

Chinese Citizen's Involvement in the Supply of MKS Pressure Transducers to Iran: Preventing a Reoccurrence

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On April 4, 2014, the United States District Court in the District of Massachusetts unsealed ten-count charges against Sihai Cheng, a resident of Shanghai, for allegedly operating as a middleman seeking U.S. made pressure transducers on behalf of Iran's nuclear program.³ Cheng allegedly carried out this activity from 2009 to 2012, using his trading company Sohi Technology Co. Ltd and its locations in Shanghai and Hong Kong. He was arrested by British authorities in February 2014 pursuant to a U.S. arrest request and authorities are seeking his extradition from the United Kingdom.⁴ Three other Iran-based companies and individuals who were involved in the illicit procurement scheme are named in the indictment.

The arrest of Cheng marks the second arrest of Chinese middlemen involved with several "rogue salespeople" employed by subsidiaries of MKS Instruments Ltd in China. MKS Instruments is headquartered in Andover, Massachusetts but holds distributors throughout the world. A related case involved the illegal sale of MKS pressure transducers by the same unnamed MKS Shanghai salespeople.⁵ In that case, another Chinese middleman, Qiang Hu, schemed during 2007 to 2012 to facilitate the purchase of pressure transducers likely for Iran's and other countries' nuclear programs. While attending an MKS training session in Andover in 2012, Hu was arrested at a nearby hotel by U.S. enforcement officials.⁶

These arrests may mark the end of what may have been one of the more damaging insider proliferation cases in recent times. This case, and likely the Hu case, positively links the diversion of thousands of MKS pressure transducers to entities associated with Iran's gas centrifuge program, providing unique insights into the operation of Iran's illicit procurement efforts and of the techniques and drivers of Chinese middlemen who are major facilitators of proliferation. Unanswered is whether this alleged,

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³ United States District Court in the District of Massachusetts, *Grand Jury Indictment: United States of America v. Sihai Cheng et al.*, Crim. No. 13cr10332, Filed November 21, 2013.

⁴ BBC News Online, 'US accuses Chinese man of breaching Iran nuclear sanctions', 4 April 2014. Available online at: <http://www.bbc.com/news/world-us-canada-26892568> (Accessed 11/04/2014)

⁵ Albright, David and Stricker, Andrea, 'Case Study- Chinese Salesman Arrested in Pressure Transducer Case' (Washington, D.C.: Institute for Science and International Security, 18 January 2013). Available online at: http://isis-online.org/uploads/isis-reports/documents/Hu_illicit_trade_case_18Jan2013.pdf

⁶ Ibid.

illegal scheme also involved North Korean smuggling entities receiving pressure transducers for its gas centrifuge program.

Background

MKS Instruments is a manufacturer of pressure transducers, an instrument that can be used to accurately measure the operating pressure inside a gas centrifuge plant, and is key to the successful operation of the plant. Large numbers of pressure transducers are used in a centrifuge plant, particularly in the metal piping connecting the centrifuges into cascades, and more generally in piping running throughout the centrifuge plant. Centrifuges operate under vacuum primarily to keep the high speed rotor of the centrifuge from overheating due to friction. Vacuum pressures inside gas centrifuge cascades are understood and thus the types of pressure transducers needed are well-defined. Inquiries by would-be customers about certain pressure transducers and relatively large quantities typically increase suspicion of intended centrifuge use.

The demonstrated use of many MKS pressure transducers in Iranian centrifuge plants is contained in well-publicized 2008 images of the former president of Iran, Mahmoud Ahmadinejad, touring Iran's Pilot Fuel Enrichment Plant (PFEP) at Natanz. The photographs show that a single advanced test centrifuge has one MKS pressure transducer and a pilot centrifuge cascade has one pressure transducer per every several centrifuges in a cascade (see figures 2 and 3).

Very difficult to make, pressure transducers are therefore a key item that Iran, and for that matter North Korea and Pakistan, has had to acquire overseas for its enrichment plants. Moreover, vacuum pressure transducers have a limited lifespan – typically of around 3 years, according to one official interviewed by the authors. Therefore, consistent supply of such pressure transducers is necessary in order for Iran's enrichment efforts to proceed.

