Illicit Nuclear Procurement Networks and Nuclear Proliferation: Challenges for Intelligence, Detection, and Interdiction

Jack Boureston and James A. Russell

None of today's nine nuclear weapons states achieved their status without the assistance from people, information, equipment and/or sensitive technology that came from somewhere else. In a relatively small number of cases, transfers from one state to another happened between established political allies that shared strategic objectives. However, many of these programmes undeniably depended upon stolen knowledge and illicitly acquired materials. However much the international community wants to forget about this sordid history, the stealing of nuclear secrets has provided a regrettable but irrefutable foundation for all states seeking to build nuclear weapons.[1] This was the case at the dawn of the nuclear era, and it remains the case today.

To be sure, nuclear espionage and theft constitute just one component of a long-established international practice: stealing military-related industrial secrets - a thriving practice that remains alive and well in today's globalizing and interdependent world. In 2007, the South Korean National Intelligence Service reported that over $100 billion in technology had been stolen and illegally exported in the previous three years. Much of the stolen technology found its way to China.[2] The practice of stealing nuclear secrets has long been part of this tradition. The underworld of clandestine nuclear procurement began in the 1940s, with US and Soviet spies scouring the globe to obtain the information, people, materials, and technology necessary to build the bomb. The espionage activities of Klaus Fuchs, the Rosenbergs, and a team of Soviet spies working under cover on the Manhattan Project significantly speeded up the Soviet Union's nuclear programme.[3] More recently, China is believed to have accelerated its nuclear weapons programme courtesy of stolen US plans and technology. Many believe that China's systematic, state-directed programme of industrial espionage is ongoing.[4] In 1999, Congressional researchers declared that China's next generation of nuclear weapons would almost certainly integrate stolen US design information.[5]

Despite the international community's best efforts to administer export control regimes to control the illicit spread of the most dangerous

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technologies, consumer and suppliers alike continue to find new ways of avoiding detection. Practices honed by spies of an earlier era continue today with national authorities, quasi-governmental organizations, front companies, wayward corporate entities, and well-placed individuals helping would-be proliferators acquire technologies and materials around the world.

This paper investigates the nuclear black market of the modern era, focusing on the illicit procurement networks of four different states in their quest to build a nuclear weapon in circumvention of international export control regimes. While today's illicit procurement networks, extending from states like Iran and North Korea, are not fundamentally that different from the illicit procurement network created by the Soviet Union in the 1940s, today's increasingly interconnected world offers new avenues and opportunities for complex illicit procurement networks. If the world remains committed to controlling the spread of nuclear weapons as called for under the Nuclear Non-Proliferation Treaty, then it must keep pace with the efforts of today's suppliers and consumers as they construct illicit procurement networks. The objective of this paper is to draw attention to four illicit procurement networks from the modern era, comparing factors in these cases as a way to illustrate their similarities and differences that, in turn, can offer some general yet instructive lessons. These lessons provide a guide to the international community, and can help it in taking the necessary steps to detect future illicit networks through the collection of intelligence, thus facilitating national-level and internationally-administered efforts to interdict, and shutdown, the networks.

Terminology and Theory

What constitutes a nuclear black market? Mark Fitzpatrick, a former US non-proliferation official defined it as: 'the trade in nuclear-related technologies, components or materials that is pursued for non-peaceful purposes and most often by secretive means.'[6] It might be more accurate to describe this phenomenon as a 'grey' market, since some transactions may not be explicitly illegal, but still may take advantage of loopholes in national export regulations.

How are black markets formed and how do they operate? In their paper on proliferation rings, Braun and Chyba focused on the exchange of nuclear weapons-related and missile technologies among several developing countries. The authors called these 'second-tier proliferation networks,' consisting of such countries such as Iran, Libya, Malaysia,

Pakistan, South Africa, Turkey, and others.[7] The authors stated that 'proliferation ring members' support one another either directly at the state-to-state level or indirectly through once-removed private sector supplier networks. Their research found that 'rings' of clandestine exchanges of technologies sprang up between and among the network participants.[8] A prime example provided by the authors is that of North Korea's barter with Pakistan for missile-for-enrichment technologies. They called this exchange a 'benchmark event in the global proliferation enterprise.'

Alexander Montgomery borrowed from research on social network structures to explain that there are basically three procurement network structures: rings or circles, stars, and cliques. According to Montgomery, circles are formed with connections between each node; stars have a central hub that connects to each node; cliques are networks where all nodes are directly connected to each other. Montgomery contends that all networks so far have been star structures, with the state acting as the hub, and any future nuclear network will likely adopt the star structure in part because nuclear proliferation has greater tacit knowledge requirements.[9]

In his research on procurement networks, Bruno Gruselle noted that the controlling factors that shape the appearance of networks remain the same worldwide, even if the individual situations of network actors vary.[10] Gruselle concluded that state demand has always been the driving force for proliferation, but the structure of the networks designed to satisfy the demand is new. According to Gruselle, network structures have been made possible by three factors: (1) increased trade flow and tools to manage trade have made it possible for networks to conceal themselves in ways that are difficult to monitor; (2) the fact that various goods used for WMD development are also used for civilian purposes makes it easier for networks to hide the true intent for purchases; (3) the appearance of suppliers that are capable and willing to transfer materials and technologies contributes to the development of networks.[11]

The above literature focuses mainly on demand as the driving factor for the development of network structures. James Russell argued in 2006 that distinctions between the supply and demand aspects of weapons proliferation would become increasingly blurred in future proliferation networks.[12] He posited that non-state actors would assume more important roles in illicit procurement networks, providing proliferation market 'substructure' to function in the supply and demand sides of the market.[13] Looking at phenomena such as the Khan Network and other procurement networks, we surmise that multinational corporations, non-governmental and quasi-governmental organizations, and transnational social movements all represent examples of ever more numerous

organizational structures that operate across borders and on a global scale, therefore requiring further scrutiny by the international community. Non-state proliferation market substructures include at least one of three characteristics: (1) they deal in legitimate trade in dual-use items that can be diverted to develop WMD; (2) as front companies and subsidiaries of state-run organizations, they can operate outside national borders and circumvent export controls; and (3) they service demand of violent non-state actors that seek weapons (possibly both conventional and unconventional).

