Introduction to Illicit Nuclear Trade

ISIS Course

December 11, 2014

Types of Illicit Nuclear Trade

- State to state, or state to terrorist group
  - China to Pakistan, North Korea to Syria
- Transnational Smuggling Rings
  - Khan Network
- States organize illicit procurement networks to obtain needed facilities, goods, and technologies for own nuclear programs
  - Many examples, Iraq, Pakistan, India, North Korea, Brazil, Iran
- Today, we focus on the third type.

Let's consider what's at Stake in the case of Iran?

- Export controls and international, regional, and national sanctions aim to prevent Iran from obtaining vital goods for its nuclear programs, such as its gas centrifuge facilities.
- Such a strategy can delay or even prevent Iran from making progress on key nuclear facilities.
- However, Iran is finding ways around the controls and sanctions, despite many successful efforts to stop its smuggling efforts.
- Iran today remains committed to violating international sanctions and domestic trade control laws

“Of course we bypass sanctions. We are proud that we bypass sanctions.”

--Iranian President Hassan Rouhani, August 30, 2014

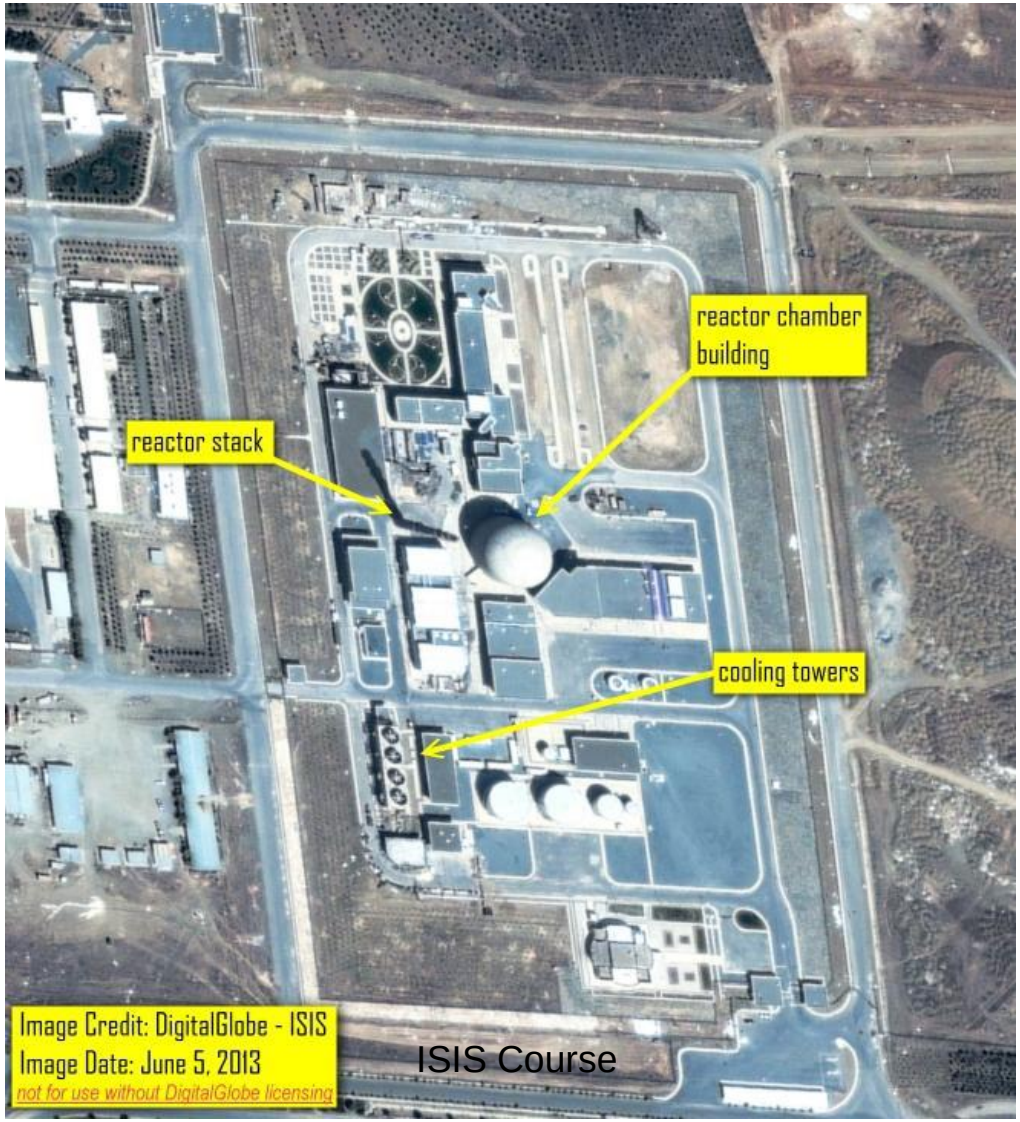
WHAT IS IRAN OUTFITTING VIA ILLICIT TRADE

Photo of Natanz Centrifuge Plant, DigitalGlobe

Natanz Plant, September 2002

Fordow Centrifuge Facility

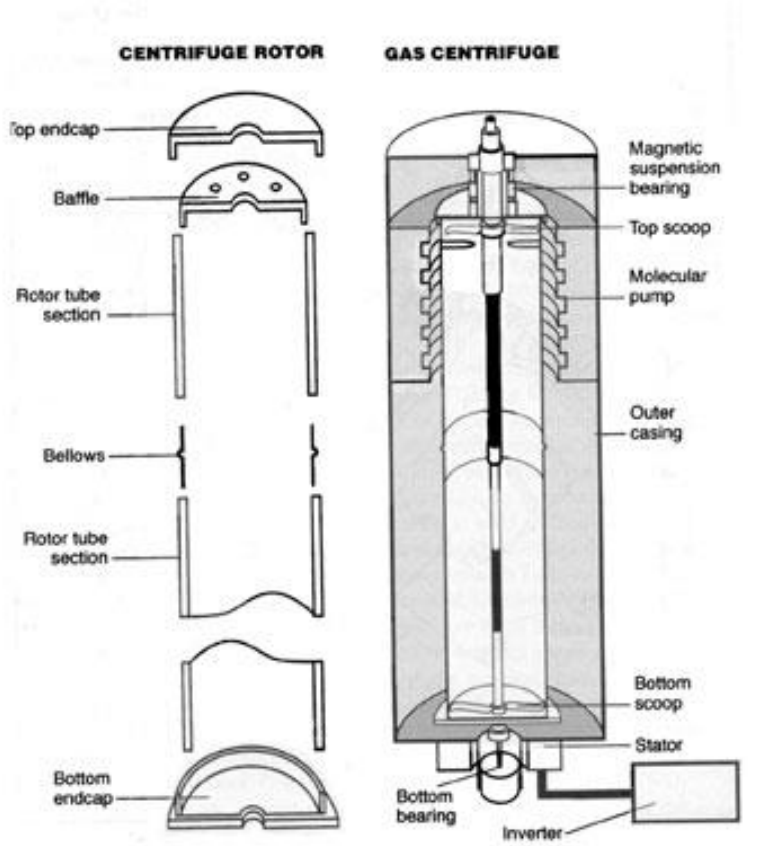
Arak Heavy Water (IR-40) Reactor



EXAMPLE OF GOODS IRAN SEEKS

Example: Iran and T-700 grade carbon fiber

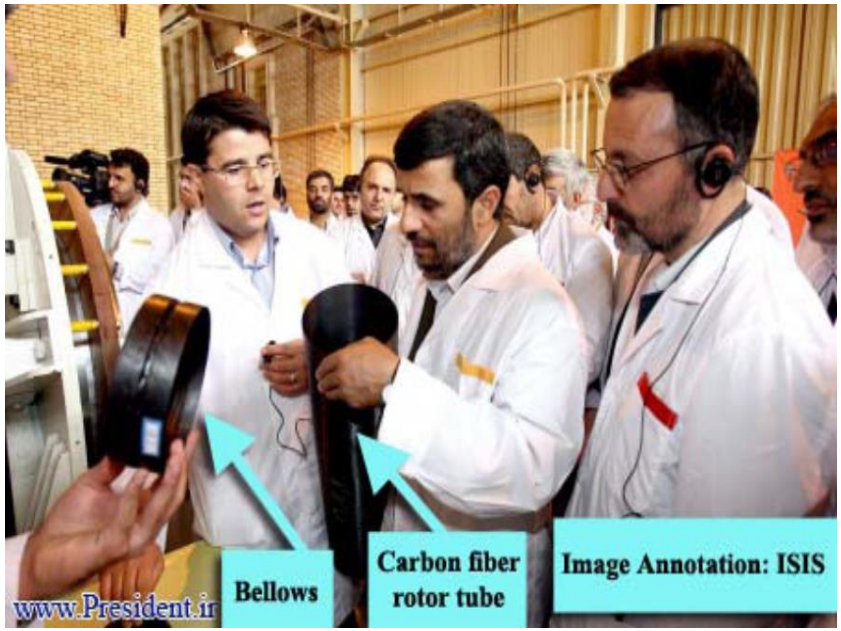
- A Iranian gas centrifuge enriches uranium in a rapidly spinning rotor assembly, comprised of rotor tubes and a "bellows"
- Here is an example of one with two rotor tubes and a single bellows.