This said, it may be that fewer pressure transducers are needed in a production cascade in the Fuel Enrichment Plant at Natanz and the one at the Fordow Fuel Enrichment Plant, compared to the large number that are visible in the cascade at the PFEP as seen in figure 3. ISIS has estimated based on this image that Iran likely uses about one pressure transducer per ten centrifuges in the cascade at the PFEP, which equates to about 16 pressure transducers per cascade. A production cascade at the FEP or Fordow may use fewer per cascade, but more may be used in the much larger amount of plant piping.

The overall number of pressure transducers in the FEP and Fordow plants is very large. At the two production sites, the centrifuge cascades are organized into modules containing 18 production cascades and large amounts of piping associated with feeding and withdrawing uranium from the cascades. Although it may be sufficient to have fewer pressure transducers attached to a particular centrifuge cascade, many would likely be used in the areas where uranium hexafluoride is transferred into the cascades and withdrawn from them after passing through the centrifuges, or where cascades are quickly emptied during malfunctions of the centrifuges.

Unlike the previous case of diversion of MKS pressure transducers by Qiang Hu in which diversion to Iran was not categorically established, at least in public documents, the indictment in this case makes a direct link with Iran's enrichment effort as some of the goods were shipped to Eyvaz Manufacturing Company – an entity designated for supplying parts to Iran's enrichment effort. All of the pressure transducers mentioned in this case are also suitable for use in enrichment: they were of the absolute type and manufactured with parts made of materials resistant to UF₆ (Inconel, in this case). Two of the

three pressure transducers operate in different but overlapping pressure regions, and combined correspond to pressure ranges that would be commonly associated with gas centrifuge enrichment, where the pressure in the centrifuge cascades is monitored from atmospheric pressure down to the medium vacuum range.

That MKS pressure transducers have been sought by Iran is not a surprise. MKS has been a leading manufacturer of the device since around the 1970s, when its products were selected for use in URENCO plants. In the decades since, MKS has been a dominant market supplier, with only a handful of rivals, such as Inficon, at any one time ever since.⁷ Such a small manufacturing base should lend itself to effective enforcement of export controls, which is perhaps what makes this case so egregious. In addition, MKS pressure transducers have been obtained by other sanctioned nuclear programs, such as by Pakistan using the A.Q. Khan network, so illicit schemes involving MKS or other pressure transducers are not new.⁸

The Scheme

This case and the Hu case involved multiple employees of MKS Shanghai Ltd who are alleged to have conspired over several years (2007-2012) to systematically evade both the export control policies of their U.S. parent company, MKS Instruments Ltd, and U.S. export controls. They are also alleged to have evaded Chinese export controls since these pressure transducers are controlled on the Nuclear Supplier Group's dual-use list. Even when photographs surfaced in 2008 of MKS pressure transducers operating at Iran's sanctioned enrichment plant, the scheme continued for several more years. Several employees of MKS Shanghai Ltd are also named as co-conspirators in this case.

The scheme operated in the following manner:

Sihai Cheng was the owner of Sohi Technology Co. Ltd located in Shanghai and Hong Kong. He worked with another, unnamed co-conspirator (referred to as Facilitator 1 here) who owned two companies in China. Cheng had also worked from China with an Iranian middleman named Seyed Abolfazl Shahab Jamili since 2005 to supply Iran with nuclear dual-use goods and materials for 'Iranian government work' using Jamili's company Nicaro Engineering Co. Ltd located in Tehran. A March 2007 e-mail from Jamili to Cheng stated the parts he sought were for 'a very big project and a secret one.' Interestingly, Iran began construction on the then-secret Fordow Fuel Enrichment Plant near Qom as early as 2006 and would have required many pressure transducers at about the time of this e-mail. The Natanz FEP, which was undergoing a major expansion, would have also needed many pressure transducers.

The indictment indicates that Jamili filled orders for Eyvaz Manufacturing Company of Tehran - an Iranian company designated by the European Union (EU) for supplying vacuum equipment to Iran's enrichment facilities. Eyvaz was sanctioned by the EU in 2011 for its involvement in nuclear and ballistic missile activities. The indictment states, "In doing so, [the EU] found that Eyvaz had produced vacuum equipment, which it supplied to two of Iran's uranium nuclear enrichment facilities, Natanz and Fordow, and that it had also supplied pressure transducers...to Kalaye Electric Company...a nuclear testing and research facility located in Tehran." Kalaye Electric, a major site of Iran's centrifuge research and

⁷ Unpublished Pressure Transducer Manufacturing Base Report, Project Alpha, King's College London.