Case Studies

Pakistan

In 1974, after India tested its 'peaceful nuclear explosion,' Pakistan assembled a group under the Pakistan Atomic Energy Commission (PAEC) to build a nuclear weapon. Recognizing that it was deficient in various technologies, the PAEC established a multi-layered procurement network to acquire nuclear related equipment and technologies. It contracted with foreign companies to obtain facilities, equipment, and know-how, and used their embassies abroad as bases for procurement missions; cooperated with allies to obtain goods; used front companies to procure items; used multiple intermediaries; falsified export control documents; and made use of personal connections to seek out and purchase essential nuclear materials. In what is now the most publicized case on nuclear networks, A.Q. Khan, a Pakistani national, was instrumental in developing an elaborate network of buyers and sellers that helped not only Pakistan develop its nuclear programme, but also Iran, Libya, and North Korea. He achieved all this while living and working in the Netherlands in the early 1970s.[14] Pakistan employed various strategies to evade international detection and controls, including purchasing individual components such as centrifuge pre-forms rather than complete assemblies; hiding critical components on long lists of useless materials; paying exaggerated prices to entice suppliers to overlook export license requirements; buying samples and the means to reproduce them; purchasing raw materials and machines to refine them; establishing trans-shipment routes; cooperating with friendly countries such as China, Libya, and North Korea; and enlisting members of the Pakistani diaspora worldwide.[15]

Pakistani buyers frequently traveled abroad to meet with relevant companies (or their representatives) to obtain goods, services, and knowledge necessary to build a nuclear weapons programme. These buy-

ers courted organizations that might have been politically sympathetic to helping Pakistan in its quest, or simply interested in selling goods to a willing buyer at mark-up prices. In early 1975, Sulfikar Ahmed Butt, thought to be the PAEC's chief nuclear buyer, befriended Rudolf Ortmayer, a manager at the West German firm Nukleartechnik GmbH (NTG), and presented him with a comprehensive wish list of items necessary for PAEC's programme.[16] NTG produced various nuclear components, including technology in nuclear medicine, heavy-ion research, heavy water production, nuclear fuel fabrication, nuclear contamination, and vacuum technology.[17] Under Ortmayer, NTG provided Pakistan with much needed items and contacted other companies on behalf of the PAEC for goods it could not provide. In 1985, NTG sold and exported a tritium recovery facility to Pakistan, calling it a heavy water purifier on licensing paperwork to elude export control regulations. The PAEC also developed a close relationship with scientists at the Karlsruhe Nuclear Research Center (KFK), located in Karlsruhe, Germany. In the 1980s, ninety per cent of KFK was owned by the West German Government. While avoiding the attention of the authorities, KFK's scientists were therefore able to transfer items such as mass spectrometer components, train Pakistani scientists, and invite some Pakistani scientists to visit the KFK facilities. As KFK was a government sponsored facility, it did not operate under the same export constraints as other companies. Despite German foreign ministry officials passing on US intelligence reports alleging illegal transfers of materials to Pakistan, Economics Ministry officials allowed exports to continue.[18]

Pakistan's procurement efforts extended to North America. From 1977 to 1980, a Canadian citizen of Pakistani origin, Abdul Aziz Khan, visited Pakistan to work with A.Q. Khan. In 1980, Abdul Aziz Khan returned to Canada, and with the help of two associates began obtaining high-frequency inverters - electrical components that are used in uranium centrifuges (devices used to enrich uranium for either nuclear reactor cores or nuclear weapons cores). Operating out of two small stores, Aziz Khan and his friends purchased the inverters, repackaged them, and made nine shipments to the Kahuta Research Laboratory (KRL) in Pakistan. They were later caught and convicted for making illegal exports. In 1981, US officials seized a package of zirconium at Kennedy Airport that was to be shipped to Dr Sarfras Mir, a retired Pakistani army colonel, who operated the front company S. J. Enterprises. The package had been labeled as mountaineering equipment.[19]

Since uncovering Libya and Iran's nuclear activities, western intelligence agencies have been busy disassembling the Khan international nuclear procurement network. Although headed by A. Q. Khan in Paki-

stan, the network relied on intermediaries in Austria, Dubai, Germany, Japan, Malaysia, the Netherlands, Singapore, South Africa, Switzerland, Turkey, the US, the UK, and possibly other places. It was made up of Khan's past schoolmates, colleagues, and contacts. Some examples include Gotthard Lerch, once a high level manager at Leybold-Heraeus and friend of Khan's; Buhary Seyed Abu Tahir (BSA Tahir), owner of SMB Computers and a contact made while Khan was maintaining the KRL; Gerhard Wisser, friend of Lerch's and supplier of South Africa's nuclear programme; Johan Meyer, manager of Tradefin Engineering and contact of Wisser's; and Hank Slebos, a school mate of Khan's in the Netherlands. The loose connections in this network underscore the importance of social networks as a basis for developing and operating a procurement network. Khan's network was used to procure, manufacture, or otherwise supply needed items. Khan established trans-shipping points in Turkey and Dubai, and manufacturing operations in South Africa and Malaysia. Firms in Japan and Singapore also contributed high-tech equipment to the network.[20] According to Grusselle, 'The A. Q. Khan Company appears to have always operated on the principle of a direct initial contact between the network leader and his customers. Once contacts had been made and main principles had been defined, Khan appears to have left his main associates responsible for operational implementation.'[21]

Iraq

After the 1981 bombing of its Osirak reactor, Iraq established a sophisticated procurement network to obtain the technologies necessary for its nuclear programme. In the 1980s, the Ministry of Industry and Military Industrialization (MIMI), coordinated with Iraq's commercial, diplomatic, and intelligence services to establish front companies, use intelligence services, use embassies, and find ways to evade the export controls of other nations. Their efforts mimicked many of the techniques successfully developed by Pakistan.