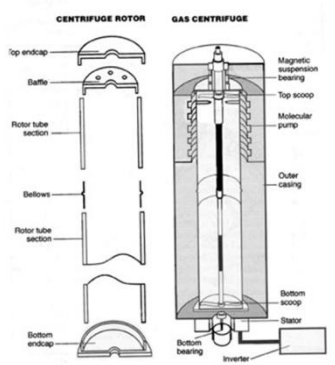


Source: Albright, D. and Hibbs, M., 'Iraq's shop-till-you-drop nuclear program', *Bulletin of the Atomic Scientists*, vol. 48, no. 3 (Apr. 1992), pp. 32 and 33.

IR-2m Centrifuge and Carbon Fiber

- T-700 grade carbon fiber is assessed as used to make rotor tubes of the IR-2m centrifuge. About 1,000 IR-2m's deployed at the Natanz Fuel Enrichment Plant, as of November 2013.
- Then President Ahmadinejad holds a carbon fiber rotor tube; visible is also a bellows





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Iran Smuggles T-700 carbon fiber

- Iran cannot make high quality carbon fiber; so Iran must import it. It is on dual use lists and banned for sale to Iran's nuclear programs.
- Moreover, few suppliers can make this grade of carbon fiber, making control easier. And there have been important successes in thwarting Iran's attempted purchases, including important interdictions.
- But Iran is getting carbon fiber nonetheless.

A Successful Iranian Smuggling Effort

- In one important recent case, T 700 carbon fiber, which was made in Japan, was sold to a reliable U.S. company, which in turn re-sold all or part of the original supply to a reliable company in an European Union (EU) country, with little scrutiny. Part of the original shipment of carbon fiber was subsequently sold to other less reliable companies within the EU without the need for an export license, and ultimately a significant amount "disappeared" and was trucked to Iran via Turkey.
- As a result of this case and at least one other, Iran is now assessed to have acquired enough carbon fiber for at least 3,000, and perhaps enough for 10,000, advanced IR-2m centrifuges.
- There is a need to do better!

Theft and Spread of Classified and Sensitive Information

- Building nuclear facilities, such as centrifuge plants, or developing a reliable nuclear weapon without access to classified or other sensitive information is extremely time consuming and guaranteed to experience delays and problems. To avoid this problem, Iran and other countries have sought and obtained sensitive nuclear information.
- The problem of controlling classified and sensitive nuclear and nuclear-related information was highlighted by the vast amount of such information disseminated by the A.Q. Khan network to U.S. adversaries, including Iran
  - Iran, Libya, North Korea obtained centrifuge designs, manufacturing instructions, and likely a complete nuclear weapon design. South Africa was offered centrifuge designs
- Cyber theft and espionage now increase chances of states obtaining technology
- Proprietary technology of US companies can spread through joint ventures or collaboration in China—Chinese companies can then develop the industrial capability to sell dual-use goods to adversaries

ILLICIT NUCLEAR TRADE, MORE GENERALLY

Stepping Back: How is Illicit Nuclear Trade Defined?

Illicit nuclear trade, or trafficking in nuclear commodities or technologies, is defined as trade that is not authorized:

1) by the state in which goods originate;

2) by the United Nations Security Council or regional authorities, such as the European Union;

3) by the states through which goods transit; or

4) for import into the buying state.

Illicit Nuclear Trade poised to worsen

- Of roughly two dozen countries that have pursued or obtained nuclear weapons during the last fifty years, almost all depended importantly on foreign supplies.
- **Over the next five to ten years,** illicit nuclear trade is likely to be conducted by several nations seeking nuclear weapons or wanting to maintain existing nuclear weapons arsenals or capabilities.
- Despite many recent U.S., EU, and partner successes, stopping this trade will remain difficult.
- Absent mitigating actions, several existing or expected trends are projected to make it easier for smugglers to succeed in acquiring nuclear and nuclear-related goods and technology.

Iran, North Korea, and Pakistan drive much of the world's illicit nuclear trade

- North Korea, Pakistan, and Iran, like many other proliferant states, have depended on illicit nuclear trade to acquire the wherewithal to make both plutonium and highly enriched uranium (HEU).
- North Korea, Pakistan, and possibly Iran use illicit trade to obtain the means to make the nuclear weapon itself, a process often called nuclear weaponization.
- North Korea and Pakistan, via the Khan network, have also engaged in significant nuclear proliferation activities. Iran may do so in the future.
- Little reason to doubt that Iran, North Korea, or Pakistan will continue seeking critical goods for their nuclear programs from abroad.

Countries that Could Use Illicit Nuclear Trade to Develop or Improve Nuclear Arsenals – Future Demand Side

I. NPT Weapon states:	II. Non-NPT states improving arsenals	III. Nuclear Aspirants, dependent on illicit trade	IV. Developed of concern, North Asia context, and probability	V. Developing of concern, Mid East context, and probability	VI. Non-state actors
CHINA (esp. for nuclear weapons and intel'l prop.)	PAKISTAN	IRAN (depends of success of Joint Plan of Action)	S. KOREA (low probability)	EGYPT (low probability)	AL QAEDA
	INDIA		TAIWAN (low)	ALGERIA (low)	OTHER TERRORIST GROUPS
	N. KOREA			TURKEY (med)	SMUGGLING NETWORKS
	ISRAEL (on occasion)			SAUDI ARABIA (med)	
				SYRIA (very low, given civil war)	
				FAILED STATES IN AFRICA AND ASIA	

States Using Illicit Trade to Acquire Centrifuges

- Countries heavily reliant on illicit nuclear trade to obtain centrifuges:
  - Brazil, Iran, Iraq, North Korea, Pakistan, India, and South Africa have
  - Iran, North Korea, Pakistan, and likely India still do
- All required key centrifuge and centrifuge-related technology from overseas
- Required key goods from abroad that were too difficult to make:
  - Measuring equipment
  - Vacuum pumps and high speed valves
  - High grade maraging steel, high strength aluminum, and high strength carbon fiber
- Countries have sought even items they could have made themselves overseas in order to save costs and time and obtain higher quality, more reliable goods