⁸ See Box 4 on previous attempts on pages 69-70 in Albright, D, Stricker, A, and Wood, H. *Future World of Illicit Nuclear Trade: Mitigating the Threat* (Washington, D.C.: Institute for Science and International Security, July 29, 2013). Available online at: http://isis-online.org/uploads/isis-reports/documents/Full_Report_DTRA-PASCC_29July2013-FINAL.pdf

development, was sanctioned by the United Nations Security Council in 2006 under resolution 1737 for carrying out undeclared uranium enrichment R&D. The United States also designated Kalaye Electric as a proliferator of WMD in 2007.

In 2009 Jamili approached Cheng with an order for pressure transducers, which he claimed he was unable to acquire from his first target, Edwards in the UK, a recognized vacuum company that has a well-developed internal trade control system. Cheng contacted those named in the indictment as Co-Conspirators 1 and 5 (Co-Conspirator 1 being Facilitator 1) about placing an order, initially describing it as on behalf of 'our Hong Kong Sohi Technology Co Ltd. Our old customer from Singapore wants to purchase PRESSURE TRANSMITTER.' The two next spoke by phone about cooperating on the alleged illicit deal that later took place. The order was separated into numerous batches on the advice of the Iranians in order to reduce the likelihood that MKS HQ would realize that the goods were being diverted.

MKS Shanghai Ltd staff, according to the indictment, next knowingly used the *bona fides* of numerous Chinese companies and the Hong Kong location of Sohi Technology Co. in order to acquire or use U.S. export licenses. MKS staff are alleged to have used details of two real customers of MKS Shanghai Ltd and two companies that were created by the MKS Shanghai employees and the unnamed Chinese Facilitator (Facilitator 1), when placing the intra-company requests to the MKS Andover office. Andover, in turn, submitted license applications to the U.S. Commerce Department where necessary or authorized the shipment and release of goods under existing customer-specific licenses. Facilitator 1 served as the temporary recipient of the goods in Shanghai, in addition to Sohi Technology Co's location in Hong Kong, until Cheng could send them to Nicaro Eng. Co. or the actual end-user, Eyvaz Manufacturing Company, in Iran.⁹ Ultimately, under U.S. export licenses, hundreds of pressure transducers were allegedly exported to China then diverted to Iran.

⁹ *United States of America v. Sihai Cheng et al.*, Filed November 21, 2013.