In the 1980s, Iraq used its embassy personnel to help it identify willing sellers of equipment needed for its programme. In one important case, Ali Abdul Muttalib, commercial attaché at the Iraqi embassy in Bonn, Germany, identified companies that could be useful to fill item requests. He also learned how to elude European export controls by describing equipment in such a way that would facilitate approval of licenses.[22] Muttalib also facilitated buying missions from Iraqi delegations. In 1987, for instance, Khadhir Hamza lead a delegation to Germany to locate needed equipment such as highly enriched uranium (HEU) processing equipment and high speed measuring equipment to help Iraq

develop high explosive lenses. Muttalib identified relevant companies including Leybold and Degussa, and introduced Hamza to Werner Sonntag, a representative of the Neuero and Inwako companies. The Iraqis gave Sonntag a long list of explosive test equipment and the technologies necessary for designing a facility to conduct explosive testing. Hamza and Sonntaq are known to have had extensive contracts with Iraq.[23] Inwako provided other equipment, including ring magnets to stabilize centrifuge rotors and helped Britain's Swift-Levick to transfer magnets to Iraq. Inwako helped Iraq upgrade its SCUD-B missile systems.[24]

Iraq used experts in countries such as Germany to help them obtain needed materials for their nuclear programme. For instance, Karl Heinz Schaab, ex-MAN Technologien AG employee helped to provide centrifuge rotors to Iraq. MAN was a principle consulting company to the URENCO uranium enrichment consortium, supplying that company with carbon-fiber rotors for its more advanced uranium centrifuges. Schaab left MAN New Technology because he felt that they did not promote him fairly. He subsequently established his own small firm. During that time he was often without projects and therefore took every opportunity to work, including taking on jobs that were beneath his ability with the rationale that he'd gain more appropriate contracts in the future. In the mid-1980s, Dietrich Hinze and Bruno Stemmler - also a former MAN employee who had dealings with the Iraqis in the past - introduced Schaab to their Iraqi contacts for possible work. Schaab and his colleagues may also have worked together on projects in Brazil. Schaab trusted and admired Stemmler and therefore did not question the Iraqis' stated purpose of their requests. Although Schaab was technically adept as an engineer, he was not experienced as a businessman. This reportedly made him more susceptible to Iraqi influences. The Iraqis treated Schaab with the respect and kindness that he felt he deserved. On two occasions, Schaab and his colleagues made shipments to Iraq. The first occurred in 1989, when Schaab shipped a small number of rotor samples. In 1990, Schaab shipped twenty complete rotors. Schaab manufactured the rotors himself using an S-glass fiber supplied by the Japanese firm Toray and a filament winding machine, then sent to a firm in Austria. Apparently both shipments went to the Austrian firm which then shipped the rotors on to Iraq.[25] According to sources, Schaab was a centrifuge expert and therefore had the technical know-how to assist the Iraqis to set-up a centrifuge programme for uranium enrichment. Schaab also sold classified MAN-blueprints of a sub-critical centrifuge for forty thousand dollars to the Iraqis, along with thirty-six carbon fiber rotors during a meeting in Kaufbeuren. The Iraqis may have exported the rotors through diplomatic channels to conceal their transport. In

total, Schaab sold the Iraqis equipment and items for the total amount of approximately one million dollars. He also provided technical assistance to the Iraqis, such as installing a prototype test-rotor in a Baghdad laboratory.[26] Iraqi agents often found companies such as Schaab's that were small and needed infusions of capital for their operations.[27]

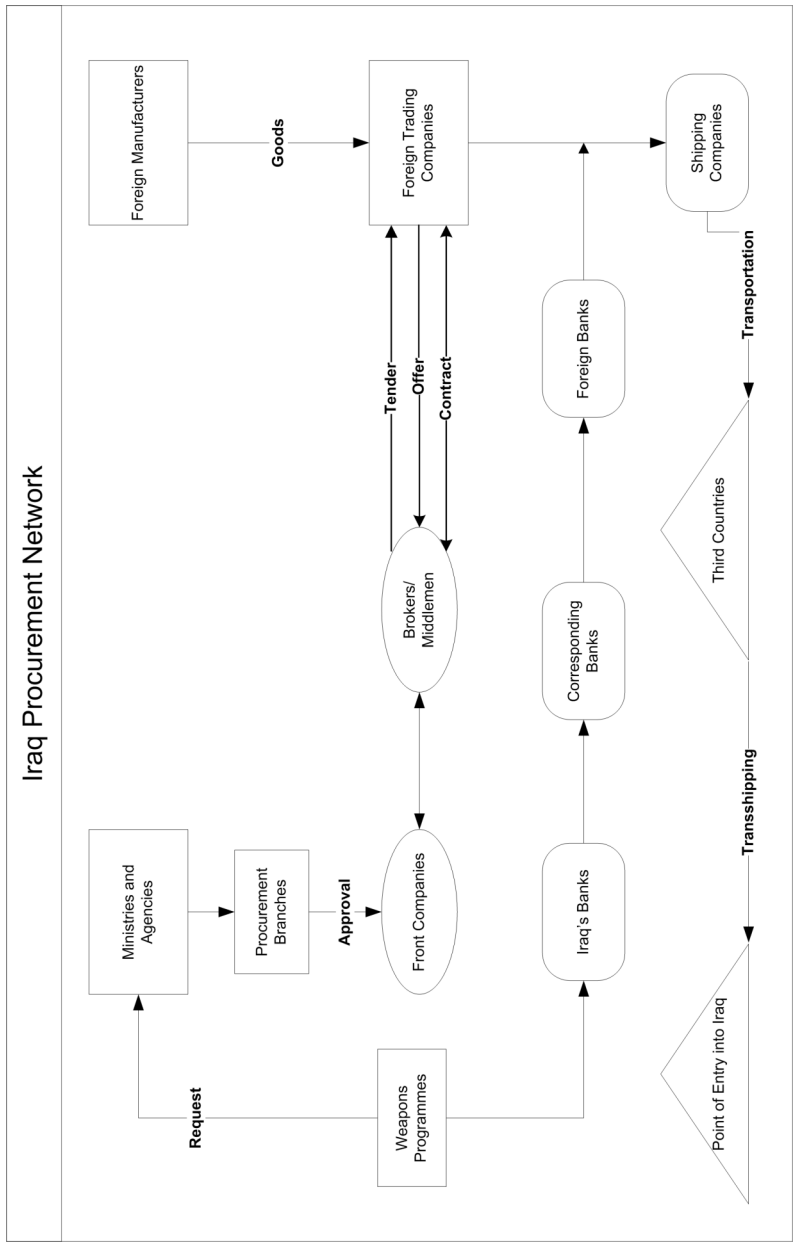
As a part of its network Iraq established a series of front companies to procure items and disguise their final destination and end-use. MIMI set-up the Al-Arabi Trading Company and Nassr General Establishment to procure materials for Iraq's conventional and unconventional weapon programmes, and Iraq's nuclear establishment directed other front companies such as the Industrial Projects Company (IPC) to purchase components for Iraq's centrifuge programme.[28] The Iraqis also used these companies to purchase or buy controlling stocks in other companies to procure needed items and other business benefits. For instance, in 1987, Al-Arabi secretly purchased a fifty per cent stake of the German Firm H + H Metalform GmbH.