States Forgoing Assistance: Few Successes

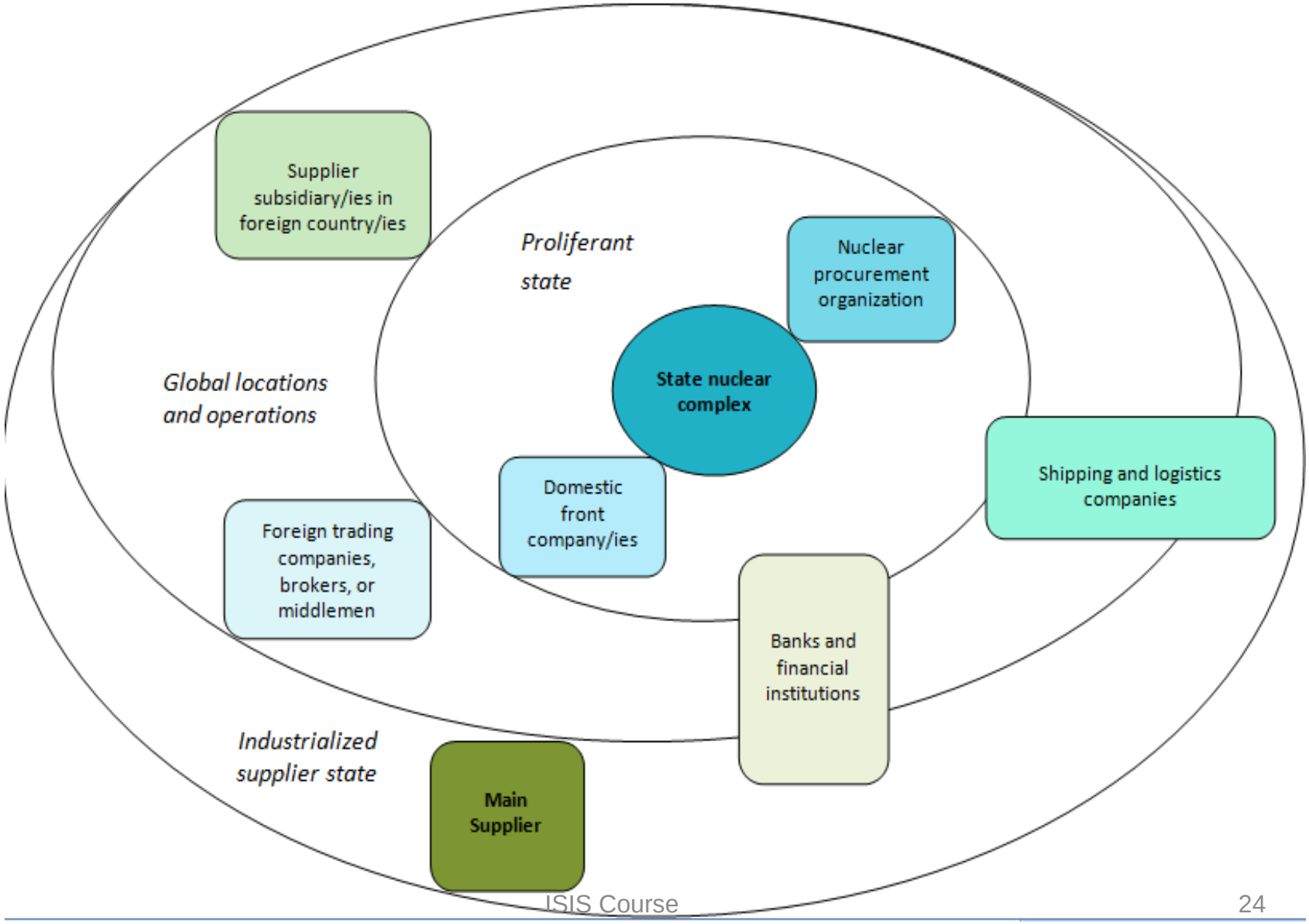
- States that have forgone outside assistance (more developed nations), have encountered significant obstacles to developing optimally performing centrifuges:
  - Australia, which proceeded indigenously with a limited number of engineers and technicians, took years to produce a functioning centrifuge program
  - Sweden spent years developing centrifuges but did not build a functioning one before cancelling its program.
  - In the 1990s, China decided to drop its indigenous centrifuge program in favor of buying centrifuges from Russia. Only in last few years has it reached the point of deploying its own centrifuges

Typical components of an illicit procurement network

- Aim of illicit nuclear trade efforts is to illegitimately procure goods controlled by national and international trade control regimes and international or regional sanctions.
- Organization of smuggling efforts typically has a network structure, which differs, for example, from a hierarchical structure.
- A network in the illicit nuclear trade sense is made up of an interacting collection of governments, companies, and individuals engaged in the process of procuring or supplying nuclear goods or capabilities.
  - Includes all aspects of the activities necessary to organize the acquisition of goods and deceive suppliers, including ordering goods, paying for them, and shipping them.
  - Each component is termed a “node,” or a “hub,” if the node is particularly active.
  - Nodes and hubs are connected by interactions, typically represented by lines, which can represent communications, orders, shipments, or bank transactions.

Typical components of an illicit procurement network (cont.)

Connecting lines omitted

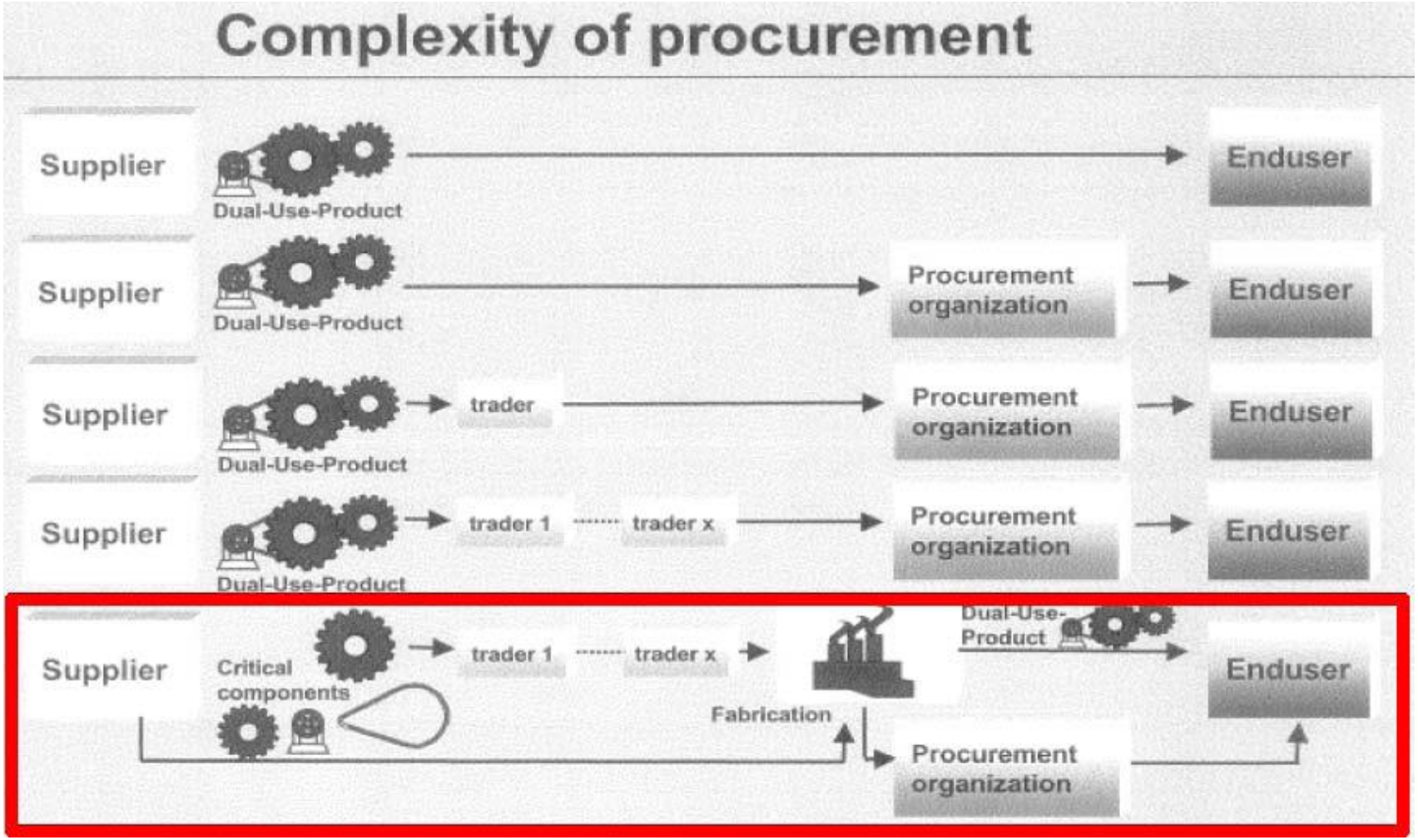


How do smuggling networks operate?