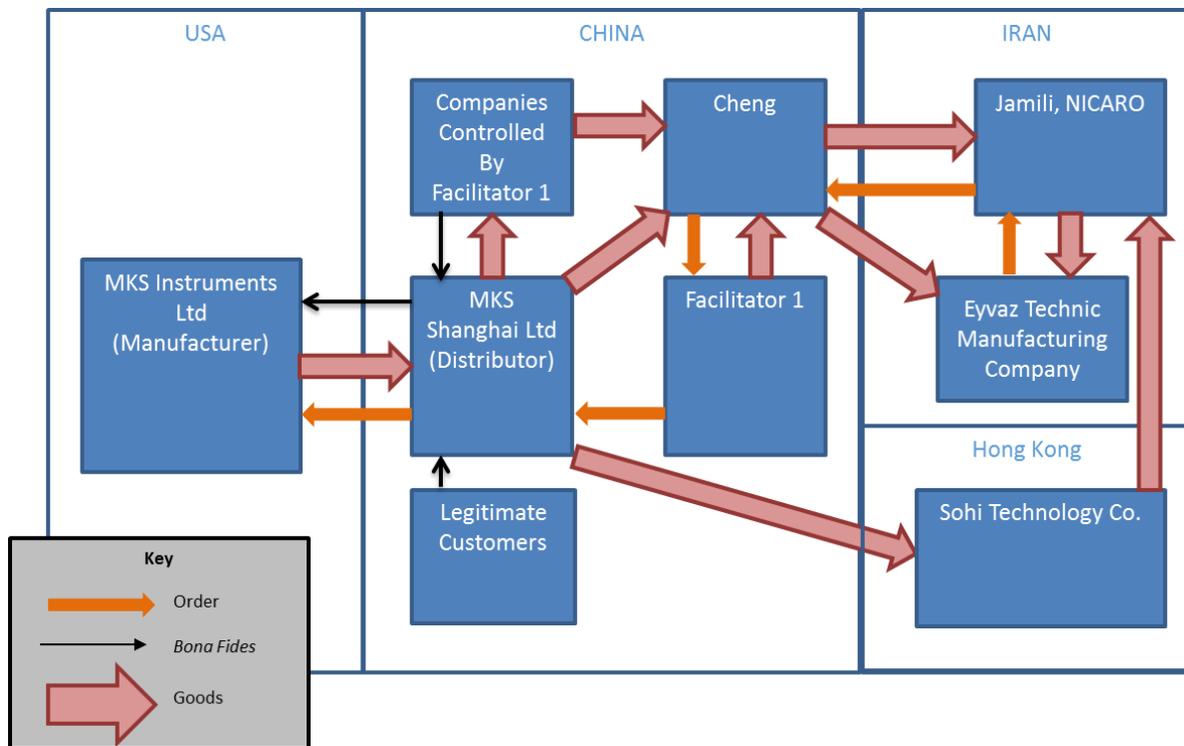


Figure 1: Overview of the Scheme

Illicit Procurement Methods and Tactics

In this case, there is a direct link with Iran’s nuclear program through the involvement of the Iranian entity, Eyvaz Manufacturing Company. This is not always the case in illicit trade schemes that become public. Between 2009 and 2012, through this route, hundreds of pressure transducers were shipped from the United States to China and then to Iran; in essence China was what is called a ‘country of diversion concern’ for U.S. goods.

This case helps to highlight several methods used by Iran and its network in procuring goods from the international marketplace and in particular China:

1. Iranian agents formed an enduring relationship with Chinese businessman Cheng, who was able to acquire sensitive goods repeatedly over a number of years.
2. One Chinese intermediary (Cheng) created companies in China and Hong Kong for the purposes of facilitating illicit trade.
3. This Chinese intermediary built enduring (and allegedly corrupt) relationships with staff of MKS Shanghai Ltd, through which the MKS staff were persuaded to engage in illicit proliferation practices.
4. Corrupt MKS staff, according to the indictment, helped Facilitator 1 establish and use his two front companies for the purpose of evading U.S. export controls.
5. The alleged illicit procurement scheme appears to have been able to evade both company internal compliance procedures and due diligence of the U.S. export licencing system, along with any Chinese export controls.
6. The Iranian entities requested that the order be sourced in batches of 50-150 pressure transducers ‘otherwise, if the factory knows the final destination, it may causes that

they will stop further business.’ But it should be noted that among European companies and governments, who have also been targeted by Iran’s illegal schemes to acquire pressure transducers, by 2008 or 2009, any inquiry or request for a price quote involving more than 50 pressure transducers would trigger suspicion and further corporate and governmental investigations.

7. The Iranian intermediary expressed concern about a potential price increase by MKS of 8%, indicating that financial considerations are not secondary in relation to illicit procurement of vital equipment.
8. Chinese intermediary (Cheng) allegedly shipped directly to Nicaro or Eyvaz in Tehran using such standard shipping entities as DHL, UPS, and TNT Express, or airlines such as Iran Air, Qatar Air, and Mahan Air, indicating the difficulty authorities face in detecting illicitly obtained goods at the point of shipment.
9. Apart from China, Hong Kong served as one shipment point before goods were diverted to Iran.
10. Chinese intermediary (Cheng) allegedly used bank accounts located in the UK and the United Arab Emirates to transfer payment for the goods.