Co-founder of H+H, Dietrich Hinze was an engineer who worked for over twenty years in the tool making and mechanical engineering firm Leifeld and Co. in Germany. In the early 1980s, Hinze decided to set up his own business, together with his partner Hütten, who was once the sales manager at Leifeld. Together, in 1983, they founded the company H+H Metalform. The name of the new firm, H+H, stood for *Herstellung und Handel* in German or 'production and trade' in English. One of the main activities of H+H was the production and sale of vertical-flow-forming machines, developed by Mr. Hinze. Flow-forming machines have both military and civilian applications. They can be used to produce steel tubes for ammunition and missile casings, as well as centrifuge rotors for uranium enrichment but can also be used to produce industrial gas-cylinders and pressure cookers.

In April 1987 H+H was contacted by the London-based company, Meed International, which belonged to an industrial network responsible for procuring military equipment, especially in the field of rocket technology for Iraq. Meed's parent company was the Nassr Establishment for Mechanical Industry Ltd., located in Taji, Iraq. During contract negotiations between Hinze and the Nassr Establishment, it soon became clear that Nassr wanted to produce artillery with diameters of 122-262 mm. The Iraqis needed flow-forming equipment for this and other purposes although these were never openly stated. Hinze was in Baghdad several times to supervise the installation of his machines and other equipment. He gave further assistance in technical problems regarding the production of flow forming parts that later turned out to be items for the Scud missile. Altogether, the contract was subsequently concluded for the sup-

ply of nine flow-forming machines (each worth between $1-2 million). To produce their machines, the young company H+H needed additional capital. The banks approached by Mr. Hinze refused to give credit because the company could not offer sufficient security. Therefore they had no option but to accept an offer from the Iraqis to acquire a fifty per cent stake in H+H. This is how another subsidiary of Nassr, Al-Arabien Co Ltd., came to have a share holding in H+H. From 1987 through 1990, H+H Metalform supplied machines tools and equipment for the production of rockets and ballistic missiles worth altogether around twenty-five million dollars. In nearly all cases, export permits were issued by Germany's Federal Office for Trade and Industry (BAW). Part of this is due to H+H declarations that the machines were to be for civilian purposes, like producing gas-cylinders, hydraulic-cylinders, lamp-posts, etc. However, these were covers to escape suspicion and gain export licenses. Iraq's contracts with H+H included provisions for machines, equipment, and technical assistance. In addition, H+H provided Iraq with contacts to other firms who cooperated because of their long-standing relationship with H+H Metalform.[29]

Iraqi intelligence services also established front companies to procure needed items. Some of these companies operated subsidiaries in other countries such as Jordan to facilitate the procurement and shipment to end-users in Iraq. For example, the Iraqi Al-Eman group organized material flows through Jordan to Iraq, often labeling the contents of packages and end-users in such a way as to quell suspicions of illegal activity. According to the Iraq Survey Group's final report, the Sattam Hamid Farhan al-Gaaod company established the Al-Eman Commercial Investment group in the 1990s and Satam Hamid had a special relationship with the Agricultural Supplies Committee of the Ministry of Agriculture (MoA). From 1990 to 2003, Al-Eman shipped approximately one container a month through Jordan to Iraq via the Iraqi Embassy in Jordan. For Instance, in 1995, Al-Eman purchased a kit of reagents worth five thousand dollars from the Swiss firm Elisa for an organization named AL-IBAA, a special unit in the Iraqi MoA. AL-IBAA was connected to Saddam, had a special research facility and was granted an unlimited budget. AL-IBAA was able to obtain any equipment and support within Iraq that it needed and paid cash for all its orders.[30] A diagram of Iraq's procurement network is described below.