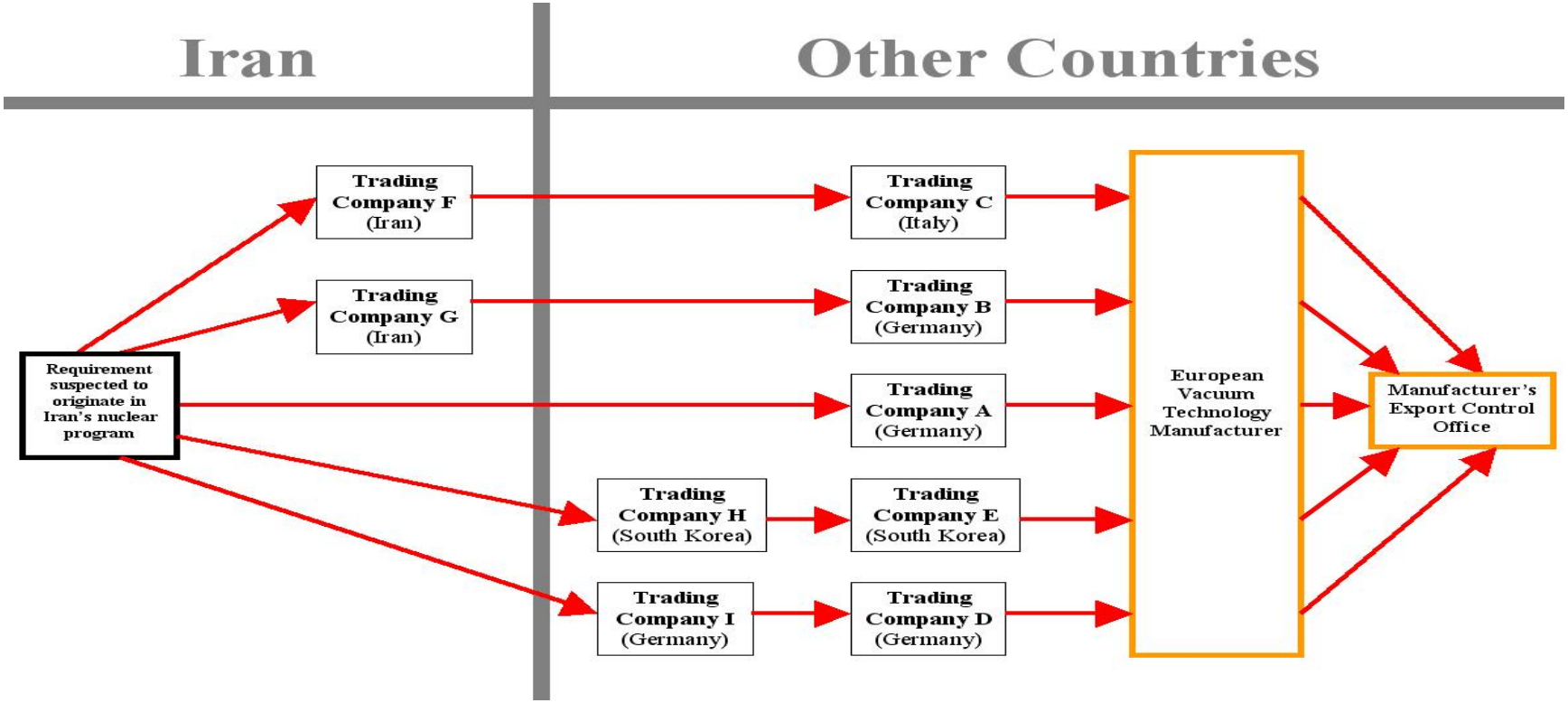
- Nuclear smuggling networks have become very sophisticated over the last fifty years. Smuggling networks have learned that suppliers in any country, including the United States, European Union, or China can be tricked into selling sensitive goods.
- Smugglers use a wide variety of approaches to obtain goods, varying from legal to illegal methods and from straightforward to highly deceptive schemes.
- Smuggling networks often route their illegal procurements through countries with weak or nonexistent export controls. By using trading companies in third countries, international shippers, and complex payment schemes, these networks can use any country as a transshipment point, often called a “turntable” or a country of diversion concern

Schemes to Obtain Sensitive Goods

(From FATF report)



Many suspicious enquiries, or price requests, for fast acting valves were received by a European vacuum equipment manufacturer



- In early 2000s, a European manufacturer noticed multiple similar item requests for large numbers of fast acting valves (over 200,000). Manufacturer's daughter companies and agents were barraged with these orders.
- Item requests originated from Iran.
- Manufacturer's centralized trade control office received them all and assessed that the most likely end-user was a large gas centrifuge plant.
- Specific valves ordered were not on control lists.
- European manufacturer notified its government authority. Government investigated and confirmed requests could be for a centrifuge program. In fact, the requests were likely intended for a new centrifuge plant in Iran, soon to be known as the Natanz complex.

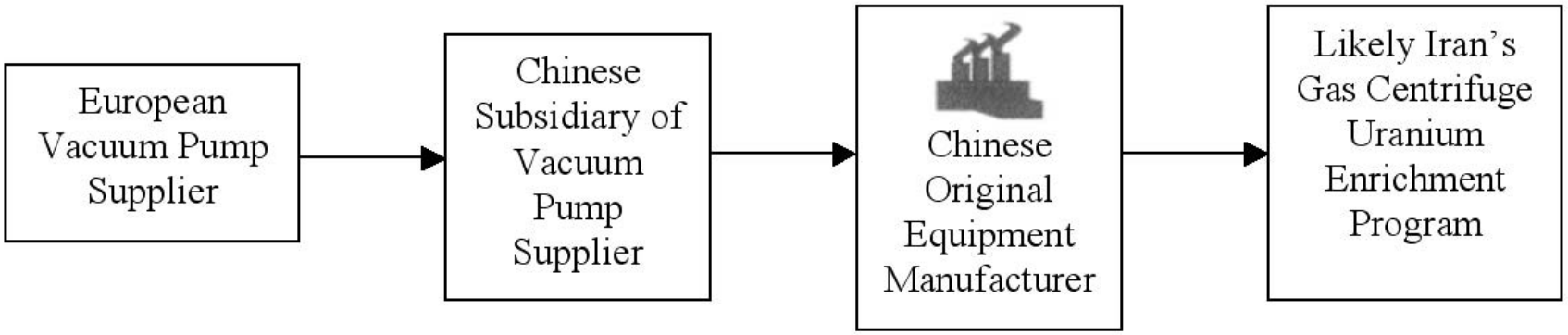
Example: North Korea's Efforts

- The North Korean government and nuclear programs directs highly organized and centralized smuggling efforts.
  - They use North Korean government officials stationed at embassies to conduct illicit procurement related business.
- North Korea has established entities abroad under its control that seek goods usually via foreign trading companies.
- It also uses North Korean expatriates who own private companies abroad.
- In the past, North Korean government entities have cooperated closely with other governments, such as Pakistan, that have been willing to provide training or needed goods and sensitive technologies.
- It is active in China seeking goods for its nuclear and other military related programs.
  - North Korean entities contract with private Chinese trading companies and middlemen to acquire these goods, either from Chinese suppliers or subsidiaries of Western or Japanese suppliers in China.

China as a Country of Diversion Concern

Nuclear programs of proliferant states can hide behind seemingly-legitimate manufacturing companies that have never raised red flags with suppliers

- **Vacuum pumps sold to a Chinese manufacturer from a European supplier,**
- **Chinese manufacturer sent pump systems to Iran, where they were likely utilized by Iran's gas centrifuge program.**
- **After receiving a tip from a domestic intelligence agency, the company was able to stop the second part of the shipment.**



Role of China as a Direct Supplier and a Country of Diversion Concern

- North Korea and Iran have bought a wide variety of goods for their gas centrifuge and other nuclear programs in China.
- Some goods are made in China but many are not. Many high-tech goods are made in Europe, United States, and Japan and in essence are transshipped through China to either Iran or North Korea illicitly.
- The motivation to acquire these non-Chinese high-tech goods appears to be the desire for higher quality and greater reliability, characteristics especially important in nuclear facilities.
- In China, it is private Chinese companies and not state-run entities that are being implicated in illicit nuclear trade.

