHAPE WITH STEET CAP AND BELOW RANGE OUTTER DIAMETER: DO(EQUAL) 6-5 CM (PLUS SIGN) OR MINUSMARK THAN 20 PERCENT INNERDIAMETER:22 CM (SMALLER OR EQUAL) DI (SMLR OR EQL) 3.2 CM THICKNESS : H=4MM-6MM NO OF POLES: 6-8 POLES MAGNETIZED AXIALLY IN SEGMENTS WITH ALTERNATING POLES .	To: VAC (VAC D)	Price quote request for the items
679	MSG NO:1174.204	12/17/1990	PHRC Purchasing Dept	PLS QUOTE US YR BEST PRICE FOR THE CONVERTERS WITH FLWG SPECIFICATIONS TYPE POWER VOUT-MAX FREQUENCY MAX ═══════ ý4470 8KVA 380V 3000HZ ý4450 2KVA 200V 2500HZ THEREFORE PLS SND US A PRICE LIST FOR THE A.M DETAILES BY TELEFAX	TO KAVO ELEKTROTECHNISCH ES WE	Seeking price quote
680	1171.206/A	12/17/1990	SHFT Purchasing Dept	10 SAMPLES OF MAGNETS IN SHAPE OF RING N DISC N RECTANGULAR FROM DERSTIT 400 OR 450 OR 500 N SECOLIT N NERONIT WHICH MAGNETIZED AXIALLY FOR RING N DISC N HAVING 2 TO 12 POLES N RECTANGULAR MUST BE MAGNETIZED THROUGH THICKNESS WITH 2 POLES DIM.FOR RING:OUTSIDE DIA.LESS THAN 120 MM, INSIDE DIA.MORE THAN 40 MM, THICKNESS LESS THAN 10 MM, FOR DISC DIA.LESS THAN 120 MM, THICKNESS LESS THAN 10 MM, FOR TECTANGULAR:LENGTH LESS THAN 60 MM, WIDTH FROM 10 TO 30 MM, THICKNESS LESS THAN 10 MM	Thyssen	Seeking samples and price list
694	1171.206/A	12/17/1990	PURCHASING MANAGER SHFT IR	re: magnets	TEW?, H.J. Nocke	Notifying that cannot make requested shapes/sizes, need more info on required magnets
660	11170.203/C	12/17/1990 (The year is a probable)	PHRC	10 SAMPLES OF MAGNETS IN SHAPE OF RING AND DISC AND RECTANGULAR N FROM {NDFEB} N {SMCO} OF TWO TYPES PLASTIC PLASTIC BONDED, N WITHOUT BONDED N MAGNETIZED AXIALLY WITH 2 POLES N WITH DIMENSION FOR RING B: MORE THAN 40 MM, A: LESS THAN 100 MM , C: LESS THAN 10 MM, FOR DISC A: BETWEEN 60MM N 100MM, B: LESS THAN 10MM, FOR RECTANGULAR A:BETWEEN 20 MM N 50MM, B:FROM 10 MM TO 30MM, C: LESS THAN 10MM	Bakker Madava	Seeking magnet samples and price list for 1000 pcs N samples
677	1218.221	1/10/1991	SHFT Purchasing Dept	4 SAMPLES FROM ALLOY MAGNETS N IN SHAPE OF SQUARE BAR N MAGNETIZED THROUGH THE LENGTH.DIMENSION:10 X 10 X 200 MM, 20 PCS.FROM BREMAG 18 IN SHAPE OF RECTANGULAR N MAGNETIZED THROUGH THE THICKNESS.DIMNSION:28 X 19X6 MM 10 PCS.FROM BREMAG 8 IN SHAPE OF CIRCULAR N MAGNETIZED AXIALLY WITH 2 POLES . QUANTITY 20 PCS DIMENSION:50 X 12 X QP MM N 30 X 30 X 10 MM	Magnet Applications Ltd	Seeking catalogues and 10000 pcs samples for testing

Figure 8. An excerpt from an ISIS tabulation of magnet inquiries. Many of the inquiries appear to be related. Two are even identical and appear to have been sent on the same day. PHRC and Sharif University, however, are listed interchangeably as the entity requesting the items. There should not have been a need to use PHRC as a procurement agent for Sharif University, as Iran has stated to the IAEA, if Iran was already using the name of the university in related telexes to companies.

The Iranian Covert Nuclear Sector

Technological disciplines relevant for the attainment of a nuclear weapon in PHRC

PHRC's Departments:

Dept. 1: Nuclear Physics or Neutronics

Dept. 2: Centrifuge Enrichment

Dept. 3: Laser Enrichment

Dept. 4: Uranium Conversion

Dept. 5: Geology, including Uranium Exploration

Dept. 6: Health Physics or Radiation Safety

Dept. 7: Workshop or Metallurgy

Dept. 8: Heavy Water Production

Dept. 9: Analytical Laboratory?

Dept. 10: Computing?

Figure 9. A list of departments under the Physics Research Center (PHRC) compiled by the IAEA modified by ISIS information. This table is essentially the combination of two similar tables describing the departments. Based on the telexes available to ISIS, ISIS has so far confirmed the first eight departments. ISIS continues to assess the available information.