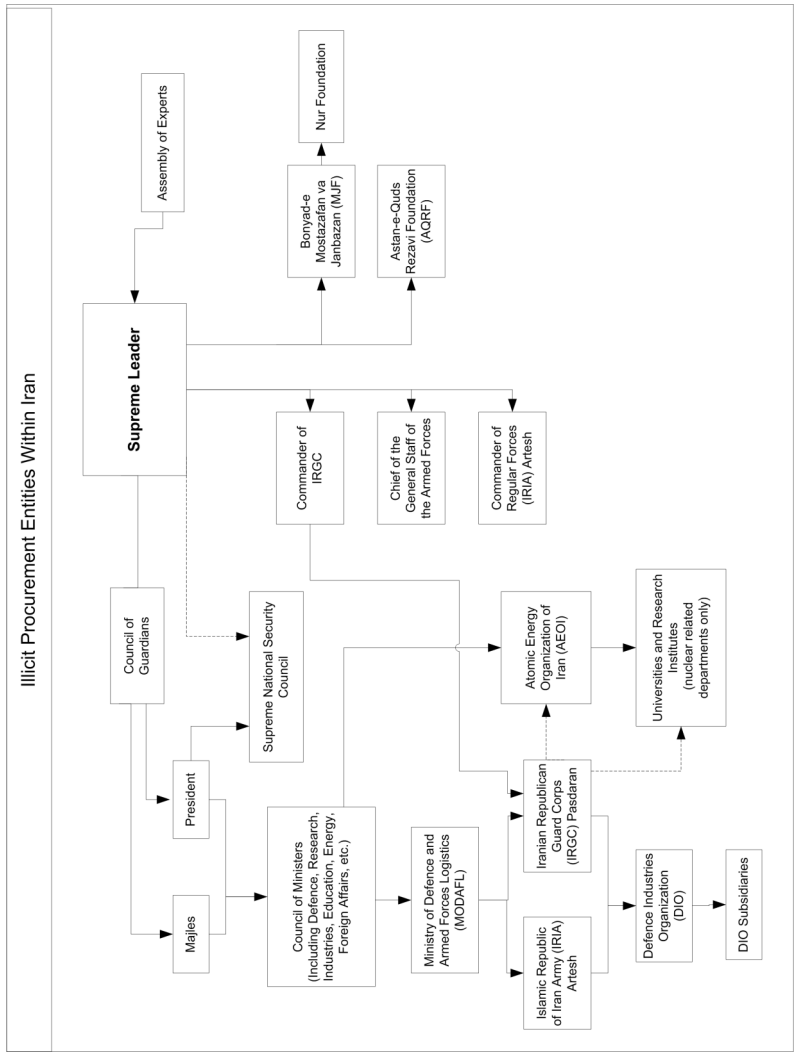


Source: Mark Fitzpatrick, ed., *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks – A Net Assessment* (London: International Institute for Strategic Studies, 2007).

Since the 1980s, Iran has acquired nuclear-related materials and equipment, designs, and assistance from a multitude of entities in countries including China, France, Germany, Japan, the Netherlands, Pakistan, Russia, Switzerland, and the United States. The type of equipment obtained ranges from high-strength aluminum and steel, electron beam welders, balancing machines, vacuum pumps, computer-numerically controlled (CNC) machine tools, and flow-forming machines, to whole centrifuges and uranium conversion plants.[31] Iran developed its model for procurement in a similar fashion to those of Pakistan and Iraq. Commonalities include the use of persons in national embassies to make contacts, use of front companies and falsified end-user certificates to conceal end users, and the use of middlemen to contact willing suppliers, to obtain the required equipment and assistance.

In 1987, Iran became the Khan network's second client after Pakistan when it purchased a set of centrifuge blueprints and sample pieces of obsolete equipment from the Pakistani programme. It also purchased a nuclear weapon design blueprint which was thought to be based on an early Chinese model, but may also have been a more modern Chinese design. Khan may have provided a number of other items to Iran, including nuclear weapon designs and a number of studies including some on the manufacture of uranium hemispheres. In the late 1990s Dr Khan provided North Korean nuclear experts with up to twenty discarded centrifuges, sets of drawings, technical data, and a quantity of uranium hexafluoride (UF_6). All items are useful for uranium enrichment research.[32] Khan's last known customer was Libya. Khan and his network provided a long list of items and information including: twenty pre-assembled L-1 centrifuges and components for an additional two hundred L-1 centrifuges; ten thousand L-2 machines and supporting equipment, including feed stations, product and tails withdrawal stations, vacuum equipment, cascade piping, drive systems, and other miscellaneous equipment. Khan's procurement network helped to manufacture and ship the components and equipment from entities in different countries. In addition, the network provided Libya with technical assistance and design information on a conversion and fuel fabrication laboratory (referred to as Project 702); a post-irradiation examination facility, designed for the receipt and disassembly of pressurized water reactor (PWR) spent fuel assemblies (Project 307); a radiochemical separation laboratory, consisting of a pilot scale Purex reprocessing plant designed for processing approximately 1100 kg of uranium per year of PWR spent fuel and recovering

approximately 10 kg of plutonium per year (Project 701); and a high level liquid waste vitrification plant that is designed for solidifying high level waste from the reprocessing plant (Project 303). Lastly, the Khan network provided Libya with design information for the fabrication of a nuclear explosive device, including information related to high enriched uranium re-conversion, casting and machining, and the testing of nuclear weapons components. Much of the sensitive information coming



Source: author research

from the network existed in electronic form, enabling easier use and dissemination. This includes information that relates to uranium centrifuge enrichment and, more disturbingly, information that relates to nuclear weapon design.[33]

Iran's procurement network appears to be controlled by the top tiers of government. The President appoints the cabinet, called the Council of Ministers, and the appointees must be confirmed by the legislature, the Majlis. Included in the Council of Ministers are the Ministry of Defense and Armed Forces Logistics (MODAFL), the Ministry of Energy, and the Ministry of Education and Research. These ministries serve as three conduits for procurement and administration of Iran's WMD programmes. The diagram of Iran's procurement structure is above.