Challenges Facing China

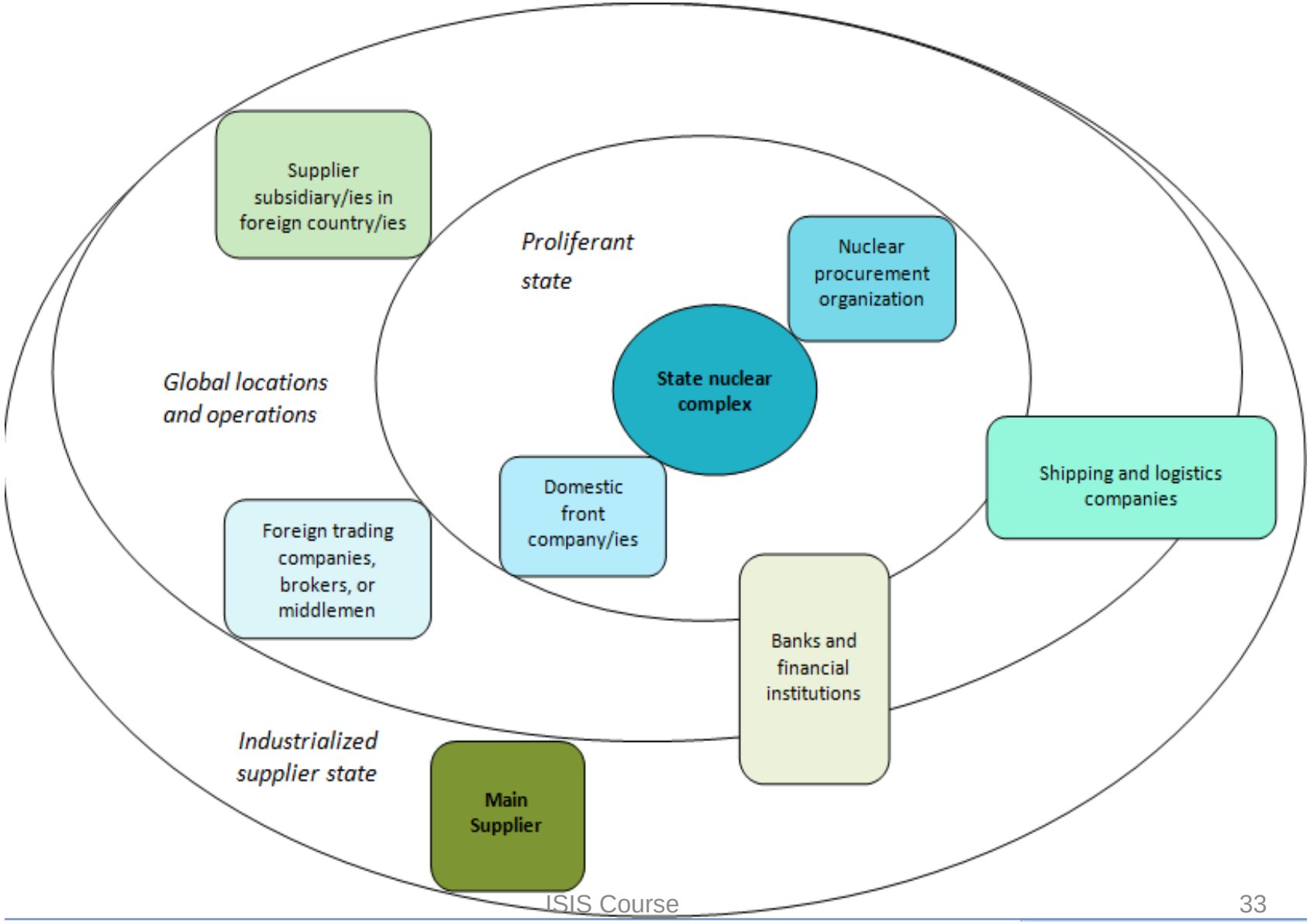
- China is immense and rapidly growing economically
- There is a heavy emphasis on exports and far less emphasis on non-proliferation and trade controls.
- There is a huge number of companies that need to be controlled. Chinese government officials state that China has about 800,000 private companies declared as involved in exports and imports. Most of these companies are small or medium in size. Many of these companies have little or no awareness of trade control laws or dual-use lists.
- There are limited resources to educate these companies and enforce trade controls
- Corruption also plays a role. Some Chinese officials have stated that corruption among Chinese officials with business interests complicates getting companies to comply with Chinese trade control laws and regulations.
- Western companies in China need to be extra vigilant!

Important Vulnerabilities of Illicit Trade Networks and Schemes

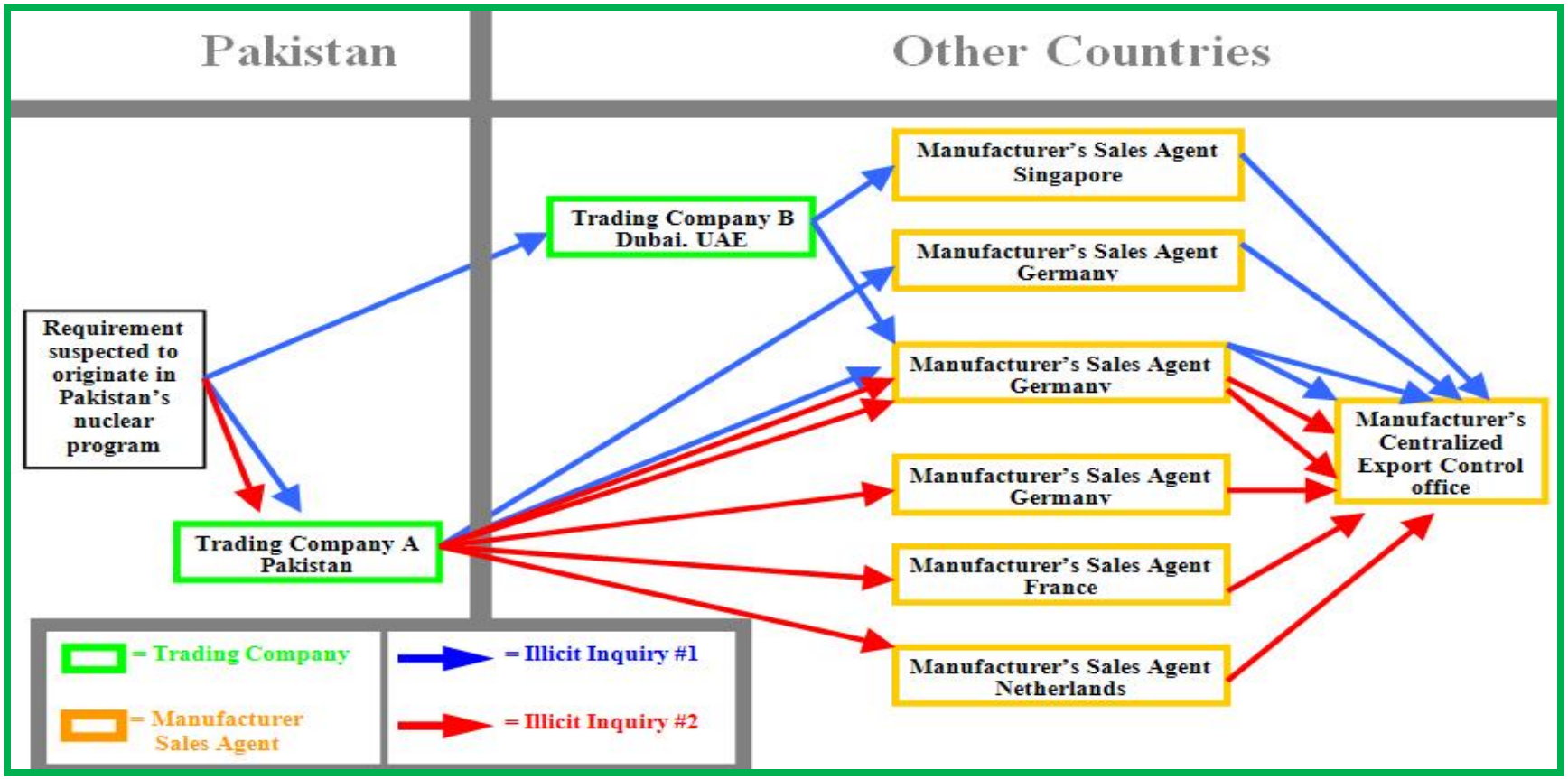
- The situation is not all bleak.
- Illicit nuclear trading schemes and networks have several vulnerabilities that authorities can exploit in order to track and disrupt networks and their agents and accomplices.
- Three important ones
  - Smugglers need to purchase specialized goods for nuclear programs that are available in a commercial market filled with legitimate suppliers; this market can be monitored, leading to the concept of a "watch list"
  - Proliferation entities leave visible traces as they try to acquire nuclear and dual-use goods and services from the open market. Companies and governments can detect these traces.
  - An illicit trade network can have "small world" characteristics, which in this case means that the supplier is not "far" from those nodes acquiring the items for a nuclear program. This helps explain the critical importance of cooperation between governments and suppliers to detect smuggling operations.