Price and Profit

The indictment suggests that MKS Shanghai Ltd sold pressure transducers to its customers for the price of around \$860 each. However, Cheng quoted the price of \$1.8m for 790 units to Jamili, which equates to around \$1800 each. This therefore indicates that the two Chinese middlemen could split a little over a 100% markup on the sale, although there would also be costs to pay including potentially payoffs to MKS staff. Perhaps because of this, there is some evidence to suggest that the majority of the markup went to Facilitator 1. For example, a company owned by Facilitator 1 is alleged to have sold Cheng 60 units for the price of \$1568 each, which equates to around a 75-25% split.

Original Inquiry (Request for price quote) by Cheng	Order	Price to Facilitator 1	Price to Cheng	Price to Iran	Price per unit	Part Series 722A/722B			Comment
						11TGA2FJ	13TGA2FJ	01TGA2FJ	
790				\$1,418,840	\$1796		790		
Actual Order Placed with Facilitator									
	1000+			>\$1,800,000	> \$1800	1000+			Specific types not provided
Alleged Successful Shipments to Iran									
	30								
	60 (became 61)	\$52,033 (\$853 Each)	\$94,080 (\$1568 Each)			45	5	11	This price suggests that Cheng made approximately \$230 each
	38	\$32,738 (\$861 Each)				27	1	10	This price suggests that Iran paid a premium of approximately \$931 each
	56	\$48,174 (\$860 Each)				39	3	14	

Table 1: Orders, Prices, and Profit for Pressure Transducers as listed in the indictment¹⁰

MKS Instruments Ltd Take Steps to Respond

This case highlights many of the challenges posed by illicit trade. MKS Instruments Ltd headquarters (HQ) in Andover diligently applied for U.S. export licenses for each of the orders submitted by MKS Shanghai. MKS Instruments Ltd maintained a stock of pressure transducers at MKS Shanghai that could be used to service urgent client orders. No allegations that the authors are aware of have come to light that suggest that MKS Instruments Ltd HQ acted knowingly to break export laws. MKS HQ did cooperate in resolving this case.

That said, thousands of MKS products nonetheless ended up with unauthorized end users, including, as the Hu case and this most recent indictment suggest, Iran’s nuclear program. Lessons therefore must be learned by all companies that hold particularly sensitive items: an internal centralized export compliance system is needed and controls over the supply chain matter.

In this case the staff involved in the MKS subsidiary (which acted as a distributor or agent) were clearly aware of export controls – their knowledge of the system was so good, in fact, that they were able to

¹⁰ United States District Court in the District of Massachusetts, *Grand Jury Indictment: United States of America v. Sihai Cheng et al.*, Crim. No. 13cr10332, Filed November 21, 2013.

work around it. However, this is often not the case: too often overseas subsidiaries, agents, brokers or even customers either implement no export compliance system or operate a system that is not sufficiently robust. Why then after the 2008 photos became public of the pressure transducers operating in Iran did the scheme continue, presumably, undetected? Why did a company that supplies sensitive equipment not keep better, more centralized oversight over the activities of its Shanghai sales agents? Why was there no investigation into the *bona fides* of claimed end users, particularly those located in known turntable countries and territories such as China and Hong Kong? Most companies that operated these kinds of decentralized or poorly administered export compliance systems and ended up supplying the nuclear programs of proliferant states learned these embarrassing lessons many years ago. There is little excuse on the part of MKS for failing to learn and take those lessons seriously. Indeed, the U.S. export licensing system too appears to have failed at exercising due diligence in investigating the claimed end users in this case.

MKS has responded to these embarrassing cases, implementing what they have described as their “Controlled Delivery Model.” In effect, it is a headquarter controlled compliance and logistics system in which shipments can be released only if a central compliance manager is content that the order is genuine, that the export licenses are in place, and that the goods are destined for the customer specified. MKS also introduced a system of end user validation, which requires all customers to be validated by an official from the United States.¹¹ The system still has some issues and some responsible suppliers have complained that orders for large numbers of pressure transducers were reported to authorities. But at this stage, overreaction on the part of MKS is tolerable, given the seriousness of the past lapses. The challenge for MKS going forward will be to ensure that legitimate orders can be serviced while the potentially proliferation-related ones can be identified and excluded.