MODAFL controls both the Artesh, the regular military and the Pasdaran — also known as the Iranian Revolutionary Guard Corps (IRGC).[34] The IRGC initially had an independent command structure after its creation in 1979. Following the end of the Iran-Iraq War, the Iranian government sought to modernize and professionalize the IRGC and the regular military under MODAFL.[35] At this time, the industrial and procurement organizations of both militaries were combined into the Defense Industries Organization (DIO), the organization which supplies both MODAFL and the IRGC. DIO is staffed by, and linked to, both the Artesh and the IRGC. However, most directors of IO and the MODAFL were IRGC officers.[36] MODAFL, DIO, and subsidiaries have been listed in UNSC Resolution 1737, US State Department sanctions lists, and Japanese METI sanctions lists for involvement in the nuclear and ballistic missile programmes source.[37] The IRGC uses Iran's Defense Industrial Organization (DIO) and its subsidiaries, some universities, and the 'bonyads' (see below) to attempt to acquire dual-use nuclear technology in countries such as Japan and Germany. The IRGC maintains links to each leg of this network. The DIO is normally directed by an IRGC commander, for example, former DIO director and current Minister of Defense and Armed Forces Logistics (MODAFL) Brig. General Mostafa Muhammad Najjar.[38]

Outside of formal state control, and believed to answer only to the Supreme Leader, is a network of NGOs known as 'bonyads.' These organizations possess an independent authority beyond the reach of elected officials and other parts of the government.[39] They publish no accounts, are tax exempt, and have special relationships to state power.[40] Operationally, bonyads are special cooperative corporations that are responsible for a large segment of the Iranian economy, and they manage groups of companies with offices within Iran and around the world.

Some bonyads have alleged links to proliferation activities, including the Mostazafan va Janzaban Foundation (MJF), the Nur foundation, the Astan-e-Qods Rezavi Foundation (AQRF), and the Imam Reza Holy Shrine.[41] Cases against MJF, AQRF, and Nur Foundation originate from the German Intelligence Service (BND) and NCRI, respectively. The MJF, AQRF, and the Nur foundation are staffed with former IRGC commanders. Mohsen Rafiqdust, a founding member of the IRGC and former its former commanding officer, was director of MJF from 1989-98 and director of Nur from 1999 to the present day.[42] In 1997, the weekly Germany magazine *Stern* reported that a BND investigation was underway to determine if the MJF was a conduit to procure materials useful for WMD production. According to the report, at the time the MJF was headed by the former head of the IRGCC, Mohamed Rafighdost. *Stern* quoted a German Government report confirming that MJF had created 'fake' companies to act as intermediaries to purchase goods related to the production of WMD.[43] According to the BND report, 'DIO couriers carry parcels full of microelectronics components and files out of the office in Duesseldorf in the evening and take them to the Iranian Embassy in Bonn.'[44] In 2000, a BND report noted that the MJF makes illegal purchases through dealers and dummy companies in Dubai and ships them back to Iran.[45] Noted examples are the Alborz, Aliaf P.P. Azar, Tizro Trading Company, Yusaf Universal Import-Export Est, and Company 209.[46] MJF may also operate in the US According to a 2007 *Wall Street Journal* report, 'a group calling itself the Mostazafan Foundation of New York took control of a Manhattan office tower built in the 1970s by the deposed Shah.'[47] The group later changed its name to *The New York Foundation* and maintained majority control of the building.

The Imam Reza Holy Shrine also has links to Iran's WMD programme, albeit only tangentially. The shrine's custodian is Ayatollah Abbas Vaez Tabassi, cell mate to the Supreme Leader Ayatollah Ali Khamenei prior to the Iranian Revolution. Tabassi's son, Nasser Vaez Tabassi owns and operates Al-Makasseb, a multimillion dollar company based in Dubai.[48] Al-Makasseb was financed by Bank Melli, Iran's largest financial institution, which has 3500 branch offices worldwide.

Like Iraq, Iran invested in foreign companies to fulfill its procurement needs. For instance, in 1987 Iran invested in the Rio Tinto-Zinc mining company in Namibia.[49] In 1996, Iran may have purchased the German machine-tool manufacturer Sket Magdeburg.[50]

As noted earlier, both the IRGC and Atomic Energy Organization of Iran have used various Iranian universities as procurement fronts for Iran's nuclear programme. In 1991, the Sharif University of Technology in Tehran ordered centrifuge components from the Austrian firm

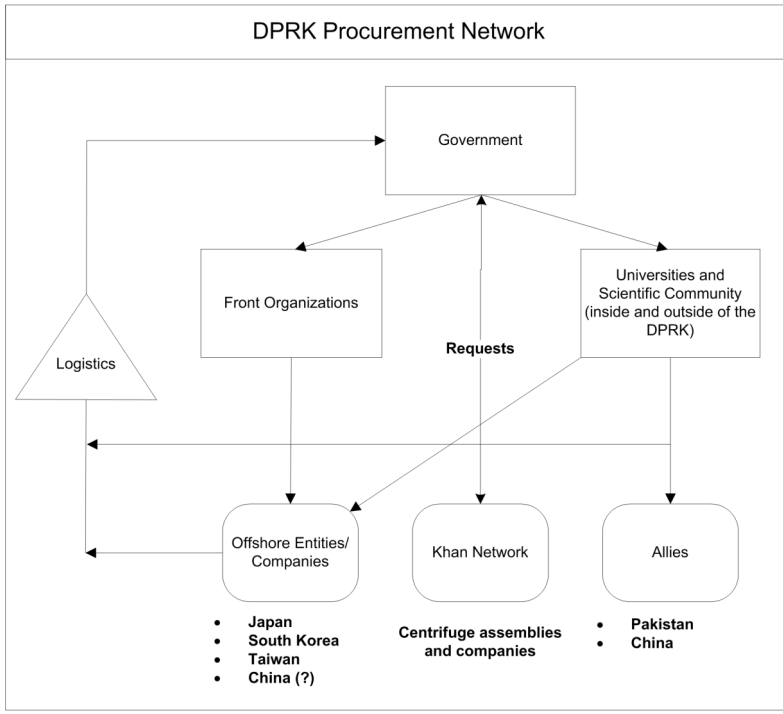
Tribacher.[51] That same year, Sharif also ordered ring magnets from Thyssen, a German machining company and sought to purchase vacuum pumps from Leybold. Another German firm, Karl Shenck of Darmstadt transferred Sharif a balancing machine.[52] In 1993, AGIE and Charmilles Technologies sold Sharif electronic discharge machinery that can be used to produce nuclear fuel production equipment and gas centrifuge components.[53] In 2003, the Australian firm GBC Scientific Equipment attempted to deliver a mass spectrometer (used to evaluate the enrichment of uranium) to Amir Kabir University of Technology. In 2002, GBC had exported a mass spectrometer to the Centre for Agriculture and Medicine at Karaj. The equipment was used to measure uranium isotope enrichment levels.[54]

North Korea

The Democratic People's Republic of Korea (DPRK) established its illicit nuclear procurement networks as far back as the 1970s, developing a system of using expatriates and agents traveling around the world to acquire the necessary items to support their nuclear programme. North Korea was also aided by its allies in Russia, China, and Pakistan in obtaining goods and services.