It's a Small World

Connecting lines omitted

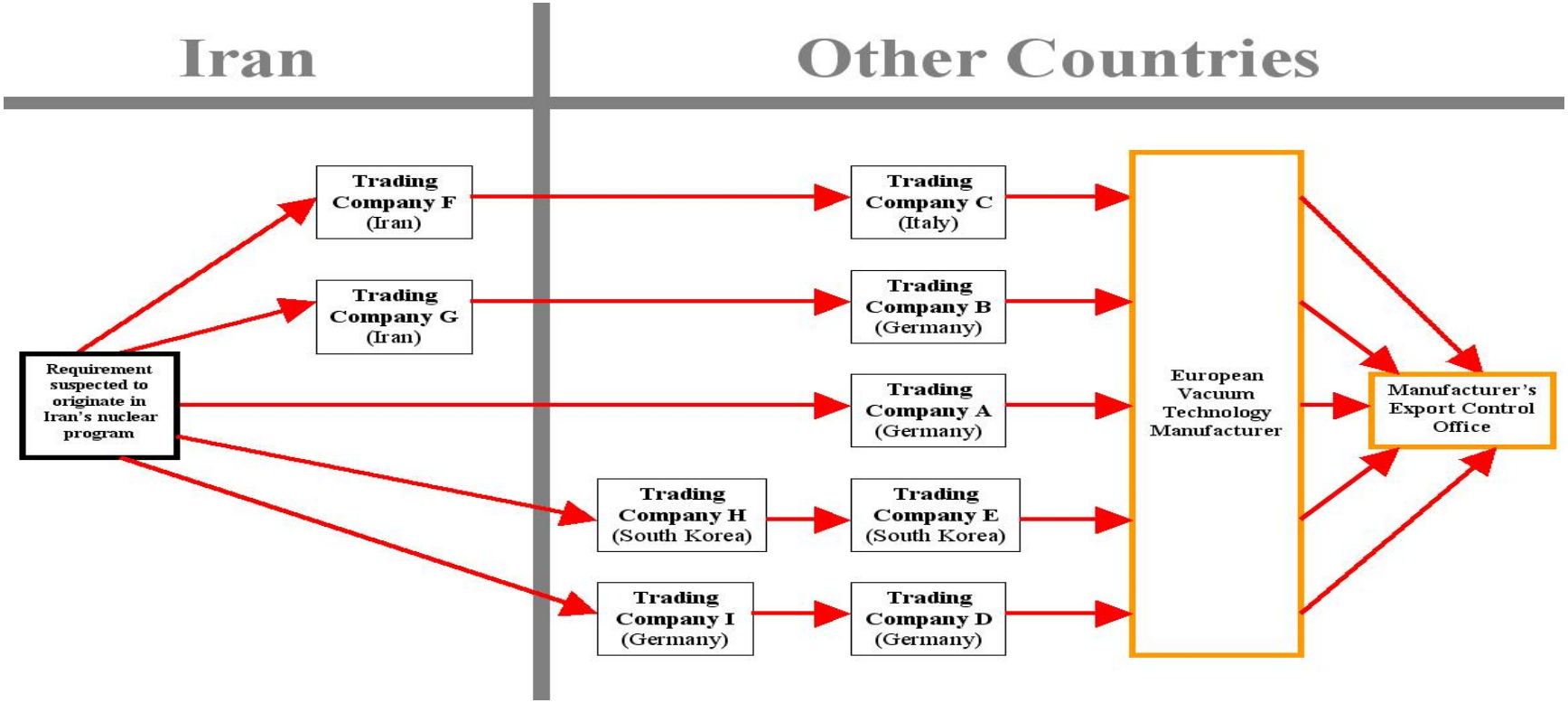


It's a Small World:
Company export control office can detect illicit nuclear trading scheme



Shows how procurement networks of countries use barrages of enquiries (requests for prices), even to multiple foreign offices of the same company, to fulfill requirements. This Pakistani nuclear-related effort was detected.

Visible traces in the form of enquiries to a vacuum company of an Iranian effort to obtain valves, judged for a centrifuge effort



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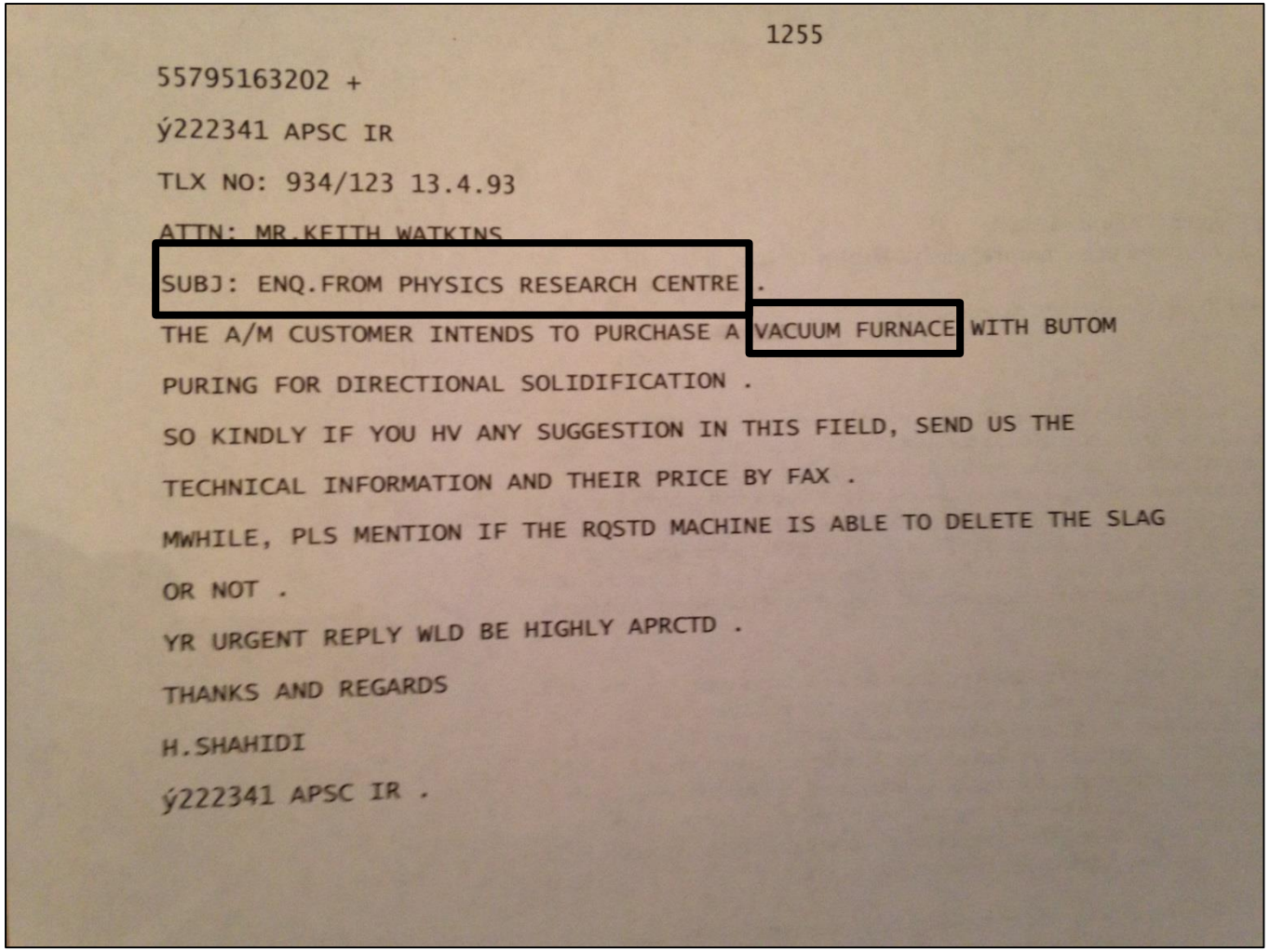
Enquiries from March 2013 **Detected** from a Pakistani Trading Company, seeking a Germany company to buy US goods for it

02.		Chrome steel bearing balls Dia: 4.000 mm	Nos	5000	VXB.com Ball Bearings, USA.

Likely for use in bottom bearing of gas centrifuge

1993 Physics Research Center **Intercepted** Request via an Iranian Trading Co. Applied Science Co. (potential supplier unspecified)



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TLX NO: 934/123 13.4.93

ATTN: MR.KEITH WATKINS

SUBJ: ENQ.FROM PHYSICS RESEARCH CENTRE .

THE A/M CUSTOMER INTENDS TO PURCHASE A VACUUM FURNACE WITH BUTOM PURING FOR DIRECTIONAL SOLIDIFICATION .

SO KINDLY IF YOU HV ANY SUGGESTION IN THIS FIELD, SEND US THE TECHNICAL INFORMATION AND THEIR PRICE BY FAX .

MWHILE, PLS MENTION IF THE RQSTD MACHINE IS ABLE TO DELETE THE SLAG OR NOT .

YR URGENT REPLY WLD BE HIGHLY APRCTD .

THANKS AND REGARDS

H.SHAHIDI

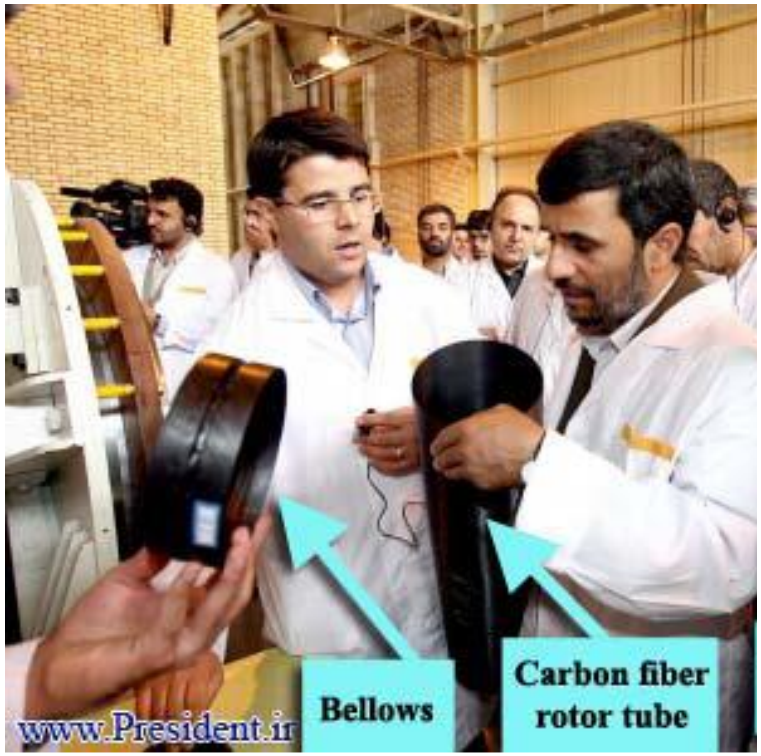
ý222341 APSC IR .