Chinese Measures

It appears that Chinese authorities took no enforcement action in this case or against illicit exporters of pressure transducers more generally that have been operating from its territory in recent years. The indictment also identifies Cheng as a serial proliferator, who had aided Iran’s program in acquiring proliferation-sensitive goods for a number of years before the order for the 2008-2012 pressure transducers was received. It seems unlikely that the Chinese authorities were not aware of the concerns regarding Cheng’s activities.

This case is similar to another involving the now infamous serial proliferator Karl Lee of the Chinese company Limmt. For years, international partners asked China to take action to halt Lee’s shipments of missile components and materials to Iran, but Chinese authorities appear to have taken no enforcement action.¹²

¹¹ Stewart, Ian J and McGovern, John 'Beyond Compliance : Preventing the Diversion of Sensitive Vacuum Measuring Equipment- The 'Controlled Delivery Model', CSSS Occasional Paper Series, No.3 (King's College London: 2013).

¹² Stricker, Andrea, 'A Smuggler’s Use of the U.S. Financial System to Receive Illegal Payments from Iran' (Washington, D.C.: Institute for Science and International Security, February 11, 2011 update). Available online at: http://isis-online.org/uploads/isis-reports/documents/Limmt_Li_Fang_Wei_23Oct2009_update9Feb2011.pdf

One part of the solution is for China to conduct more outreach to its private companies. When China conducts outreach, the central or provincial Ministry of Commerce officials must insist that firms, including the myriad trading companies on its territory, attend export compliance training.¹³

While compliance by China and its state-owned enterprises has generally improved in recent years following the use of U.S. designations (although significant corruption still exists), China must become more diligent in implementing and enforcing its export and sanctions laws, respond more proactively to foreign concerns about proliferation by its entities, and exercise transparency about what enforcement action is taken. It must also put significantly more resources into investigations, enforcement, and industry outreach if proliferation is to be stemmed.

Given the seriousness of this and other cases, ISIS recommends that the U.S. government should designate China as a country of diversion concern, at least with respect to pressure transducers, under U.S. Iran sanctions legislation. Such a designation would trigger more extensive scrutiny of U.S. exports to China.

Controls on Newer Pressure Gauges are Finally Being Implemented

Several years ago, several companies introduced a new type of pressure transducer onto the market that utilizes ceramic, such as aluminum oxide, rather than specialized metal, parts, which triggered controls in the case of the MKS pressure transducers. These newer types that avoided the use of controlled metals were not included on dual-use control lists, creating a loophole in the controls. Iran has made numerous illicit procurement efforts over the last several years to acquire these other types of pressure transducers, particularly those made by the European company Inficon. In some cases, Iran has succeeded in acquiring them. In 2009, for example, a Chinese company, Roc-Master Manufacture and Supply Company, working on behalf of an Iranian client brokered a deal for 108 European-made pressure transducers with a distributor of this equipment located in Taiwan. The Taiwanese distributor misled the European manufacturer Inficon that the end user was in China and instead forwarded the pressure transducers to Iran.¹⁴ However, tens of other Iranian attempts were thwarted.¹⁵

In response to concerns about this loophole, the Nuclear Suppliers Group has recently moved to control pressure transducers made from these materials, but the NSG's updated list has not yet been implemented into the national export controls of most countries. Nations, however, could already include these other types of pressure transducers under UN Security Council sanctions. Roc-Master brokered its deal for Iran just before Taiwan had amended its laws incorporating the sanctions in the UN Security Council resolutions on Iran, and the updated law would have made illegal the sale of the Inficon pressure transducers to Iran. Many other countries have implemented UN Security Council sanctions in such a way as to ban sales of this pressure transducer to Iran; an exception has apparently been China, which has narrowly interpreted the sanction. Thus, there remains a need to officially include prohibitions on exports to Iran of these other types of pressure transducers in UN Security Council sanctions lists.

¹³ For discussion of policy options for preventing illicit trade through China, See Bowen, W., Stewart, I., Salisbury, D., "Engaging China in Preventing Proliferation", *The Bulletin of the Atomic Scientists*, Available online at: <http://thebulletin.org/engaging-china-proliferation-prevention>

¹⁴ "How Nuclear Equipment Reached Iran", The Associated Press. March 1, 2010. The supplier was the Liechtenstein company Inficon. <http://www.ynetnews.com/articles/0,7340,L-3856130,00.html>

¹⁵ Box 4 on previous attempts, pages 69-70, *Future World of Illicit Nuclear Trade: Mitigating the Threat*, July 29, 2013.