In the late 1980s, A. Q. Khan offered centrifuge technology to the North Koreans, with major shipments occurring in the late 1990s. Those shipments may have coincided with the provisions of the agreed framework which mandated the halting of any reprocessing activities.[55] In 1997, Khan may have also provided the North Koreans with the same shopping list that he did the Iranians in 1987. That list helped the North target willing companies and stay below the radar of foreign authorities. Between 1999 and 2000, Khan provided North Korean engineers with up to twenty P-1 centrifuges and technical advice on the operation of centrifuges.[56] Since the late 1990s North Korea has been working to develop its uranium enrichment programme. The North's procurement agents used Khan's list of nuclear suppliers to help them obtain related equipment. For instance, the Japanese company Mitutoyo is known to have transferred goods to Scomi International, as part of an order from the Khan network, to Iran, Libya, and North Korea. Mitutoyo is a privately-owned company that makes three-dimensional precision measuring machines.[57] These machines can be used to help produce the rotors needed for a centrifuge-based uranium enrichment programme. In each case of transfer, Mitutoyo is known to have eluded export controls by falsely stating that overseas subsidiaries were the final destination.[58] In the case of transfers to Iran, the company sold the machines to a locally based

Iranian trading company, Seian trading company, which is thought to be an Iranian front company to help Iran purchase equipment for its own nuclear programme.[59]



Source: author research

For many years, agents of the DPRK tapped into Japan's North Korean population and industrial base to obtain the materials they need for its WMD programmes.[60] In 1946, North Korean scientists living in Japan established an association in the Kanto area of Japan. Over the years, the association underwent several changes and in 1985 it merged with other organizations to form the Kyako or Korean Association of Science and Technology (KAST). According to some media reports, KAST is under the direct control of the external relations division of the Korean Workers Party in Pyongyang.[61] The group is comprised of approximately 1,200 members, some of whom work in fields such as physics and engineering, and have periodically visited North Korea.[62] KAST operates twelve branches all over Japan and manages a number of Japanese corporations. These include the Daiei Machinery Corporation (later renamed the Diastar Corporation) and the Shinei Shouji Corporation. Members work in a number of other research institutes, national universities, and

corporations that could be helpful in WMD development.[63] Illicit equipment transfers have been traced back to those companies. For instance, in 1993, Daiei arranged for the export of measurement equipment to North Korea. In 1994 Japanese authorities discovered that a KAST related company had transferred a jet mill machine – equipment used to grind materials finely - to North Korea.[64] Another organization, the Kim Man-Yu Science Foundation, established with the objective of assisting North Korean scientists in Japan, may have helped Korean scientists living in Japan both to obtain goods and nuclear know-how and then send it back to North Korea.[65] The structure of the DPRK procurement network is described above.

North Korea established and operated a viable logistical system between itself and Japan to transport items home without raising suspicions. Specifically, the North Korean ferry, *Man Gyong Bong*, that runs between North Korea and Japan was used to ship items home. According to news reports, before the Taepo-Dong-1's first test launch in 1997, missile components were regularly exported from Japan to North Korea.[66] In 2003, the Tokyo Vacuum Corporation, a vacuum pump maker, and an export agent, Nakano Corp., transported vacuum pumps to North Korea via a Taipei company.[67] According to press reports, the pumps could be used in uranium enrichment processes. However, there seems to be some confusion regarding their specific use.[68] In another example, between August 2006 and August 2007, the Taipei company, Hua Yueh International, made as many as fourteen shipments of Japanese dual-use components (including stainless steel pipes, computer software and computer numerical controlled machine tools) to North Korea. The company reportedly mislabeled the point of destination as 'China.'[69]

For decades, North and South Korea have held scientific and educational exchanges in the hope that they would engender better relations between the two countries. These exchanges also facilitated transfers of goods and assistance. For instance, the Korea Mining and Development Corporation (KOMID) assisted North Korea in its missile proliferation efforts.[70] According to a BBC report in 2004, the Horkos Corp. in Fukuyama mislabeled tools that can be modified to produce centrifuge rotors and sent them to South Korea. Investigators suspect that the ultimate destination of the tools was North Korea.[71]

North Korea procurement agents are also known to be targeting European companies to fulfill its requirements. For instance, in 2002, North Korean experts made an effort to procure 22 metres of 6061-T6-grade aluminum pipes from the Optonic GmbH in Germany.[72] North Korea also imported 2600 aluminum tubes from Russia.[73] In addition to targeting European companies, North Korean diplomats may have re-

cruited South Korean intellectuals living in Germany for clandestine procurement activities. In October 2003, South Korean sociologist Chong Ty-yul was arrested for engaging in an organized anti-government and anti-democratic movement in Germany since the 1970s.[74]

Network Commonalities

In each of these cases there are some common procurement practices. Each network started out affiliated with and organized by the state, but in some cases they are semi-autonomous in nature. In each case the network used embassies located in industrial centers around the world as bases for making purchases and shipping materials home. They also created fronts such as phony companies, education institutions, and nonprofit organizations to conceal procurement activities, and they established offshore logistics and financial centers to move acquired technologies and pay for them.