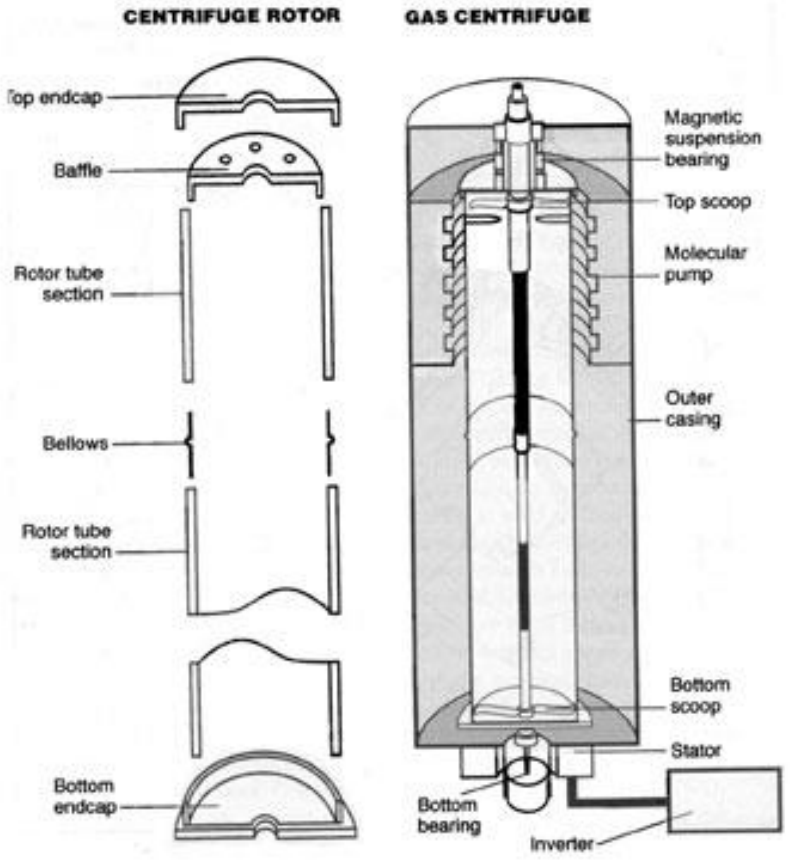
ISIS Course: highlights added

What is a Watch List?

- We use the term “watch list” to refer to a list of critical equipment used in a particular nuclear program. It is an important subset of the hundreds or thousands of specialized goods needed in a nuclear program, many of which are commonplace.
- The watch list serves as a guide to suppliers or governments of which goods to monitor in order to prevent sales or identify illicit procurement networks.
- A good on the list may or may not be on a control list; in fact, the list is not a control list.
- If a good is not on a control list, it is on the watch list typically because proliferant states have often sought this item for their nuclear programs.

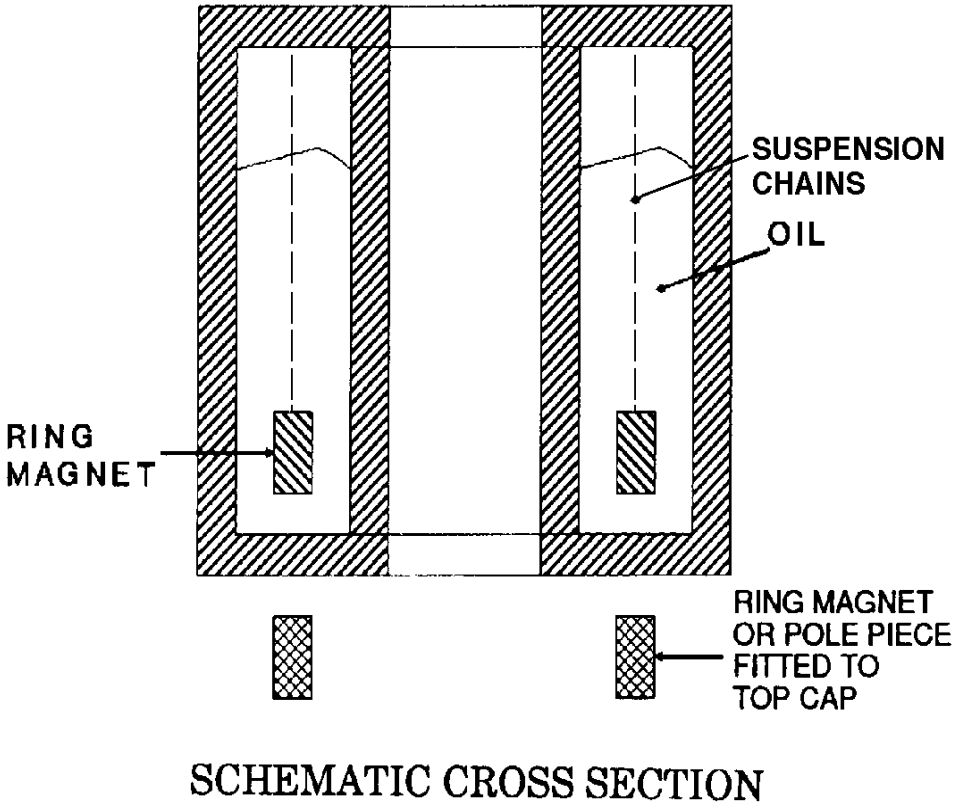
Items on Gas Centrifuge Watch List: Carbon Fiber





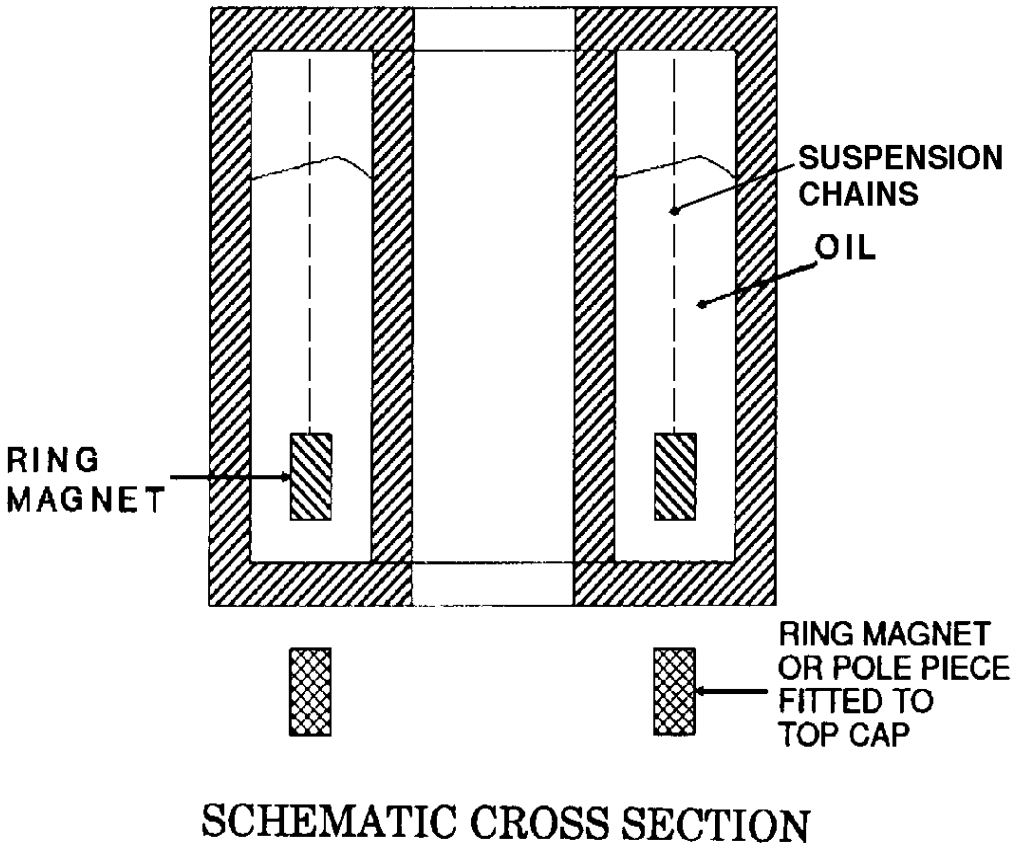
Source: Albright, D. and Hibbs, M., 'Iraq's shop-till-you-drop nuclear program', *Bulletin of the Atomic Scientists*, vol. 48, no. 3 (Apr. 1992), pp. 32 and 33.