This case study also highlights the risks of shipping sensitive items to stock and to non-validated end users. For the most sensitive items, including pressure transducers, the Nuclear Suppliers Group should reiterate that the items should not be shipped to stock. Members of the NSG should also agree to provide the IAEA with details of imports and exports, including customer names, to the IAEA regardless of whether the country has concluded an Additional Protocol with the IAEA.

A Nuclear Deal with Iran Must Prevent Future Illicit Trade

As the P5+1 negotiate a comprehensive agreement with Iran over its nuclear program, they must ensure that future illicit nuclear trade by Iran is prohibited in the agreement's provisions. To that end, Iran needs to commit to not conduct illicit nuclear trade, defined broadly as trade that violates suppliers' national and regional export controls and sanctions laws and regulations.

A key goal of the negotiations is also to give the IAEA visibility of, and the right to inspect, imports of proliferation-sensitive goods to ensure that they are either destined for a declared nuclear end use or that they are not destined for an undeclared nuclear end use. The P5+1 should also maintain for the duration of a comprehensive agreement some sanctions or limitations on the supply of sensitive nuclear and nuclear-related exports to Iran.¹⁶

Conclusions

Iran has obtained hundreds, if not thousands, of pressure transducers that are used in uranium enrichment programs from the international marketplace, in large part due to the decentralized nature of MKS Instruments' pre-2012 export compliance system and poor oversight of its salespeople. Iran succeeded in this effort by utilizing Chinese middlemen who were effective in persuading not one but several employees of the MKS subsidiary in China to engage in prohibited activities.

There were two main Chinese facilitators, one of whom has so far been named and arrested. Facilitator 1 is apparently still at large. The potential profit associated with this case is a strong indication that at least some of the Chinese middlemen were driven by financial factors.

A major cause for Iran's success in evading trade controls and sanctions lies with the lack of Chinese implementation and enforcement of its own laws. This case and many others in recent years point to systematic illicit procurement and transshipment efforts through China to Iran. China must do more to stop these illegal activities and to enforce both its own trade control laws and UN Security Council sanctions on Iran and North Korea. China's poor record in this regard should be recognized as an international problem requiring urgent action.

Until China takes action, these types of cases will remain persistent problems for Western suppliers with subsidiaries in China. U.S. and other governments must make special efforts to help their companies thwart proliferation attempts in China, partly by insisting that companies institute extra due diligence but also by informing them of schemes to obtain sensitive goods via their Chinese locations. In this case, cooperation between non-Chinese governments and their companies with subsidiaries in China is essential.

¹⁶ For additional recommendations on the comprehensive agreement and preventing illicit nuclear trade into the future, see: ISIS, 'Defining Iranian Nuclear Programs in a Comprehensive Solution under the Joint Plan of Action' January 15, 2014. Available online at:

http://www.isisnucleariran.org/assets/pdf/Elements_of_a_Comprehensive_Solution_20Jan2014_1.pdf

An everpresent issue is that Iran's illicit nuclear trade continues to be tolerated by many key supplier and transshipment countries. Iran's illicit nuclear trade must be verifiably banned in any comprehensive solution over its nuclear program.

The case highlights the need to redouble efforts to counter illicit nuclear trade. Decentralized export compliance too often cannot be effective in preventing proliferation. Instead, manufacturers of proliferation-sensitive technologies must implement compliance systems that ensure that the goods cannot be diverted in the supply chain.



Figure 2: Former Iranian president Mahmoud Ahmadinejad examines an advanced gas centrifuge test stand at the Natanz pilot fuel enrichment plant during a 2008 visit. An MKS pressure transducer can be seen. Source: Website archive of the president of Iran, www.President.ir



Figure 3: Former President Ahmadinejad examines gas centrifuge equipment, which includes an older MKS pressure transducer (next to his right hand) during a visit to the Natanz pilot fuel enrichment plant in 2008. In the background is an IR-1 gas centrifuge cascade which contains many more recent (mid-2000s) models of MKS pressure transducers. Source: Website archive of the president of Iran, www.President.ir