In some cases, procurement network substructures have emerged as semi-independent bodies that may function as third tier supplier networks depending on their intentions and motivations. These third tier networks include quasi- or non-governmental organizations, military organizations, state-owned companies, and nonprofit or religious organizations. Again, Khan may have been the most flagrant example, but other examples may include the IRGC and bonyads in Iran or even KAST in Japan. Each was set up by the state with specific purposes and given functions that required that they establish a procurement network structure, with a high level of autonomy. These entities could help other countries or other allies develop WMDs if it was to their advantage to do so. In the case of the IRGC for instance, if it seemed advantageous for them to provide WMD to a non-state actor — a terrorist or military group in Iraq, Lebanon, or elsewhere — to defeat Iran's enemies, then this could be achieved with or without the knowledge of the head of state, given their somewhat autonomous nature, and control of WMD facilities.

Companies such as Mitutoyo may also provide products to groups that it knows are aiding suspected proliferators, but in this case, it may be to increase company's profits.

New Nuclear Suppliers?

As nations have developed their procurement efforts and perfected the methods of evading export controls, some have emerged as future nuclear suppliers. A case in point is the revelation that North Korean enti-

ties have contracted with Syrian officials to help Syria build a nuclear programme. Although the details are not well known, there is evidence that North Korean engineers were building a nuclear reactor similar to the twenty to twenty-five megawatt thermal reactor in Al-Kibar outside of the city of Al-Tibnah.[75] To support its contract with the Syrians, North Korea employed one of its own procurement agents to travel abroad and purchase needed items. According to a recent *Washington Post* report, western intelligence has been tracking the activities of the North Korean company, Namchongang Trading Group (NCG). According to the *Post*'s report, NCG employees have traveled to several European countries such as Germany to purchase an array of items including electric timers, steel pipes, vacuum pumps, transformers, and aluminum pipes cut to precise dimensions. These items were purchased and shipped to NCG's branch office in Beijing, then sent on to the Al-Kibar site. According to David Albright, 'because it's a branch office in China, NCG can buy equipment from suppliers throughout the world, even in Europe and possibly the United States, particularly if the companies have subsidiaries in China.'[76] China is a nuclear-armed state, meaning some export regulations are different. Additionally, as Albright indicates, if items were being purchased in China, but by a branch office in China, then it may not attract the attention of the authorities. Like North Korea, China has good relations with Syria.

This is not a new phenomenon. During the cold war, states in the western and eastern blocs benefited from the technological developments of their allies. Now that it is confirmed that North Korean entities have been assisting Syria, it is distressing to think that other countries could also receive North Korean assistance. Iran has similarly offered to help its allies (or potential allies) with nuclear technologies, and some countries that are just looking to join an expanding nuclear market, such as Brazil and Argentina, may also be future illicit conduits. Perhaps even more disconcerting is the whole set of substructures such as the IRGC, KAST, and the myriad front companies, that could, given sufficient motivation (be it financial or political) act on their own to supply would be proliferators.

Challenges for Intelligence and Detection

Given that we know what items are necessary to build nuclear programmes, and we know the common methods that networks use to acquire these items, what can be done to curtail the development of future networks? The underlying remedy to chronic illicit nuclear transactions

is developing more transparency and greater control over the export of nuclear-related and dual-use materials. More intelligence collection, information sharing, and policing are needed. By monitoring information sources and focusing on the common elements found among procurement networks, we can detect sales (and attempted sales) of relevant items. More export-related information is needed. As intelligence agencies and other government agencies collect information about possible illicit transactions, regulatory bodies and police organizations need to be given this information to help them stop these transactions. More collection and analysis of industry information, business transactions, dubious business enquiries, and suspicious bid offers is needed. And more sharing of information is needed between nations and international bodies such as the International Atomic Energy Agency (IAEA). Within the IAEA, the Trade and Technology Analysis unit (TTA) is asking member states to provide information about enquiries for potential purchases of goods and services. TTA hopes to get any information on communications to learn who is interested in purchases and what they are interested in acquiring. This information can help detect third party activity that can then be stopped.

National agencies could also share information of suspicious foreign enquiries with industries who, in turn, could alert their constituents to illicit activities. More work needs to be done to make companies aware of illicit network activities, holding companies more responsible for ensuring that their employees are not transferring nuclear related goods illicitly. David Albright called companies the first line of defense and perhaps the most important line of defense.[77] Commercial entities need to be made more aware of the dangers of buyers attempting to buy their goods while concealing the end-use or purpose for the purchase.

Conclusion

As nations continue to develop nuclear programmes and established suppliers look for ways to compete against others to increase profits, they will look for new methods to evade export controls and transfer goods under the radar. Clearly the most dangerous materials being trafficked today are those that are related to nuclear programmes. Although in the past the press had reported on illicit procurement activities, their significance was not realized until authorities acted to break up the Khan network.[78] The proliferation activities of Pakistan, Iran, Iraq, and North Korea illustrate the problem faced today by the international community: procurement networks are staying ahead of export controls by altering

their tactics, learning new and more evasive techniques and finding ways to exploit legitimate trade practices to acquire sensitive materials. While control regimes may have successfully slowed the first and second tier of proliferation networks, there is actually a third tier of networks - a 'substructure' that is comprised of a variety of semi-autonomous groups that can service the demand size of today's nuclear black market.[79]

The challenge for intelligence agencies, and international and national regulatory bodies, is to continue to investigate questionable activities and to find new tools to interdict any transactions which may result. Looking for indicators such as frequent buying missions to industrial countries, suspicious contacts and organizations operating out of embassies, scientific exchanges and other doubtful alliances among allied nations, and nationals living overseas shipping materials to their home country, investigators can identify and analyze the existence of new and existing procurement networks. This information then needs to be shared with industries and companies that produce sensitive items to make them more aware of illicit procurement efforts and thereby enable them to ward off illicit attempts to buy their products. These and other more innovative measures are needed to help enable the international community to stifle nuclear procurement activities, thereby slowing the spread of nuclear weapons. ■

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