Ring Magnets in Top Magnetic Bearing



SCHEMATIC CROSS SECTION

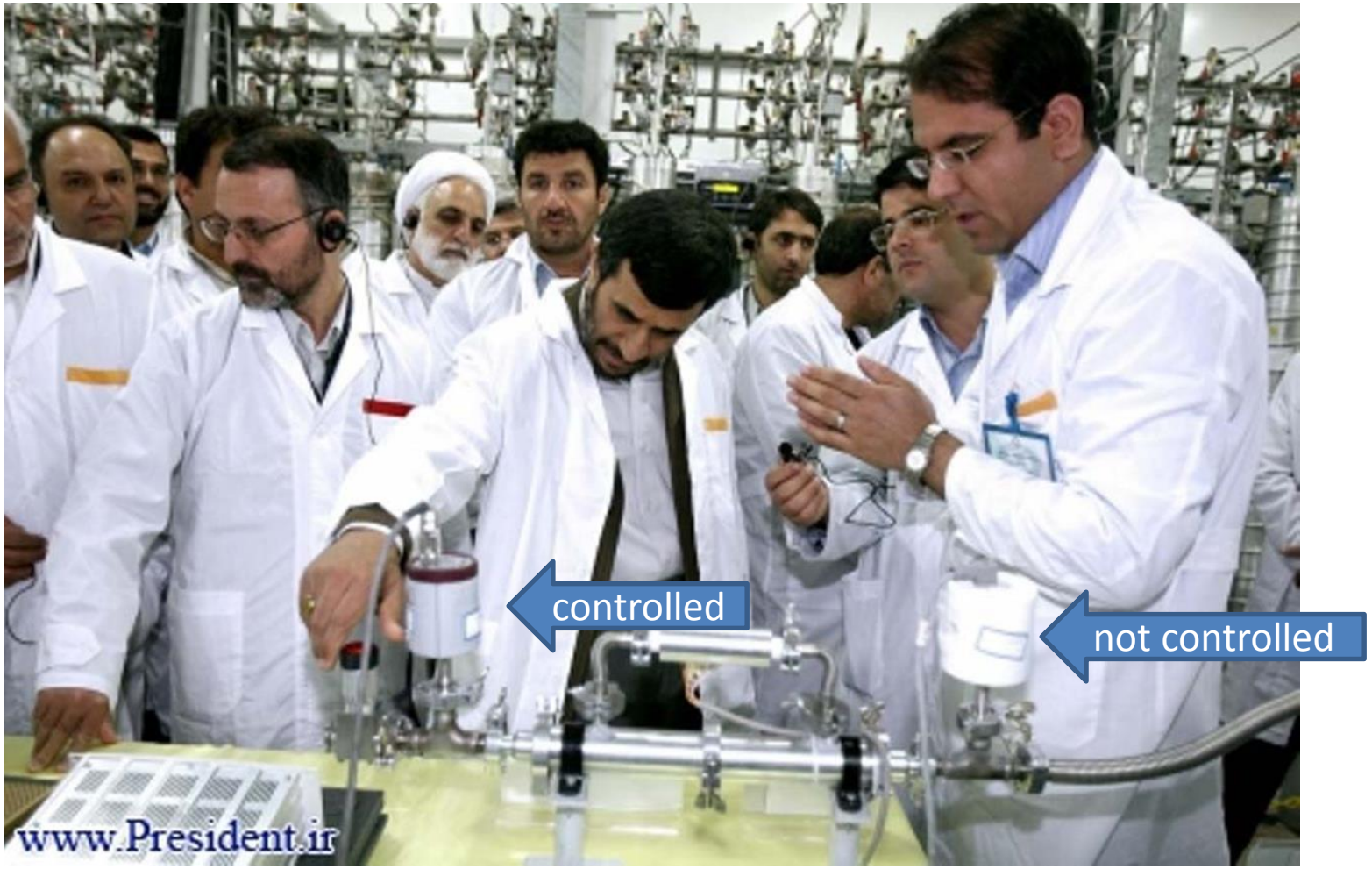
Centrifuge Ring Magnets-Distinctive Dimensions and Specifications



Centrifuge Cascades: Dual-Use Goods Involved

IR-1 Centrifuges in Cascades in Iran

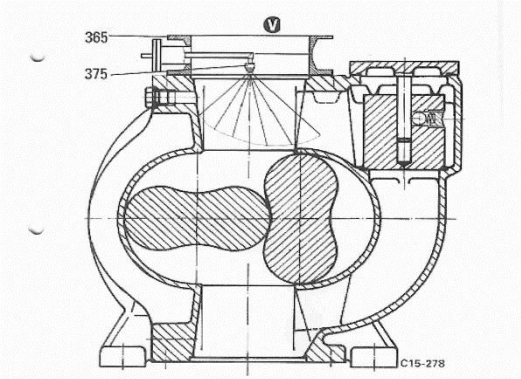

Pressure Transducer



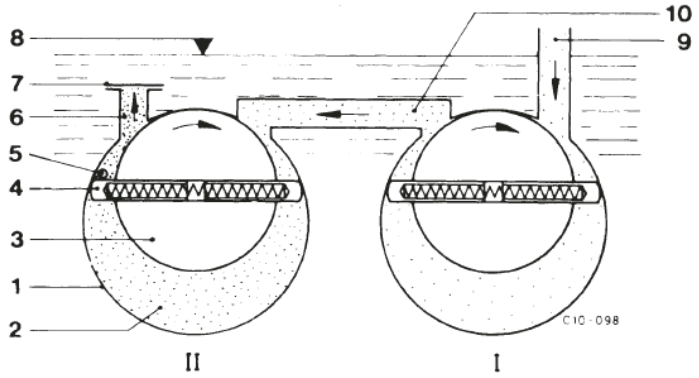
President Ahmadinejad examines gas centrifuge equipment, which includes an older MKS pressure transducer (next to his right hand) during a visit to the Natanz pilot fuel enrichment plant in 2008. In the background is an IR-1 gas centrifuge cascade which contains many more recent (mid-2000s) models of MKS pressure transducers. The MKS pressure transducers are controlled on dual-use lists; the white pressure transducer on the right in the foreground was not on the dual use list at the time it was sold to Iran.

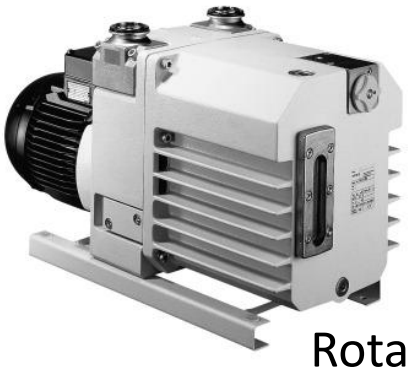
Source: Website archive of the president of Iran, www.President.ir

Roots and Rotary Vane Pumps



Roots Pump





Rotary Vane Pump
Two Stage

Partly Dismantled Bellows Sealed Valve

Process Gas Pipework
-Bellows Sealed Valves-

Watch List for Gas Centrifuges (illustrative, not exhaustive)

- Vacuum roots and rotary pumps
- Vacuum measuring equipment, such as pressure transducers and pirani gauges adapted for corrosive gases
- Corrosive gas flow meters
- High strength maraging steel
- CNC Flow forming machines, certain other CNC machines
- High strength aluminum alloy
- Aluminum extrusions of medium strength and of certain dimensions
- Frequency converters
- Bellows sealed valves
- Small fast acting shut-off valves
- Fibrous or filamentary materials
- Filament winding machines
- Perfluorinated lubricants
- Ring magnets
- Semi- hard magnetic alloys in strip form

FUTURE CHALLENGES

Future Trends in Smuggling

1. Over the next five to ten years, gas centrifuge uranium enrichment programs and reactors coupled with plutonium separation plants are likely to remain the preferred methods of making fissile material.
2. On-the-horizon technologies such as laser enrichment and lesser known methods of producing plutonium may emerge.
3. Information about technologies is spreading rapidly.
4. More advanced countries are unlikely to seek self-sufficiency in the manufacture of all the goods needed to make nuclear explosive materials or nuclear weapons, preferring to exploit the interconnected global marketplace.
5. Emerging markets with weak export controls and the growing capability to produce high-tech, dual-use equipment could develop important suppliers of high-tech dual use goods that will be exploited by smuggling networks.
6. Iran and North Korea could be major future suppliers of last resort, in addition to cooperating together on nuclear matters.
7. New transit points and proliferation financing hubs could emerge where these patterns continue.